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PURDUE IMPROVED COWPEA STORAGE (PICS) SUPPLY CHAIN STUDY

by

Jeanne Coulibaly, Stephen D'Alessandro,
Theodore Nouhoheflin, Casimir Aitchedji, Maiyaki Damisa,
Dieudonné Baributsa and J. Lowenberg-DeBoer

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November 2012

Abstract

The Purdue Improved Cowpea Storage (PICS) project was launched in 2007 with a grant from the Bill and Melinda Gates Foundation. The project was designed to help farmers access low-cost and chemical-free cowpea storage technology designed to store their cowpeas at harvest affordably, with minimal loss, in order to take advantage of seasonal price variability. One of the specific objectives was to develop supply chains for triple-layer plastic bags to make the technology available to farmers and provide opportunities to local businesses. To achieve the supply chain objective, the project has been pioneering investments in the development of factory-to-farm distribution systems across West and Central Africa. While notable progress has been made, project interventions have evolved over time, and experiences across the PICS countries have been uneven. This study provides an overview of the supply chain experience by country and some of the key lessons learned including: 1) PICS bags are well adapted to the storage needs of smallholder farmers, but not as well accepted by large scale grain traders; 2) the PICS incremental rollout strategy over five years allowed for learning in the early years to be incorporated in subsequent countries; 3) risk sharing strategies are needed for manufacturers and distributors of PICS bags; 4) agro-dealers are some of the best PICS vendors, but cell phone vendors and other entrepreneurs can be effective PICS retailers; 5) public sector institutions like national extension services are not well suited to sales of PICS bags, but individual public sector employees can be good vendors as a supplementary activity; 6) credit is not a key constraint for most PICS vendors, but low profitability and risk are; 7) first year reference price programs have substantial negative effects on market development in subsequent years; 8) crop forecasts are key to timely availability of PICS bags; 9) trademarking the PICS logo was a useful step, but it is not a substitute for patent protection; and 10) PICS project business consultants played a key role in market development which should be gradually shifted to the private sector.

Key words: supply chain, agricultural inputs, grain storage, hermetic, Africa, risk sharing, credit

JEL codes: O13, Q12

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PREFACE

The Purdue Improved Cowpea Storage (PICS) Supply Chain Study was co-authored by Jeanne Coulibaly, Stephen D'Alessandro, Theodore Nouhoheflin, Casimir Aitchedji, Maiyaki Damisa, Dieudonné Baributsa and James Lowenberg-DeBoer. Not every co-author visited every country. Coulibaly's focus countries for the supply chain study were Burkina Faso and Niger; Nouhoheflin studied Ghana, Mali, and Senegal; Aitchedji worked in Benin, Togo, Cameroon and Thcad; and Damisa in Nigeria. Baributsa and Lowenberg-DeBoer visted all the PICS countries as part of their leadership roles in the PICS project, but not specifically for the supply chain study. D'Alessandro worked with the Supply Chain Team to prepare for the on the ground data collection, joined them on the ground while in Burkina Faso, and worked with them to compile information once collected. He is primarily responsible for the Introduction in the study. The conclusions are a joint effort.

The reader will note that the study is divided into individual country studies and the writing style for each author is different and therefore, country reporting is different. Though the overall theme is the same for each country, what each team member evaluated to be most important to capture varies. For one, it may be the overall picture; for another, it was the individual interviews and their personal story. This variation in allows the reader to have an in depth and overall picture of the PICS supply chain on a business and personal level. Because each country study is kept intact as a chapter of the whole study, there is repetition of some key observations from one country chapter to the next. Rather than deleting repetition, it was decided to keep all of the information so that the reader could refer to one country as needed.

Throughout the study, many of the names of lower level participants have been coded to protect their privacy. Each country is represented by a letter and a number is assigned to each individual.

Benin	B
Burkina Faso	BF
Cameroon	C
Ghana	G
Mali	M
Niger	N
Nigeria	Na
Senegal	S
Tchad	Tc
Togo	T

The names that were not changed are prominent actors in the supply chain and their names are known in the industry.

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Of the many people who have participated in the preparation of the Supply Chain Study, the PICS Project is especially thankful to the Bill and Melinda Gates Foundation for their support throughout the project, to Laura Bergdoll, Carole Braund, and Heather Fabriès for compiling and editing the many versions of the report, and to all of the supply chain participants who were willing to give their time to talk with the supply chain consultants.

LIST OF ACRONYMS

3N	Les Nigeriens Nourissent les Nigeriens – Nigeriens Feeding Nigeriens
ABC	Agricultural Business Centers
ADP	Agricultural Development Program
ADRA	Adventist Development and Relief Agency
AFDI	Association for International Development
AGRA	Alliance for Green Revolution in Africa
ALS	African Livestock Security
ANCAR	Agence Nationale de Conseil Agricole et Rural
AOPK	Farmers' Associations of KABBIA
APA-Togo	Project for Self-Agricultural Promotion
APIL	Action Pour la Promotion des Initiatives Locales
APR	Association for Rural Promotion
ASSAILD	L'Association d'Appui aux Initiatives Locales de Développement
ATADER	Tchadian Association for Rural Development
AVDD-TOGO	Association of Dedicated Volunteers for Development in Togo
BAGCO	Nigerian Bag Manufacturing Company Plc
BC	Business Consultant
BELACD	Bureau d'Etude et de Liaison pour l'Action Caritative de développement
BICL	Betheven Industrial Company Limited
BNDA	La Banque Nationale de Développement Agricole
CAIMA	la Centrale d'Approvisionnement en Matériels Agricoles
CAR	Central African Republic
CARITAS	a confederation of Catholic relief, development and social service organisations
CCNI	Compagnie Commerciale du Niger
CDA	Chef de District Agricole
CDD	Diocesan Development Committee
CECADEC	Centre Chretien D'Appui au Developpement Communautaire
CECPA	Centre Communal pour la Promotion Agricole
CERPA	Centre Régional pour la Promotion Agricole
CeVuTCo	The Centre for Technology Extension for Conservation

CHANGE	Community Health And Gender Education Empowerment
CIC-B	Comité Inter professionnel des Céréales du Burkina
CLUSA	Cooperative League of the United States of America
CMDT	Compagnie malienne pour le développement du textile
CNFA	Citizens Network for Foreign Affairs
CNPC-C	National Confederation of Cotton Producers of Cameroon
COFISAC	Compagnie de Filature et de Sacherie
CORDAID	Christian Organizations in Relief and Development
CPC	Consumer Protection Commission
CRS	Catholic Relief Service
CRUS	Conseil Regional des Unions du Sahel
CSIR	Council of Scientific and Industrial Research
DDA	Direction Departementale de l'Agriculture
DNA	Department of Agriculture (Mali)
DRA	Direction Régionales d'Agriculture
EA	Extension Agents
EM	Emballage Miankala
FACEA	Force Associative pour la Culture, l'Elevage et l'Agriculture
FADEC	Fédération des Associations de Développment Communautaires
FAO	Food and Agriculture Organization
FASO	"Fatherland" in local language
FBO	Farmer Based Organization
FERT	Fondation pour l'Epanouissement et le Renouveau de la Terre
FIDA	Fonds international de développement agricole
FOB	freight on board
FoReVA	Fonds Régional de Vulgarisation Agricole
FUGPCV	Federations of GIC unions of cotton and food crops producers
GADD	Ghana Agro-Dealer Development
GAIDA	Ghana Agro-Dealer Association
GIE	Groupement d'Intérêt Economique
GOANA	Grande Offensive Agricole pour la Nourriture et l'Abondance
GPCV	GIC of cotton and food crops producer at the base
GRAMED	Groupe de Recherche et d'Action pour le mieux-être et le Développement

HYK	Yaya Kone
IARBIC	Intensification de l'Agriculture par les Boutiques d'Intrants Coopératives
ICAT	Institut de Conseil et d'Appui Technique
IER	Institut d'Economie Rural
IFDC	International Fertilizer Development Center
IITA	International Institute of Tropical Agriculture
INERA	Institut de l'Environnement et de Recherches Agricoles
INRAN	Institut National de Recherche Agronomique
IPS	Industrial Promotion Services
IPS-WA	Industrial Promotion Service—West Africa
IRAD	Agricultural Research for Development Institute
ISRA	Senegalese Institute of Agricultural Research
ITRA	Institut Togolais de Recherche Agronomique
ITRAD	Institut Tchadien de Recherche Agronomique pour le Developpement
JARDA	Jigawa Agricultural and Rural Development Agency
KNARDA	Kano Agricultural and Rural Development Agency
MEC	Mutuelle d'Epargne et de Crédit
MOFA	Ministry of Agriculture – Ghana
MVCP	Mission Volunteers against Poverty
NGO	Non-Government Organizations
NSCT	New Cotton Company of Togo
OBC	Open the Bag Ceremony
OCADES	Organisation Catholique pour le Développement et la Solidarité
OHVN	Office de la Haute Vallée du Niger
ONDR	Office National de Dévelopment Rural
OPVN	Office des Produits Vivriers du Niger
OVC	orphans and vulnerable children
PADAB 2	Programme d'Appui au Développement du Secteur Agricole au Burkina, phase II
PAFASP	Projet d'Appui aux Filière Agro-Sylvo Pastorale
PAPA	Programme d'Analyse des Politiques Agricole
PAPSA	Projet d'Amélioration de la Productivité Agricole et de la Sécurité Alimentaire
PNVRA	National Agricultural Extension and Research Program

PP	Polypropylene
P4P	Purchase for Progress
PRECAD	Projet de Renforcement des Capacités pour une Agriculture Durable
PRODIB	Professionalization of Agro-Input Dealers in Burkina
PSAOP	Programme Sectoriel d'Appui au Organisations Paysannes pour la production des semences
PTP	Project / Programmes of technical and financial partners in development
PVM	Millennium Villages Project
RCPA	Responsable Communal pour la Promotion Agricole
RENATA	Réseau National des Associations des Tantines
RID	Rural Infrastructural Development
RMCR	Réseau de Micro institutions de Croissance de Revenus
ROSOC	Organization of Civil Society Network
RRELG	Réseau Régional d'Expertise Genre
SAA	Sasakawa Africa Association
SARI	Savannah Agricultural Research Institute
SITCO	Sai International Tading Company
SON	Standards Organization of Nigeria
SONAGESS	Société Nationale de Gestion des Stocks et de Sécurité
SONAPRA	Société Nationale pour le Promotion Agricole
Tearfund	The Evangelical Alliance Relief (TEAR) Fund
TFP	The Technical and Financial Partners
UGPCV	GIC Unions of cotton and food crops producers
URCLEC	Renovated Union of Local Banks and Savings Credit
WASA-Ghana	West African Seed Alliance of Ghana
WDI	Women's Development Initiative
WFP	World Food Program
WV	World Vision

INTRODUCTION

Background

To raise productivity, reduce post-harvest losses, and increase rural incomes, smallholder farmers need new and better technology. Investments in improved seeds, crop protection, and storage solutions are important; however, the real challenge is getting these tools into farmers' hands when and where they need them most—and at the right price. To facilitate broad-based farmer uptake and mainstreaming of new technologies, effective, efficient and, ultimately, sustainable delivery mechanisms are needed.

In Africa, dissemination to farmers of agricultural innovations has long depended on top-down participatory extension approaches, non-governmental organizations (NGOs) and time-bound, donor-driven initiatives. While often effective in the short-term in promoting farmers' awareness and increasing adoption of innovative tools and farm management approaches, these programs are often quixotic. Many rely on subsidies to bring down costs and increase farmer access. Some have lasting impact on farmer behavior; however, most are unsustainable over the long run.

The challenge of mainstreaming innovations is nothing new, nor is it unique to the agricultural sector. What is new is growing interest among stakeholders in exploring alternative, market-driven delivery approaches to help smallholders to become more competitive and increase their incomes, and thereby improve rural livelihoods. How can the private sector in Africa be mobilized to disseminate agricultural technologies more effectively, more cheaply, and more sustainably? Where are possible entry points for enhanced public-private collaboration? What are appropriate strategies to balance risks and rewards? What incentives are needed to encourage buy in and galvanize commercial supply chain investments? Finding good answers to these and other questions is high on the development priority list.

In 2007, Purdue University launched the *Purdue Improved Cowpea Storage* (PICS) project, a five-year initiative supported by a grant from the Bill and Melinda Gates Foundation. The project was designed to help farmers access an innovative low-cost and chemical-free cowpea storage technology. PICS technology was designed to enable smallholder cowpea farmers to store their beans at harvest affordably with minimal loss in order to take advantage of seasonal price variability. The project's primary objective was to achieve an adoption threshold by 2012 for hermetic technology of 50% of on-farm cowpea stored in West and Central Africa. The project was given a mandate to: (1) determine the best design for a one-piece commercially available triple-layer plastic cowpea storage bag; (2) disseminate information on non-chemical cowpea storage methods to extension services, NGOs, and farmers; (3) demonstrate the most effective cowpea storage methods in the major cowpea areas; and, (4) develop supply chains for triple-layer plastic bags to make the technology available to farmers and provide opportunities to local businesses.

In line with this last objective, the project has been pioneering investments in the development of factory-to-farm distribution systems across West and Central Africa. While

notable progress has been made, project interventions have evolved over time, and experiences across the 10 PICS countries[1] have been uneven. A better understanding of the challenges, as well as opportunities that have the greatest potential to catalyze the future growth and development of PICS supply chains, is needed. More broadly, documenting the PICS experience can also potentially enhance the general knowledge base and contribute to improving the future deployment of agricultural technology in developing countries.

Goals and Objectives

The goal of this study is to document and learn from the project's experience in developing supply chains for PICS bags in West and Central Africa. This study is not an assessment of the PICS project overall—it focuses only on the project's supply chain development activities. Key objectives of the study are: (1) identifying and analyzing key constraints, risks and challenges to supply chain growth; (2) highlighting and assessing the value of investments by the project, its partners, and supply chain actors to expand the distribution system and increase bag sales; and, (3) making practical recommendations on prospective ways to build on the PICS experience to date and support the future development of PICS supply chains.

Hypotheses

Several hypotheses were developed based on the study's objectives to test against the data that would be collected during the data collection phase. These hypotheses are as follows:

H1. PICS technology responds well to the needs of smallholders for whom the bags were designed.
H2. Training and promotional activities led by the project and its local partners have been critical in stimulating demand for PICS bags.
H3. At $2-3 retail, PICS bags are affordable to the average smallholder farmer.
H4. Poor availability of PICS bags among rural farming households represents a formidable constraint to market development.
H5. Existing PICS distribution networks are based largely on informal business relationships and trust-based social capital.
H6. Poor access to credit among PICS vendors is a binding constraint to the growth and development of the supply chain.
H7. Existing full-line agro-dealer networks selling a range of complementary inputs such as seeds, fertilizers, and crop protection products offer optimal distribution channels to reach rural farmers.

[1] The PICS project is currently active in Benin, Burkina Faso, Cameroon, Ghana, Mali, Niger, Nigeria, Senegal, Tchad, and Togo.

Methodology

Pre-field preparation was initially informed by a comprehensive review of the PICS project documentation. This consisted of an extensive database of staff and field consultant trip logs, annual project reports, and scientific research studies, among other materials. The document review was complemented by a critical review of the literature, which highlighted considerable gaps in available research on the subject. Issues around supply chain development in the broader context of globalization are dealt with extensively, yet there is little relevance to the African agricultural context. Much of what is available focuses on the challenges and approaches of linking Africa's smallholder farmers to agro food output markets (Trienekens et al., 2003; Webber and Labaste, 2010). Equal attention has been given to evaluating returns (Alston et al. 2000; Birner et al. 2006) and identifying best practices within agricultural extension and advisory systems (Swanson, 2008; Swanson and Rajalahti, 2010). Rogers (2003) and others evaluate adoption behavior among farmers of new agricultural innovations and how to improve adoption rates of fertilizers and other productivity enhancing technologies (Crawford, Jayne, and Kelly, 2006; Bumb, B., M. Johnson, P. Fuentes. 2011).

In terms of input supply, considerable research has been devoted to identifying constraints that hamper input market development in Africa. These constraints are well-documented. On the demand side, cash-strapped smallholder farmers have limited access to information about productivity-enhancing technologies such as improved seeds, fertilizers, and crop protection products, as well as limited resources in which to invest. On the supply side, input vendors are hampered by, *inter alia*, underdeveloped financial and insurance markets, weak public institutions for contract law and enforcement, and poor infrastructure (Biggs and Shah, 2006). Lack of capacity to manage business risks and poorly developed road networks raise transaction and marketing costs, making it costly to do business. Dorward (2009) explores the impact of "smart subsidies" and other policy programs designed to stimulate production and improve food security, but which often reduce profitability and stifle private sector investments in input supply.

While some argue that farmer-based organizations offer part of the solution (Chambo, 2009), many are plagued by internal governance issues and moral hazard, among other challenges. Other studies focus attention on the need to support the growth of competitive agricultural input markets in Africa as elsewhere. Kelly et al. (2003) argue that donors should invest in upgrading public goods (e.g., legal and market regulatory institutions, transportation and communication infrastructure) that support agro dealers and that enable input markets to function. Others highlight the need for credit and micro-credit strategies to incentivize private sector investments in production and distribution of agro inputs (ECA, 2010). In recent years, Citizens Network for Foreign Affairs (CNFA), International Fertilizer Development Center (IFDC), and others have been investing in the development of competitive agricultural input supply systems by strengthening private agro dealers' networks; however, these efforts are not as yet well documented.

Case studies are an appropriate methodology early in a research program. When one does not know the right questions to ask, it is often better to document what is happening and ask

participants in the phenomena about the issues. Given the pioneering nature of the PICS experience and the paucity of existing research on the subject, a case study approach was adopted as the most appropriate analytical framework for the present assessment. To some extent, this drew from Prahalad (2004) exploring strategies to deliver innovative goods and services to economically marginalized, yet vast consumer markets. The case study approach is often used to explore, describe, and explain real life experiences where traditional statistical methods may be less appropriate. The case study methodology used in this research draws on social science and the business method and is structured along the lines defined by Yin (2003).

Because the objective of this research is to provide an in-depth understanding of the PICS supply chains and not to derive statistical inferences, an information-oriented selection strategy was preferred to a rigorous random sampling in the selection of informants for the case study. Typical subjects (i.e., average, representative actors) and outlier subjects were included in the sample to capture more thoroughly the stage of development of the supply chain in each country. The subjects were selected based on trip reports, interviews with Purdue staff, and input from PICS business consultants.

Information was collected largely through a broad-based consultative process emphasizing key informant interviews with project staff and supply chain participants in each of the ten PICS countries. PICS bag manufacturers, vendors (i.e., wholesalers, semi-wholesalers, retailers), partner NGOs and research institutes, PICS business consultants, and other relevant actors were interviewed to solicit input. The PICS team at Purdue provided support during the duration of the study (e.g., data collection, travel facilitation, data analysis). Preliminary findings were presented to stakeholders at an April 11-13, 2012, workshop in Accra, Ghana. Feedback received during the workshop was incorporated into the analysis and is reflected in this report's conclusions.

To facilitate the data collection efforts, a set of analytical tools was developed. These included: (1) customized interview guides for each type of actor; (2) illustrative maps depicting the organizational structure of the supply chain in each country; (3) timelines of major milestones and events that contributed to their development; (4) analyses of margins and costs across the supply chain; and, (5) geographical maps depicting the footprint of vendor networks. These tools also facilitated the analysis of the case studies to identify similarities and divergences in experiences across the 10 PICS countries.

The initial analysis of the data collected and stakeholder input offers some valuable insights for the future rollout of PICS technology and potentially other agricultural innovations. First, the PICS triple-ply, hermetically sealed storage technology was designed specifically to meet the needs of a specific market segment: smallholder cowpea farmers for on-farm storage. Evidence of strong and growing demand for PICS bags across the region suggests that the technology responds well to their needs. Along with this, the project's progressive rollout over five years (2007-2012) and ten countries allowed for an expanding knowledge base and refinement of strategies for improved impact. While agro-dealer networks can be effective distribution channels, other vendor types can be equally effective in getting PICS bags into farmers' hands. In terms of constraints to supply chain growth, the evidence suggests that lack

of access to institutional credit does not in itself constitute a binding constraint to supply chain growth; rather, high interests rates and the slow rate of turnover of PICS bags discourages vendors from using borrowed capital to finance their inventory. Finally, first year price-setting programs designed to protect consumers and discourage market speculation can significantly dampen investment in the supply chain, especially among downstream vendors. This, in turn, impinges on market availability of PICS bags in rural areas. This study will explore these and other lessons learned.

Outline of the report

The next chapter presents the case studies. Each case study documents the PICS experience in one of the ten countries where the project has been active in West and Central Africa. Each highlights: (1) the current situation of the supply chain; (2) the evolution of the supply chain, including major milestones and various investments by the project, its partners, and other actors that contributed to expansion of distribution networks and to increase in the volume of bag sales; (3) some of the key challenges to growth, as well as opportunities to ensure future sustainability; and, (4) the key lessons learned based on the analysis of the overall PICS experience in the country. The study concludes with a cross-country comparison analysis highlighting similarities and divergences in the PICS experience across the ten PICS countries, major achievements, and some prospective recommendations for the future of PICS activities and the commercial deployment of other agricultural innovations.

BENIN

Presentation of PICS supply chain case study

Benin has an annual production of cowpea that represents three percent of the total production of West and Central Africa. It exports primarily to Nigeria and Gabon. Benin was selected as one of the ten initial PICS-targeted countries. The PICS project was initially implemented in Benin during the 2009-2010 cropping season. The major components of the project include: (1) the technical component, consisting of awareness building, conducting public demonstrations, monitoring farmers who stored cowpea in PICS bags, and organizing public the "open-the-bag events" (OBC) by Centre Régional pour la Promotion Agricole (CERPA) with assistance of the International Institute of Tropical Agriculture (IITA); (2) the marketing and communication component, led by the business consultant/journalist; and, (3) the sale and distribution of the bags led by the national distributor, Mr. Léopold Gansou, with the support of the business consultant. The outreach activities were conducted by CERPA with technical support of IITA during the 2009-2010, 2010-2011, and 2011-2012 cropping seasons.

Current situation

Mapping out the supply chain

Gansou is the national distributor of PICS bags in Benin since 2009. He sourced the bags from Lela-Agro, the manufacturer of PICS bags in Kano, Nigeria. Only one order has been made so far: 25,000 bags ordered by Christian Organizations in Relief and Development (CORDAID), which included 12,700 bags for Togo delivered at the Benin-Togo border at 850 FCFA/bag. From the border, the bales of bags were received by a team from IITA-Cotonou. The bales were exempted from tax because of IITA's classification as a non-profit organization in Benin. For the first order, Gansou directly invested 20% of his capital (or 4,250,000 FCFA) and the PICS project lent 80% (or 17,000,000 FCFA) in 2009, according to the terms of contract signed by the two parties. Funds paid by Purdue University are reimbursed by Gansou gradually as long as sales continue. Note that Gansou still owes Purdue a total amount of 5,400,000 FCFA based on information received from him.

The distribution of the bags was based on a network developed by Gansou, composed of traders and collectors of maize and other food crops across the country. Gansou's employees, his parents, and friends were also part of the distribution network. Thecurrent network is considered deadlocked, as there are no records of the inventory and no periodic reports. In Gansou's network, the sale of PICS bags is considered as a secondary activity, with very little commitment and motivation of actors involved in the distribution. Their primary activity is the commercialization of grain and other food products. There is also a lack of motivation of agents involved in Gansou's distribution network (semi-wholesalers and retailers). Since the 2010-2011 cropping season, there was a strong involvement of facilitators and technicians from CERPA in the network as semi-wholesalers and retailers in North Benin. This is the case of B1 (CERPA Parakou) and Benin Retailer 2 (CERPA Natitingou).

Supply chain actors

The supply chain of Benin is composed of Gansou as the wholesaler and some semi-wholesalers who interacted with him. For the distribution of PICS bags, there is a group of semi-wholesalers who are directly connected to Gansou and the in-country partners. This group received the bales of PICS bags from Gansou for distribution to other semi-wholesalers preselected in their regions or localities. For example, Benin Retailer 3 (from SONAPRA (Société Nationale pour le Promotion Agricole)-Parakou) was a semi-wholesaler for the northern region of Benin. He stored the bales in his house and then distributed them to other semi-wholesalers. Benin Retailer 4, a semi-wholesaler located in Bohicon (department of Zou-Collines) received the bales of bags directly from Gansou and distributed them to other semi-wholesalers of these departments. She stored the bales at the maize warehouse of Bohicon. To distribute PICS bags in villages and make them available and accessible to small famers, each semi-wholesaler works with a sub-network of retailers in village.

The development of the PICS bags supply chain started in Benin in 2009 with the PICS project. The main actors were the national distributor (Gansou), semi-wholesalers, retailers, NGO, and the in-country project partners. Currently, the supply chain in Benin is blocked, without any forseen solution. There is no entry of new actors in the distribution chain since 2009 and no tracking record about the procurement and the sale of the bags with the national distributor. The main actors involved in the project at the implementation are:

Purdue University: International Coordination

Purdue University is the promotor of the PICS project and the key actor in the creation of the distribution chain of PICS bags in Benin in 2009. With the support of IITA, Purdue, represented by Dr. Jess Lowenberg-DeBoer, identified Gansou as the national wholesaler of PICS bags in Benin and Togo. A contract was signed in 2009 to make this collaboration official.

In an effort to interest private sectors in the distribution of the bags in Benin, Purdue University initiated an incentive program at the beginning of the project. It provided a significant direct financial support to the distribution chain by providing 80% of the initial investment to the national distributor to procure the bags from Lela Agro, the manufacturer in Nigeria. This debt vis-à-vis Purdue was cleared gradually as long as the sales were evolving in Benin and Togo. Purdue also acted as a moral guarantee for the wholesaler vis-à-vis the manufacturer Lela Agro. Purdue linked up Gansou and Lela Agro in a business relationship. It was within this framework that the sales representative of Lela Agro, Mr. Ahmed Kaumi, visited the wholesaler in 2009 to discuss the technical and logistics arrangements associated with the contract.

The PICS project itself was a volume buyer of PICS bags in 2009-2010, 2010-2011, and 2011-2012. To motivate and strengthen the development of the chain, the project purchased about 5,839 PICS bags (or 47% of the first order of bags) at a retail price of 1,000 FCFA from the wholesaler, semi-wholesalers, and retailers for public demonstrations. Purdue University, in collaboration with IITA, hired a business consultant named Mr. Corneille Yehoume for a two-

year contract (2009-2011) to help all stakeholders involved in the sale and distribution of the bags to establish and expand the distribution network. Purdue University had provided funding through IITA and CERPA to technical activities to create and stimulate the demand for PICS bags. These activites include sensitization, public demonstrations in villages and markets, OBCs, training of NGOs, and journalists. Similarly, several media activities were initiated and financed by the project, including television spots, radio ads, newspaper messages, and media coverage of OBCs. All these activities have strengthened the diffusion of information about PICS technology across the country in 2009-2010 and in 2011-2012.

To strengthen the supply chain actors and to increase the odds of sustainability of the distribution network of PICS bags, the project also financed the training of semi-wholesalers on PICS technology. Purdue University has also overseen the overall project activities, including the tracking of bags sales and the development of the chain. To ensure good coordination, the Team Manager based at Purdue, Dr. Dieudonné Baributsa, has travelled extensively to Benin for follow-up.

IITA: Regional and National Coordination

The International Institute of Tropical Agriculture (IITA) is the regional partner of PICS in West and Central Africa (covering the countries of Benin, Togo, Nigeria and Cameroon). IITA has a sub-contract with Purdue for this function. This coordination is overseen by Dr. Abdoulaye Tahirou, based at IITA-Ibadan (Nigeria). Dr. Ousmane Coulibaly has coordinated specific activities in Benin and Togo. A team was set up to conduct the training of facilitators and technicians, as well as to monitor the outreach activities, including sensitization, demonstrations, and OBCs. A journalist consultant, Mr. Emmanuel Tachin, was recruited by IITA to organize the media component of the project.

CERPA: National Partner for Outreach Activities in Benin

CERPA is the research and extension branch of the Ministry of Agriculture in Benin. Benin has six administrative departments: Atacora-Donga; Borgou-Alibori; Zou-Collines; Oueme-Plateau; Mono-Couffo; and Atlantique-Litoral. Each department contains a CERPA branch to oversee the research and extension activities in that department. The CERPAs are the national technical partner of PICS in Benin. Each CERPA has signed a contract with IITA to conduct the outreach activities of PICS bags. A total of 946 villages were selected to implement PICS activities in 2009-2011. The technical support of CERPAs was essential for the training of actors and, therefore, for the sustainability of the distribution network. Today, some CERPAs have included PICS activities as part of their portfolios of their annual program.

Lela Agro: PICS bag manufacturer (Kano, Nigeria)

PICS bags sold in Benin were imported from Kano, Nigeria by the wholesalers with the collaboration of IITA-Benin. After production, the bags were delivered by Lela Agro at the Benin-Nigeria border with the supervision of Kaumi, the commercial representative of Lela Agro. Due to IITA's agreement with the government of Benin, the bags were exempted from taxes.

Gansou: PICS bag national distributor in Benin

Gansou is a businessman. He is involved in many business activities, including trading cereals (maize, soybean, cowpea, and groundnut); national and international transportation; and distribution of PICS bags, among others.

For the distribution of PICS bags, Gansou worked closely with two collaborators: Mrs. Odette Akoutou and Mr. Gerome Oniyi. Gansou was selected by Purdue University in 2009, and he subsequently signed an agreement with Purdue as the main distributor of PICS bags in Benin. He was suggested by O. Coulibaly. Before the PICS project, he had developed his own network to buy grains across the country. This network is composed of relatives, friends, grains traders, and producers in villages and towns close to big food crop markets. As a volume seller, he buys, stores, and sells grains and legumes such as maize, cowpea, and groundnut across Benin and Togo. His major customers include the World Food Program (WFP), the national food security department of some countries in West Africa, and other volume buyers.

He assigned the supervision of the PICS bags distribution in Benin and Togo to one of his assistants, Mr. Patient Akoutou. She has been working with Gansou for many years. She knows all the actors in the network. She is also involved in other activities in the Gansou network apart from PICS business. The headquarters of Gansou's enterprise is located in Cotonou. For the distribution of PICS bags, he held a batch of PICS bales in Cotonou (Southern part of Benin), another batch in Bohicon (Central region) and the last one in Parakou (Northern region of Benin).

Yehoume: Business Consultant

The business consultant was hired by Purdue to assist in the supply chain development. His name is Coffi Yehoume. He worked with the wholesaler, the semi-wholesalers, retailers, and the other project partners.

Semi-wholesalers

The supply chain of PICS bags in Benin included approximately 31 semi-wholesalers. They are spread in all regions in the country, though mainly located in the cowpea growing areas. They were suggested and selected on prior experience and business relationships. They were responsible for the supervision of the sales, order, control, and all challenges in the supply chain. They were also responsible for working with the semi-wholesalers and retailers they proposed. These key persons are:

1. Gansou, national wholesaler, based in Cotonou: He proposed many persons from his existing cereals network as semi-wholesalers of PICS bags. The semi-wholesalers included those in Parakou, Kandi, Natitingou, Savalou, Bohicon, and Dogbo. The selected persons are parents, relatives and friends.
2. Corneille Yehoume, PICS business consultant, based in Cotonou: He proposed semi-wholesalers in Allada, Abomey, Mono, Couffo, Cove, and Kandi. The selected persons are his parents, relatives and friends.

3. Benin Retailer 3, semi-wholesaler: He is the semi-wholesaler based in Parakou (Northern Benin). He is a friend of Gansou and has been proposed by him. He had also proposed some semi-wholesalers/retailers from many districts such as Parakou, Savè, N'Dali, Perere, Banikoara, and Segbana.
4. Akoutou: She is a collaborator of Gansou and had proposed one semi-wholesaler based in Ifangni (department of Plateau).
5. Oniyi: He is a collaborator of Gansou and had proposed two semi-wholesalers based in Ketou and Pobe (department of Plateau).

The semi-wholesalers can be classified into three categories:

1. 1st category: Collectors, stockers, and vendors of cereal and other grains crops; members of Gansou's cereal network;
2. 2nd category: Friends and family members of Gansou, Yehoume, Akoutou, and Oniy;
3. 3rd category: PICS facilitators of CERPA.

The main sites of semi-wholesalers are:

1. Parakou: Benin Retailer 3 is the semi-wholesaler working at SONAPRA-Parakou (national cotton society) as the Regional Director of Operations. He carries out PICS business on top of his primary job in SONAPRA. He was a classmate of Gansou and is currently a member of Gansou's cereal business network. He works with his wife on grains trade and PICS bags distribution. He developed his own network of retailers to sell the PICS bags, and is the main focus point for PICS bags in Northern Benin. He directly oversaw PICS bags distribution in the department of Alibori (one semi-wholesaler) and indirectly in the departments of Donga (one semi-wholesaler), Atacora (one semi-wholesaler), and Borgou (one semi-wholesaler);
2. Glazoue: B5 is a grains trader and is part of Gansou's cereal business network. He was selected as a semi-wholesaler by Gansou. He covers the department of Collines;
3. Bohicon: B4 is a grain trader and belongs to Gansou's cereal business network. She is Gansou's sister and was selected as the semi-wholesaler of PICS bags, covering the department of Zou;
4. Abomey: B6 worked with women associations in rural areas in Abomey. She is the spouse of Yehoume and was selected by the business consultant as a semi-wholesaler of PICS bags. She became a community queen and she didn't have time for PICS bags, but she has a collaborator, B7, who takes care of the business. The area covers is the city of Abomey in the department of Zou;
5. Pobé: B8 is a grain trader. She belongs to Gansou's cereal business network. She is a relative of Oniyi. She was selected by Oniyi as a semi-wholesaler of PICS bags. She covers the entire Plateau department and part of Oueme department;
6. Ketou: B9 is a grain trader who is part of Gansou's cereal business network. She was selected as a semi-wholesaler of PICS bags by Oniyi and covers the department of Plateau;
7. Ifangni: B10 and B11 are semi-wholesalers of PICS bags. B10 is the brother of Akoutou and is a teacher in a secondary school. B11 is a small trader of different products. They

belong to Gansou's cereal business network. They were selected by Akoutou to become semi-wholesalers of PICS bags for the region of Ouémé;

8. Allada: B12 is a trader who has a small shop. She was selected by the business consultant Corneille Yehoume as a semi-wholesaler of PICS bags in the department of Atlantique. She is a close relative of Yehoume;
9. Azovè: B13 belongs to Gansou's cereal business network. He was selected by Gansou to be a semi-wholesaler in the departments of Mono and Couffo; and,
10. Lokossa: B14 was selected by the business consultant as a semi-wholesaler to lead the distribution of PICS bags in Mono.

Retailers

There are more than 100 retailers operating in cities and villages. They were self-motivated to distribute PICS bags and were suggested by some semi-wholesalers or the wholesaler. They ordered bags from semi-wholesalers and sold them directly to farmers. There are different categories of retailers: agro-dealers who were suggested or self-motivated; extension agents (EA) of CERPA; and friends and family members (not necessarily interested by PICS business) of Corneille, Benin Retailer 3, Akoutou, and Oniyi.

Volume Buyers

The volume buyers included the PICS project, NGOs, cowpea traders, government, and development projects. To implement project activities, the PICS project bought a large quantity of bags for demonstrations in Benin and Togo from the semi-wholesalers. The bags were entirely financed by the project fund.

Three local NGOs in the department of Atacora/Donga in Northern Benin were involved in PICS activities. They use the bags for public demonstrations in their target zones. They bought 600 bags in 2011. The three NGOs included: (1) Ensemble pour le Développement, which covers Natitingou; (2) Groupe de Recherche et d'Action pour le Mieux-Être et le Développement (GRAMED), which covers Tanguiéta; and (3) Réseau Régional d'Expertise Genre (RRELG), which covers Cobli. Those NGOs benefited from funds from financial and technical partners of Atacora-Donga through a comittee called Fonds Régional de Vulgarisation Agricole (FoReVa). FoReVa funds small extension projects in Atacora-Donga. CERPA Atacora-Donga is involved in this financial partnership. FoReVa received funds from development partners and made a call for proposals. The three NGOs received small grants of 1,500,000 FCFA each, with projects on PICS technology diffusion. The main activities carried by the NGOs were sensitization, public demonstrations, follow-up, and public OBCs.

Some traders bought PICS bags. For example, Akoutou said that one trader, a friend of Gansou, bought 200 bags to store grains.

They attended PICS project activities such as sensitization or demonstrations. They are the main end users of PICS bags in Benin. Individual farmers buy a few PICS bags each to store

cowpea, maize, and Bambara nuts (woandzou). Farmers' associations and women associations were also associated to the spread of PICS bags in Abomey.

Current major issues at each level of the chain

The inadequacy of the distribution network used to distribute PICS bags

The existing network of Mr. Gansou is specialized in the collection and purchase of grain and other food crops during the harvest period. This network consists of buyers of food crops and not sellers of ag inputs. It is, therefore, not suitable for sale of PICS bags. Early in the process, actors selected for the distribution of the bags have set aside the sale of PICS bags to take care of their main business. This has completely paralyzed the entire distribution system.

Selection of the actors: Wholesaler, semi-wholesalers, retailers

The selection of actors in the network is critical for the success and sustainability of the distribution chain of PICS bags. In Benin, actors selected in the chain were poorly chosen. Indeed, they are busy and focused on other activities. They do not have a personal motivation to actually sell PICS bags. This is shown by the lack of monitoring for bags placed on consignment. The quantity of bags sold by each actor remains unknown by the semi-wholesaler and even by the national distributor.

Delays and technical and promotional activities of PICS technology

Delays were observed during the implementation of outreach and demonstration activities in 2009-2010 cropping season. The low achievements of the first year demonstrations were a weakness for development of the supply chain. In some villages, the demonstrations did not take place as planned in the first year because of flooding.

The multiplication of outlets for PICS bags and the large quantity of bags PICS placed on consignment at the implementation of the project in 2009

The approach used by PICS is to lead simultaneously in both technical and promotional activities in the first year of the project. This approach did not work with a multiplicity of outlets observed across Benin. Too many bags were placed with retailers that first year. Because the technology was new, the sale of the first year was very low; consequently, semi-wholesalers and retailers were left with large stocks of unsold PICS bags at the end of the 2009-2010 cropping season. This was a source of disincentive and an overall lack of interest observed across the chain until now.

Problems related to the marketing and communication component

The delays and weaknesses observed at the marketing and communication side were caused by several factors. The communication activities did not happen concurrently with the technical activities; consequently, the expected effects of commercials, radio advertisements, and

interactive programs have not been met. Another gap noted is the absence of television spots on PICS bags.

Complaints relating to reference prices set during the first year

The prices set in the network during the first year (2009-2010) were 925 FCFA/bag for the semi-wholesaler and 1000 FCFA/bag for the retailer. These reference prices were broadcasted. For example, the bags were delivered to Benin Retailer 3 at 925 FCFA/bag who sold them to retailers at 1000 FCFA/bag. Gansou gave instructions about the compliance with the reference prices across the chain. Fixing the price along the distribution chain prevented sellers from speculations, but the price cap at each level of the chain was an important disincentive factor for actors during the second year. Even through the PICS team at Purdue did not enforce reference prices the second year, they were continued by other partners.

Rupture of PICS bag stock

Stock ruptures occurred in some regions, districts and villages, but distributors tried to move the stocks of bags from one place to another. For example, at Abomey, Benin Retailer 6 said that he had experienced rupture problems at some selling points, but had overcome this quickly by going to other outlets to pick up some bags. In the North Benin departments of Parakou and Natitingou, there were some cases of ruptures observed in the network of Benin Retailer 1 of CERPA Borgou/Alibori and Benin Retailer 15 of CERPA Atacora/Donga.

Total absence of reliable methods to track inventory and monitor the sales

In the current context of network congestion, there is no reliable method that can be used to do the general inventory. There is no explicit relationship between the actors and no delivery voucher. The network was based exclusively on social relationships. Actors can easily complain with the amounts reported by the wholesaler or declare continually missing bags in bales because initially the quantity of the bags was not checked. The wholesaler has placed the bags on consignment during the first year with no followup and feedback. He did not bother to collect the money from semi-wholesalers and retailers in the chain.

Complaint about missing PICS bags in bales

Lela Agro delivered bales of 300 bags, but in some bales, there were some missing bags. The amount of missing bags varied from five to ten per bale. There were also some surpluses, but surpluses were very rare. Some bags were damaged during the baling.

PICS direct financial support during the first order

PICS project provided direct financial loans to the wholesaler at the first order. This support was to help the launch of the supply chain and motivate wholesalers to invest in PICS bags, but his support did not encourage wholesalers to take any risks. There is little leverage for Purdue to encourage Gansou to repay the capital invested by the project. If the wholesaler were responsible to reimburse 80% directly to Lela Agro, the pressure of repayment would be much higher and the wholesaler would commit himself to collect the money and pay the manufacturer.

Funds reimbursement to Purdue by the wholesaler

The non-repayment of funds to Purdue hampered the sustainability of the supply chain because Purdue was not willing to invest further in PICS bag procurement in Benin. This situation has led to the ruptures observed in Benin and Togo.

For example:

1. Gansou made a deposit at the beginning: 20% (4,250,000 FCFA)
2. The total amount of bags ordered and delivered : 21,250,000 FCFA
3. Lela Agro reimbursed Purdue 3,206,264 FCFA for over payment
4. After the payment of bags used for demonstration and some bags sold, Mr. Gansou started reimbursing Purdue:

   1st reimbursement : 8,000,000 FCFA

   2nd reimbursement : 2,000,000 FCFA

   3rd reimbursement : 1,600,000 FCFA (August 24th, 2011)

   Reimbursement remaining: 1,229,100 FCFA

Failure to transfer funds from sales to the wholesaler

The cash from sales from 2009 to 2012 were not transferred to the wholesaler. In most cases, funds have been stuck with semi-wholesalers and with some retailers. The main reason is the lack of coordination and monitoring of the sales in the wholesaler's distribution network. The unavailability of the wholesaler's bank account to semi-wholesalers to wire funds is a weakness. This is an important element which favored the non-repayment of funds by the semi-wholesalers and retailers. Some examples are:

1. Benin Retailer 3 in Parakou: When asking him whether he has paid back Gansou, he called his wife who said that no one showed up to pick the money. She said still having a sum of 60,000 FCFA. There has been no inventory, so she did not have exact figures.
2. Benin Retailer 12, a semi-wholesaler at Allada (Atlantique): At the beginning of PICS activity, she received, with hesitation, 300 bags. She did not record the quantity of bags sold except for the demos, where 126 bags were bought to serve the villages at Toffo and 143 for demos at Allada. The current inventory is about 30 bags. She still keeping the money from the sales with her because no one showed up to ask for.

Thin margin issue with semi-wholesalers

The sale of PICS bags is profitable if they are sold in bulk; otherwise, the transaction cost (including transport and phone calls) is higher, and the activity becomes less profitable. Most actors said the sale of PICS bags is a service rendered to the community given the advantages of the bags. The interviews indicate that the semi-wholesale margin is considered relatively low (75 FCFA/bag).

Poor cowpea harvest

During the 2009-2010 cropping season, cowpea production was not good due to flooding in some villages. This is the case in the region of Abomey, the valley of Ouémé and some parts in the northern region of Benin. In addition, there were difficulties in accessing certain villages where cowpea is mostly produced.

Evolution of the supply chain and major milestones

Wholesaler: Gansou

The main role of the national distributor is to lead the distribution of PICS bags in Benin and Togo by making the bags available to end users everywhere. Gansou relied on his cereals network to distribute PICS bags. There were many widespread actors in his cereals network. Gansou knew the semi-wholesalers across the country but did not know the retailers or the new semi-wholesalers proposed by the business consultant. As such, it was challenging for him and his team to do frequent inventory or to collect money back from semi-wholesalers in the first year of the project. Moreover, his major activity is to buy grains from the semi-wholesalers who, in reality, act as the regional collectors of grains and legumes (soybean, cowpea, groundnuts), not as sellers of ag inputs to farmers or ag dealers. Gansou has a transport company for public transportation at both the national and international level. PICS bag distribution, in fact, is the opposite of his traditional activity, which consists of collecting grain from semi-wholesalers (or central collectors) located in specific places in Benin. He did not know actors involved in the distribution at the downstream of the chain—in particular, the retailers. On top of these weaknesses, he did not devote enough time to PICS activities, especially in the monitoring of the bags distributed; therefore, he did not have concrete information regarding PICS activities from 2009 onward, which included a lack of data on sales, the status of the supply chain, and the major challenges faced by actors in both procuring and selling PICS bags. The consequences were the ruptures observed in certain locations, low sales of PICS bags, and a lack of new orders due to the mismanagement and lack of coordination. The overall situation is static, confused, and complex. No actor wanted to bear the responsibility of the current status of the supply chain.

Since 2009, Gansou made only one order of 25,000 bags, which included 12,300 bags for Benin and 12,700 bags for Togo. No more bags have been ordered since then because, according to Akoutou, the first order is not totally sold; given the current status of the sale of the bags, Gansou was not motivated to invest again. During the interview, Gansou said he was discouraged by PICS bags business. He said that he had lost more than 1,500,000 FCFA in PICS business. He is willing to invest when the situation becomes clear.

Gansou's enterprise has two warehouses in Cotonou (one in Vedoko and one in Agontinkon). The bales of PICS bags were stored in the Agontinkon warehouse and then were moved from Cotonou to Bohicon and stored at the warehouse of "Maizerie" in Bohicon for dispatching.

No financial report was available regarding the recovery of the funds. Only bags used for demonstrations were charged and paid for by IITA. The quantity of bags used for demonstration in Benin is 5839 bags, for a total amount of 5,839,000 FCFA (1000 FCFA/bag). In Togo, the quantity of bags used for demonstration is 6,250, which represents an amount of 6,250,000 FCFA. On top of this, 250 bags were added for market demonstration, but this extra quantity was not yet paid for.

Semi-wholesalers

There were different types of semi-wholesalers: (1) members of the Gansou's team involved in the cereal or other food crops; (2) Gansou's collaborator; (3) Gansou's friends, relatives, and wife; and, (4) preview partners in other businesses. Their role was to dispatch PICS bags to retailers in villages and in major cowpea markets. The remaining bags are still with some semi-wholesalers. There was no person designated to collect the funds from the semi-wholesalers. The majority of them have never submitted a financial report or an inventory. Most of the semi-wholesalers still have the money of the sales.

Several reasons may explain the current situation of the supply chain. First, the process by which people were selected as key actors in the supply chain may have suffered from some shortcomings. This selection was essentially based on social network with no formal agreements or legal documents showing the clear roles and conditions of work and collaboration. Related, there were no documents recording the exact quantity of PICS bags delivered to each semi-wholesaler and retailer. Second, the wholesaler and, in certain circumstances, some semi-wholesalers, chosen were not really the appropriate persons to lead the PICS business. Many of them had no background on PICS technology, nor the marketing, business, and communication investments made by the project. They were not agro-dealers; the majoritywere involved in a cereal and grains business with Gansou. Third, there were many people involved in the supply chain at the very beginning of the project. The distribution of the bags started with a lot of people at once, not progressively. Fourth, there are some important costs, including transportation, communication, labor, and taxes. These costs made the business less profitable for actors; as such, many of them refused to invest these additional costs to make the supply chain more functional. Fifth, there were some problems of communication among actors and some misunderstandings of the roles of each actor. Last, there was difficulty in keeping inventory and recovering funds due to the lack of monitoring. The network was not really designed to lead an activity like PICS business.

According to the supply chain actors interviewed, there were a few main reasons that caused the failure of the supply chain: First, the demonstration activities were not well done. Second, the information spread to producers was not well done. Third, there were inadequate linkages between technical activities (i.e., sensitization, demonstrations, OBCs) and marketing, communication, and sales of PICS bags.

Fourth, the semi-wholesalers did not take the business seriously because the bags were placed on consignment. They did not want to invest their own money, so they did not take care of the stock management and did not see the necessity to make an inventory and periodic reports to Mr. Gansou or his team. One example of this is B4; Gansou sent the bales of bags to B4's store in Parakou using his truck. In turn, B4 distributed them to semi-wholesalers and retailers in

the departments of Borgou and Alibori. B4 identified relatives and friends of his (or of Yehoume or Gansou) as retailers instead of traders or sellers. The bags were delivered to B4 on consignment. In turn, B4 has also dispatched the bags to retailers and semi wholesalers on consignment. A second example is the semi-wholesalers B10/11 in Ifangni (Oueme). According to B10/11, the poor sales of the bags are explained by:

1. Low level of adoption of PICS bags because farmers were accustomed to using cans and metal drums to store cowpea;
2. Most farmers growing maize and not cowpea. Those who bought the bags used them for maize storage;
3. The extension strategy not working well because the technician who was trained by the PICS project was assigned to Adjarra, another location. He did not lead the demonstrations until the end. The person who replaced him was not trained in PICS technology. The demonstrations were not done in all target villages or markets. Only ten PICS bags were sold through a technician who has worked in Adjarra. Apart from this example, no further requests to purchase PICS bags have been expressed through the extension agents. The technology was not well disseminated.
4. Villages are distant from each other; it is very difficult to go from village to village to deliver the bags.
5. Farmers complained they do not have money and want to buy the bags on credit.

Retailers

Retailers are the most numerous part of the distribution chain of PICS bags. They are located everywhere across the country. Most retailers were identified by semi-wholesalers. They received the bags on consignment. Some retailers are traders of agricultural inputs who are interested in selling the bags as an agricultural input. Using cash, they buy small quantities from the semi-wholesalers and sell in the markets.

One example: B16 is a retailer of PICS bags in Parakou. He was proposed by Yehoume, an old friend of his from when he rented an apartment from the Yehoumes in Parakou. B16 is a businessman who has a farm of 100 ha in N'Dali and a grocery in Parakou. For his sales strategy, he placed part of the bags at his shop in Parakou and kept the rest on his farm in N'Dali, giving him two outlets known by farmers because he is an ag inputs dealer. B16 had experienced rupture problems. To overcome this, he redirected his customers to B3. Sometimes, he went to B3's shop to get the bags for certain customers who lived far from Parakou. According to B16, the business consultant was not very committed to the work. B16 had asked Yehoume from the beginning whether or not to go to remote villages to sell the bags, and Yehoume told him to wait until technicians finish with demonstrations. For B16, this was not the best strategy to sell a new product. He said he was embarrassed by Yehoume's answer concerning the sale. Unfortunately, the sale has not evolved as expected. This raised some questions: How were demonstrations done? Why have the demonstrations not created the demand for PICS bags? Normally, producers and traders should ask for the bags, but this was not the case. Was the extension work not well done? Does the information reach the potential users? For B16, the demonstrations were not well done. B16 said that the system put into place did not work, and that he was surprised that no one came to claim for the money from the sale. He was told by Yehoume that one day people will come to ask for the money; however, Benin

Retailer 3 (B3), who gave him the bags on consignment, never asked for the money. B16 received many positive testimonials about the effectiveness of the bags. He gave the example of a lady who appreciated the bags but mentioned that the bags should be kept away from rodents. B16 does not know the wholesaler and has never attended any PICS training; he simply relies on the posters to inform and introduce the technology to customers. Regarding the margin, he said the margin is small relative to expenses incurred (i.e., phone calls, transportation costs for delivery and monitoring). With respect to the reimbursement of the funds, he had sold all the batch of bags he received but no one claimed for the money so far. There is nobody who came to track the inventory. Normally he had to go to B3's store and pay the money but B3 himself did not even asked him about the evolution of the sale.

Business consultant

The main activities carried out by the business consultant to develop and strengthen the PICS bags distribution network were:

1. Contribute in developing the supply network;
2. Periodic visits of semi-wholesalers to ensure quality control using the micrometer, price control, and market control (i.e., concurrent product, price, quality of the bags, etc.);
3. Obtaining feedback of vendors, semi-wholesalers, and retailers related to perceptions of bags, complaints, faulty bags, and the availability and accessibility of PICS bags;
4. Collecting information on the evolution of PICS bags sales to avoid rupture, including quantity received, quantity sold, and quantity remaining;
5. Monitoring the amount of PICS bags ordered (from retailer to semi-wholesaler); and,
6. Seeking new opportunities for the sale of PICS bag by meetings with cereal vendors, NGOs, Responsable Communal pour la Promotion Agricole (RCPA), and extension agents.

Volume buyers

The PICS project has purchased a large quantity of bags for public demonstrations in 946 villages. A total of 5,676 bags (six per village) were bought. In addition, 155 women groups received bags for demonstrations. Three bags were given to each group, totaling 465 bags. The bags were purchased directly from the semi-wholesalers and/or retailers. Payment of the bags for demonstrations was made by IITA Ibadan directly to Gansou. Profit margins have not yet been distributed to semi-wholesalers and retailers, which has created frustration and disincentives.

B7 is a member of the NGO FACEA (Force Associative pour la Culture, l'Elevage et l'Agriculture)-Benin. He is a collaborator of a semi-wholesaler of PICS bags. FACEA-Benin is an NGO that purchases basic and certified seeds and distributes them to farmers for multiplication. As a test, they bought four PICS bags to store cowpea seeds and it worked properly.

Sensitizations were done for women's groups about the benefits and use of PICS bags:

1. "Gbénonkpo" at Agblomèlevi (Abomey);
2. "Semevo" at Detohou (Abomey);
3. "Houenoussou" (Abomey) of B7;
4. "Yagbo" at Goli (Abomey); and,
5. “Akouegninou" at Adandokpodji (Abomey).

These groups have bought about 200 bags for cowpea storage. "Gbenonkpo" is the reference group in the use and promotion of PICS bags. They performed activities such as awareness building, demonstrations, marketing, and advertisement. The sale of bags is a good business, and the group is willing to continue with this business. According to B7, if agricultural production is good, producers and traders will always need the bags to store cowpea.

The Centre for Technology Extension for Conservation (CeVuTCo) is an NGO founded in 1994 and registered in 1996. Mr. Adoho is the President of the NGO for a term of 5 years. The NGO is represented across Benin. It focuses on the diffusion of storage and processing technologies. The sensitization, demonstrations, and OBCs have created a strong demand for PICS bags for CERPA Bohicon and also for Centre Communal pour la Promotion Agricole (CECPA) at district level. Mr. Djaho, well-informed about the actions of CeVuTCo, approached Adoho, who quickly seized the opportunity of distributing PICS bags. Since the 2010-2011 cropping season, CeVuTCo ordered and distributed 1000 bags. The orders were made through the business consultant and Benin Retailer 6 (BR6) using cash and credit. No debt was recorded to date. Adoho also attempted to contact Gansou without success. The NGO has ordered 200 additional bags through the business consultant and BR6, but there was a late delivery because of the high demand. The NGO distributes bags through the CERPA and its field technicians, the facilitators of the NGO who work directly with farmers in villages, and farmers’ networks. The NGO received the bags at 1000 FCFA/bag and sold at 1100 FCFA/bag. Buyers of the bags are producers and traders. Adoho said that his NGO can be a major distributor of bags in the province of Zou-Collines and even throughout Benin. Adoho said he planned to visit Lela Agro in January 2012 but his schedule was tight and he was not able to make it. He said the NGO can invest around 20 million FCFA for PICS activity. The NGO deals with the Bank of Africa. Adoho said that the margin is very low and transaction costs are high, so he wants to contact the manufacturer directly to negotiate the terms of the business and reduce intermediate costs.

The Technical and Financial Partners (TFP), operating in Atacora-Donga provinces, created the Regional Fund for Agricultural Extension (FoReVa), managed by the Coreva (Regional Extension committee) to contribute to extension services. CERPA plays a key role in this Committee. FoReVa issued a call for proposals on topics related to the extension. Three NGOs submitted projects on extension about PICS technology under the sponsorship of CERPA Atacora-Donga. The proposals were accepted, and each NGO received a grant of $1,500,000USD (or 4,500,000 FCFA total). The NGOs are Ensemble pour le développement from Natitingou; GRAMED from Tanguieta; and RRELG from Cobli.

The main activities of the NGOs are public awareness, public demonstrations, monitoring, and public OBCs. Each NGO has ordered 200 bags for public demonstrations in the villages for 200 pilot farmers in their intervention areas. The 600 bags were ordered using cash

through the business consultant. The fund was directly wired in the bank account indicated by the business consultant, Mr. Cornelle Yehoume.

The NGO Regional Network of Local Expertise-Gender (RRELG) has been involved. The agent of CERPA (main office) of Atacora-Donga is responsible for the promotion of women activities and rural youth. She is also the president of the NGO. She is president of a network composed of several organizations, including CERPA, Education, Health, Civil Society, Women's Association, Farmers Groups, and PTP (Project/Programs of technical and financial partners in development). The mission of this network is to work to reduce gender inequalities in Atacora / Donga. The network's activities are trainings, sensitization, mentorship, and monitoring of women in the management of credit received. For demonstrations, one bag is given per farmer for free. After the demos, the extension continues, but the major problem encountered is the availability of PICS bags. It is not recommended practice for a CERPA officer to sensitize people for bags that can't be found in the market. To allow full adoption of PICS technology, semi-wholesalers and wholesalers must commit themselves accordingly.

200 bags were sold to a business woman who is a friend of Mr. Gansou. She used the bags for cereals storage in 2009-2010. She collects, stores, and sells grains like Gansou.

Project partners

CERPA

CERPA suggested that the PICS project needed to be supported—and that the support of Purdue needed to be proactive to help the distribution network to be strong and sustainable. The role of the business consultant is very important for the sustainability of the supply chain. According to facilitators from CERPA, despite the termination of the business consultant's contract, he continued working for the PICS supply chain because many people continued to rely on him to procure the bags. The wholesaler should be involved in the payment of the service provided by the business consultant by supporting for the first year 25% of his honorarium, then increase progressively to 50%, 75% until the full support of his honorarium.

B1 of CERPA BORGOU ALIBORI

Benin Retailer 1 began with PICS bags business through the insistence of the producers who asked consistently for the bags at his shop. To obtain the bags, he has repeatedly called Yehoume and Gansou to negotiate a stock of bags for sale. He gave the bags to technicians on credit basis, and, after the sale, they pay him back and request another stock for sale.

B2

B2 is a facilitator of PICS project in the Department of Atacora. She is an extension agent of CECPA Natitingou. On top of her role as a facilitator of technical activities of the PICS

project, she became a distributor of PICS bags in Atacora because of the high demand of the bags which were not available to farmers. She informed the business consultant about this issue without success, so she decided to collect the bags from B17 and gave them to facilitators. This strategy worked. B2 said selling PICS bags had not worked because B17, the semi-wholesaler, just stored the bags in her shop. B2 went in her store to pick up the bags and distribute them in the various districts to extension agents working for the project. B2 received the approval of the business consultant before picking up the bags from B17. In total, she received 378 bags (23 November 2010) and 80 bags from another retailer. In total for 2010-2011, of the 378 bags received, 130 bags were sold and 248 bags remain. The inventory of 2011 was not yet done by the retailers. She sold directly to Mr. Allomasso (PICS /IITA) 100 PICS bags for demonstrations in the markets as part of PICS activities in 2011. After the sales in 2010 and 2011, she sent the money to the business consultant via Western Union: 130,000 FCFA in 2010 and 120,000 FCFA in 2011, for a total of 250,000 FCFA. She received the bags at a price of 925 FCFA/bag on consignment and sold them at 1000 FCFA/bag. Her distribution network is composed of CECPA farmers and traders.

Challenges faced in developing the supply chain

Challenges faced by PICS project

The choice of the wholesaler

The PICS project selected a wholesaler who had a rural network but who is apparently not interested in the PICS business. Gansou is used to other types of markets, ones with large margins. The margin on the PICS bags is too small for him. It is a big challenge for the project to have a good and motivated distributor. Another challenge is the problem of information and communication between actors and end users. The problem of monitoring and continuing public demonstrations by extension services (i.e., CERPA, CECPA, NGOs) after the project to maintain and increase the potential demand is also an important one. There are some efforts from the extension services to achieve the diffusion of PICS technology. The current distribution network developed was not able to distribute PICS bags efficiently from wholesalers to end users. The demand for PICS bags was created by public demonstrations and radio messages. As such, the potential demand exists; however, the PICS bags are not available and accessible to the end users (i.e., farmers and traders). There is a real problem of follow-up because Gansou's team is not capable to give the exact data of PICS bags inventory.

The choice of semi-wholesalers

B3 says he did not have time to monitor the sale of the bags and to track the inventory at the downstream of the chain. He added that the margin is too low and he cannot afford to travel for monitoring. B16 reports directly to the business consultant. BR18 reports directly to Akoutou, collaborator of Gansou. B3 participated in the formation of semi-wholesalers. B3 noted that retailers who are close to him can easily provide feedback compared to those who are distant. Because of the thin margin, retailers are not willing to incur any additional cost to report. He added: "When you want to diffuse a technology, someone has to pay the price. It is not the economic operator who will bear this cost". If the technology is well known, the

turnover rate may be high even though the margin is small. He criticized the fact that Gansou must bear certain expenses (20% down in advance, freight costs, taxes, etc.). Since the technology is not yet known, the extension service must work ensure that the technology becomes well-known. This extension approach is not appropriate for the distribution of PICS bags. This has frustrated actors involved in the sale of the bags and affected the demand.

Reference price

The reference price is not a good strategy for the sale of the PICS bags. It limits the dealers and does not motivate them to make efforts for marketing, communication, and distribution. After the withdrawal of Purdue University, it is more than obvious that prices will adjust to the market demand.

Challenges faced by partners

CERPA and IITA

Collaboration among institutions is an important challenge. The actors need to work together to reduce the transaction costs. For instance, IITA can carry out a study to show the structure of the transaction costs (i.e., taxes, transport, corruption) and indicate where costs increase. IITA and Programme d'Analyse des Politiques Agricole (PAPA) can collaborate to carry out some studies on PICS bags. The main problem is the application of the recommendations of the studies by the government and stakeholders involved in the chain.

PICS bags commercialization is a risk for distributors because it covers only three months in the year (October, November, and December). The solution is to assist the distributors through subsidies to reduce the cost of production or the import cost. An analysis is necessary to understand the cost structure for importing PICS bags from Nigeria to Benin in order to increase the margin for semi-wholesalers and for downstream actors.

Gaining a subsidy of PICS bags to promote the large use of PICS bags is a challenge. The government can decide to subsidize the bags, but it is necessary to ensure that the decision affects all institutions involved. The agricultural policy and government policies (taxes and subsidies) need to take into account the fact that PICS bags activity is seasonal.

Another challenge is corruption; this was a problem along the road during the delivery of the bags from the manufacturer in particular at the border.

The delivery of bags to different outlets was challenging for CERPA. CERPA often relied on technicians or paying the taxi fare to dispatch the bags to various locations. The tracking of the inventory and sales is not cost-effective. Facilitators relied on phone calls to get updated information about the sale of the bags.

During the first and second year of PICS, the distribution system set up did not work. It was difficult to get the semi-wholesalers involved in PICS bags sale as mentioned in radio messages.

There were frequent delays in the delivery of the bags by the project partners. He said he was not happy with the business consultant because there were pressures from NGOs and sponsors. The bags were delivered by public transit two months later after the order. B15 noted that the big problem today is the unavailability and inaccessibility of PICS bags in the market for producers, traders, NGOs and other users. For him, the technology worked well, but the bags were not available for sale on site during the OBCs and demonstrations.

B15 and his team discovered counterfeit bags in the market of Materi, Cobli, and Tanguiéta. The thickness of these bags was below 80 microns. The woven bag did not have the PICS logo on it. B15 said that the bags came from Burkina and cost 200 FCFA. A sample was taken to show the project team at Purdue.

Media (Radio)

The impression was that the media budget was not high enough to be able to do a proper campaign promoting the PICS bags. There is also a need to use a good communication agency to design and execute a good plan of marketing and communication corresponding to the activities of project.

Challenges faced by other actors

Transportation and dispatching of PICS bags to semi-wholesalers

The transportation of bags was an important problem for the wholesaler and the semi-wholesalers. The wholesaler used his own vehicles to dispatch the PICS bags through the network when it was possible and available. In addition, it was very difficult for the wholesalers to dispatch the PICS bags within the network because of the high transportation costs, which offset the margin.

Retailers

The consultant mentioned that he had started selecting some small vendors as retailers of PICS bags, but he was told to stop because Purdue found that travel costs were too high.

Transportation and Handling

The truck of Gansou was used to transport the bales of PICS bags from Cotonou to Bohicon and Parakou. A small truck was used to dispatch the bags to semi-wholesalers in some districts. The transportation cost was not estimated, only the semi-wholesaler tips for the gas.

Strategies developed to encourage private actors' investments

Financial support to the wholesaler (around 17,000,000 FCFA) was provided at the beginning of the project to help the wholesaler procure the bags. This fund was gradually repaid by the wholesaler.

PICS bags were purchased from the semi-wholesalers and retailers for demonstrations. The PICS project, through IITA, has purchased around 5,839 PICS bags from the wholesaler for demonstrations conducted by technicians of CERPA.

A business consultant was hired by the PICS project to help the wholesaler in the development of the distribution chain. Along witht his, a media consultant (journalist) was recruited to organize and handle the communication component of the project in Benin, which included radio spots (awareness, demonstration, monitoring, OBCs, and marketing), radio broadcasts, interactive shows on radio, and print media coverage media of the main activities.

Several training courses were organized in 2010 and 2011 for PICS semi-wholesalers. Technical activities of the project to create and stimulate the demand for PICS bags were used as well, including awareness, demonstrations in the villages, OBCs, markets demonstrations, and training of NGOs and journalists. Media activities included radio spots, video, newspaper articles, and media coverage during the opening ceremonies.

Challenges and opportunities to supply chain sustainability

Challenges

Restore the current situation of PICS bags distribution

Gansou wants to continue distributing PICS bags as a wholesaler. He said if the inventory and financial reporting were done by semi-wholesalers, they could get back their margin (profit). The major challenges encountered were: (1) availability and accessibility of bags; (2) engagement and responsibility of actors; (3) training of actors; (4) margins issues; (5) transportation issues; (6) delays in technical activities; (7) low cowpea production; (8) Communication and marketing issues; and, (8) inventory issues.

Overcoming the Rupture issue

Actors were aware that there were ruptures of PICS bags in certain localities. Some of them overcame this by getting the bags from the semi-wholesaler, while others redirected customers directly to the semi-wholesalers.

Adjusting to the withdrawal of the PICS project

The private sector does not put its money into a low profit activity. According to Benin Retailer 16 (B16), the PICS bag is not yet well-known. Once the end users become familiar with it, the selling price will reflect all the input costs of the bag. At this moment, businessmen will automatically invest their money in this business without hesitation. According to B16, if he were to procure the bags with his own capital, he would plan on a profit margin of 15 to 20% as a semi-wholesaler.

Solutions to expand the supply chain via increased investments

To expand the supply chain of PICS bags in Benin, the actors suggested many ideas, including: finding a new national wholesaler who is motivated by the margin and can meet the market demand and monitor the sale; improving the flow of information by collecting information directly from producers, retailers, extension agents at villages and districts, and from semi-wholesalers, extension services, and the wholesaler from both the provincial and national level; mapping out the supply chain to get a good picture of the distribution network, the demand at each level of the chain, and to easily track the inventory and plan the orders; improving the availability of bags through better network organization; andpromoting community storage of cowpea through inventory credits.

Potential solutions proposed towards involving the government and civil society were named, including: subsidy on PICS bags--if the price is too high, the poor farmers can't afford despite its advantages; communication--the phytosanitary services must sensitize farmers and rural communities on the health advantages of using PICS bags; and involving NGOs--national government, public services, NGOs, farmers associations, women associations, and local government each have a key role to play, as PICS technology is a solution for the public health problem. If all these partners work on information and communication aspects, the PICS bags will be well known.

Another potential solution named was building a supply chain with professionalism through:

1. Assessing the demand for the bags at all levels

   Village → District →, Province → Wholesalers
2. Continuing the training → information (text, calls) →professionalism
3. Developing a feedback system about the sale of the bags to make timely orders.

To boost and sustain the distribution network, actors must redefine the distribution system and work with local NGOs involved in agricultural activities to distribute the bags to end users. They must also seek an appropriate funding mechanism to enhance public awareness campaigns, radio ads, TV, reward vendors, vendors, and large users.

Key lessons learned from country experience

The choice of a well-established wholesaler with an existing network is not necessarily a guarantee for success of the chain. It is best to work with people that can create a network. The selection of the main actors in the supply chain is a determinant for the development, evolution and sustainability of the supply chain. PICS bag distribution cannot be developed by a wholesaler as secondary activity. The key lesson is that the PICS supply chain will be develop by actors who consider PICS bags business as a primary activity and are self-motivated to invest. The main criteria to consider with good wholesalers are:

1. The availability to do the business;
2. Self-motivation in distributing PICS bags;
3. Experience and skills in agricultural inputs business in rural areas;
4. Being knowledgeable on (and familiar with) PICS bags;
5. Having necessary capital to order bales of PICS bags; and,
6. Having, or being capable of developing, a network of semi-wholesalers based on objective criteria.

A good mechanism for coordination, monitoring and planning between Purdue University, IITA, CERPA, media partners, and the business consultant is an important success factor for the distribution chain of PICS bags.

Self-motivation, a good perception of the PICS bags business, and a good understanding of the inputs market by the wholesaler and the actors in the network are key determinants for the success and sustainability of the supply chain. In the case of the Benin network, actors are not motivated; they considered selling the bags as a secondary activity.

The use of distribution network based on social relations is a force for the success of the chain in Benin, but it is not sufficient to get the bags to the end users on time. Trainings and vendors' meetings, in particular, for the semi-wholesalers, strengthen the distribution network. A mechanism for strengthening stakeholders is essential for the sustainability of the chain. The training of semi-wholesalers and the creation of a platform linking up all the actors of the chain are essential for better coordination and to expanding the distribution network. In Benin, the majority of semi-wholesalers did not attend any training; neither has met to discuss major challenges of the supply chain, to plan the order of the bags and to track inventories.

The establishment of a flexible, efficient and effective monitoring system may help boost the sale of PICS bags. The business consultant and the sales representative of the wholesaler were expected to play this role in the network. The consultant's role is very crucial in the development and evolution of the supply chain. The choice of the business consultant must take into account his entrepreneurial ability, knowledge of rural life, and experiences in network marketing and sales.

Setting the price of PICS bags for actors across the chain during the first year and the dissemination of these prices on radio is one of the factors that hampered the development and

sustainability of the distribution chain. Indeed, the reference price helped launch the sale of PICS bags in order to create the demand at the producer and other end users' level, but this strategy failed to continually motivate chain actors, including the semi-wholesalers and retailers, especially those located at the remote villages. The majority of these actors were discouraged and demotivated, given the high transaction costs. The reference prices did not take into account the additional costs of transport, communication, handling, and taxes at the downstream of the chain. Even though this promotional price was just for the first year, the fact that the price was advertised on radios without any additional explanation has impacted the sales.

The approach used by the project affected the sale of the bags. The fact that the launch of technical and promotional activities (awareness building, demonstrations) and the distribution and sale of the bags occurred simultaneously weakened the distribution chain at the beginning of the project. Moreover, the lack of coordination between the promotional and technical activities and the sales has hindered the supply chain, especially at the beginning of the project, given the fact that PICS bags are new products. This lack of coordination is one of the factors that created disincentives among actors involved in the distribution chain (wholesaler, semi-wholesalers, and retailers) with some repercussions on the following years' sales until the total paralysis of the chain. This situation could be avoided if only few outlets were created instead of dispatching the bags in all corners across the country. This will allow producers to be familiar to the bags and help the early adopters to have the bags available to buy.

The poor estimation of the potential demand of PICS bags the first year of the project coupled with the multiple outlets where the PICS bags were placed (due to an existing and functioning network of Gansou) during the 2009-2010 cropping season was not a good strategy to strengthen the distribution network and did not favor cost effective vendors' meeting given the wide geographical distribution of the chain actors.

The financial support of PICS project to the wholesaler during the first order is a good initiative to motivate the wholesaler to invest, but this is not a sufficient condition. It is important that the wholesaler contributes at least 50% of the investment and discuss directly with the manufacturer the terms of payment. This may improve his commitments for the sale of the bags. He can benefit from the support of Purdue University if necessary as a moral guarantee vis- à-vis the manufacturer.

The exemption of taxes and tariffs for the first order of PICS bags through IITA support is a form of tax exemption or a kind of subsidy. This was a special arrangement made to the wholesaler to incentivize him to invest in the distribution chain of PICS bags.

A good functioning distribution network requires:

1. A network manager who coordinates the actions and activities of the network and is liable for the good (or poor) functioning of the chain;
2. A seasonal team to monitor the network and compile PICS bag orders from different actors to estimate the volume of bags needed, visit outlets, and seek new vendors. This

team may consist of sales agents recruited at the beginning of each cropping. In the case of Gansou, there is no structured team that has been operating this way. Akoutou could have played this role but was involved in several things at once in the company, so she did not have enough time and the capacity to oversee the activity in the network.

3. The training of semi-wholesalers has been an important activity for the development of the chain. All the actors did not attend the training and therefore had suffered from a lack of knowledge and information about PICS technology and its application.
4. Promotional activities of the PICS technology such as sensitization, demonstrations, public OBCs, radio messages, articles published in newspapers, and media coverage of events have contributed greatly in informing people about the bags and to stimulate the demand of bags. The major constraint was that the radio spots were conducted with delays according to the cropping season, which offset the effects of the promotional activities in 2009-2010 and 2010-2011.

ANNEX

Figure 1: Map showing the distribution network of PICS bags in Benin

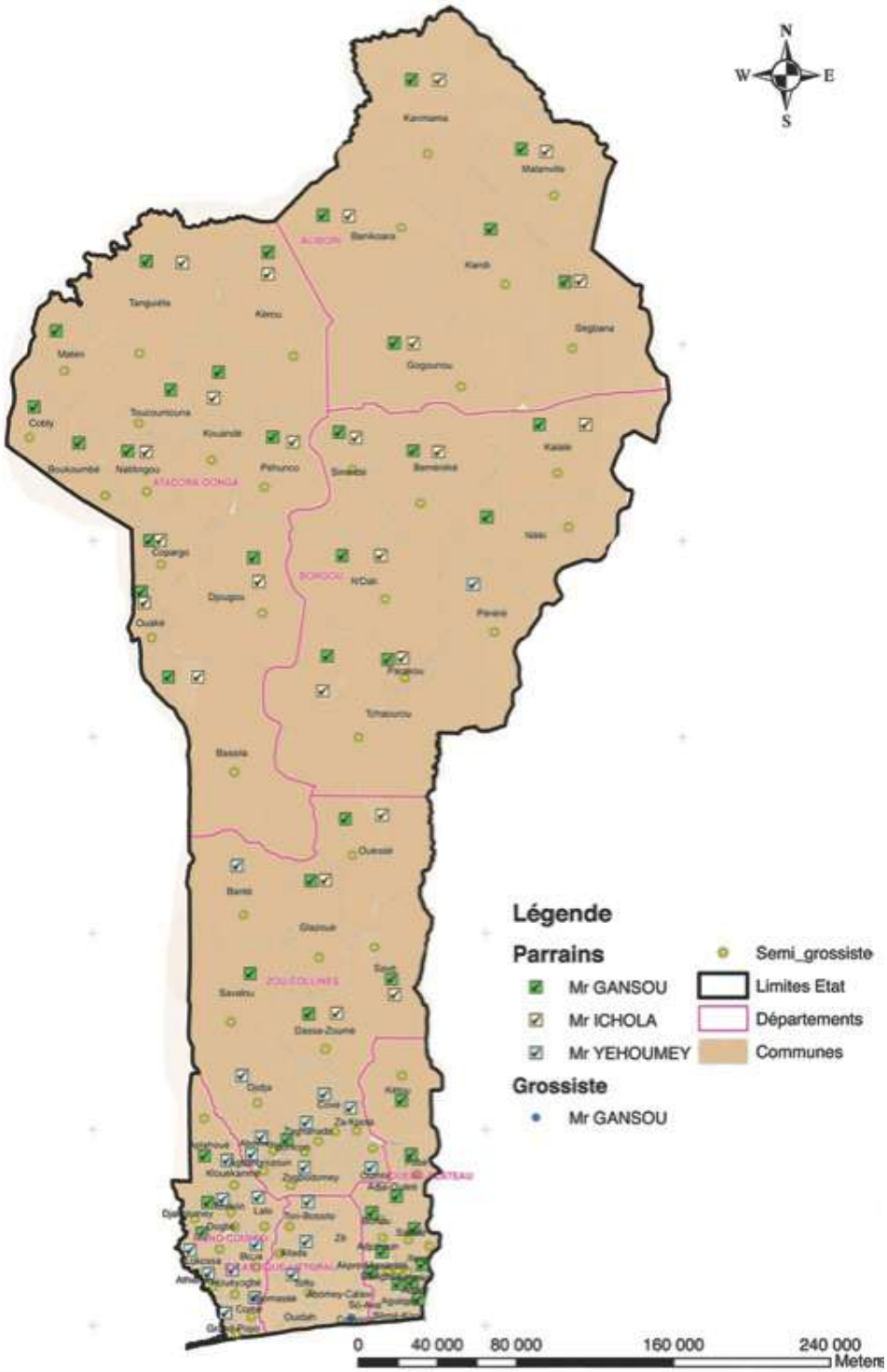


Figure 2: **Distribution network of PICS bags in Benin**

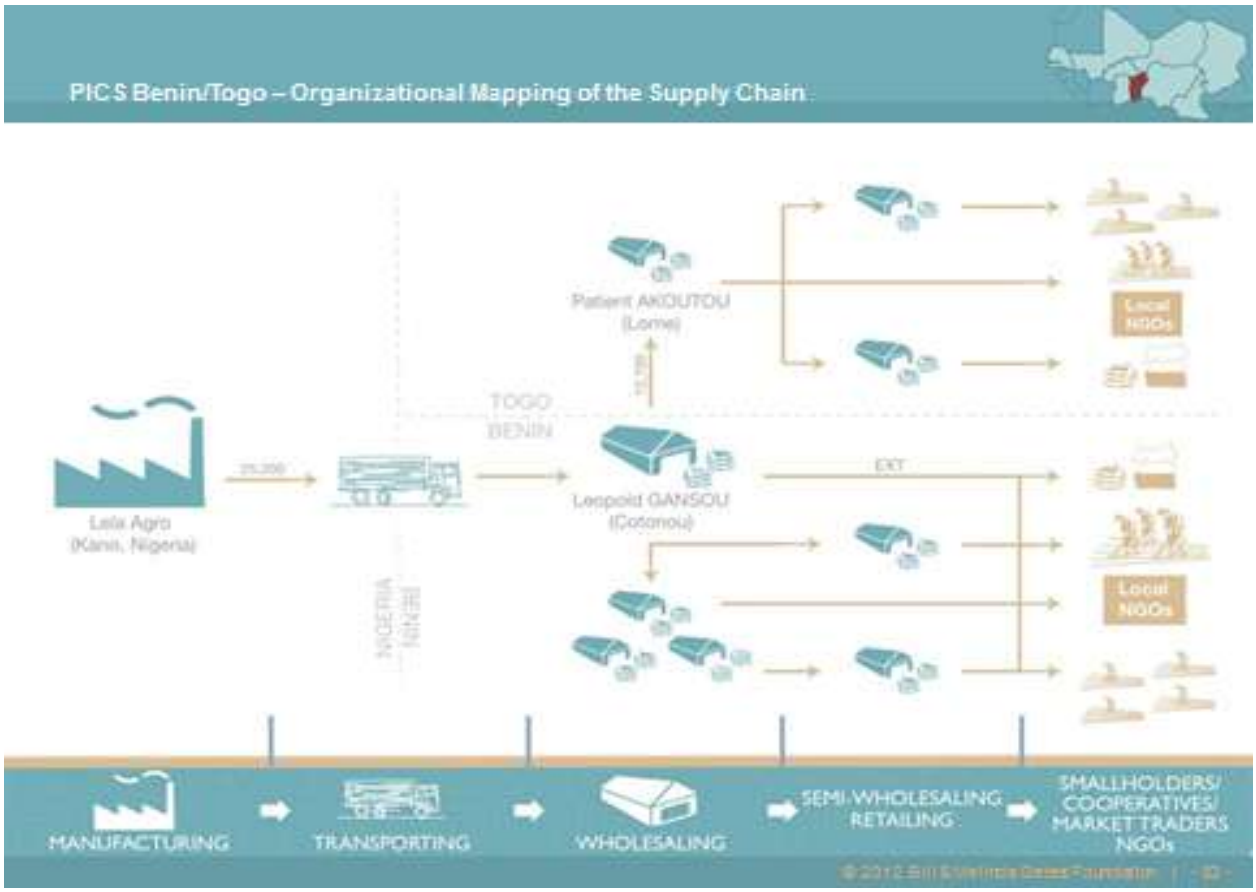
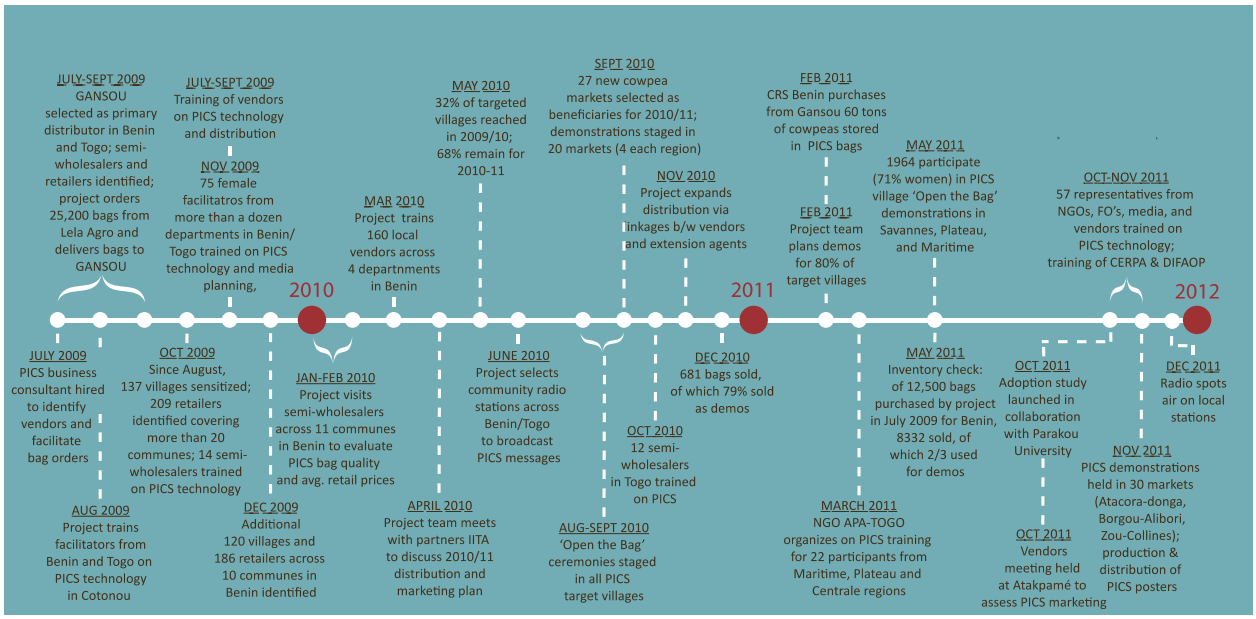


Figure 3: **Timeline of PICS activities in Benin: 2010-2012**



BURKINA FASO

Presentation of the PICS supply chain case study

The PICS supply chain case study in Burkina Faso reports the country's experience in mainstreaming the PICS bags in the commercial sector. First, this study gives an overview of the current status of the supply chain by identifying the main stakeholders and describing the flow of PICS bags from upstream to downstream stakeholders. Second, the study tracks down the evolution of the PICS supply chain with an emphasis on the major milestones and the difficulties encountered in developing the supply chain. Third, the main challenges hindering the development of the supply chain are highlighted, and potential opportunities for an expansion of the PICS supply chain in the commercial sector are laid out. Last, in light of this analysis, lessons are derived that could contribute to the growth and sustainability of the PICS supply chain.

Current situation

This section presents the current situation of the PICS supply chain in Burkina Faso. It starts by mapping out the organization of the supply chain, including the key players and the distribution channels for mainstreaming the PICS bags. The next sub-section provides details on the supply chain actors profiles and challenges faced in their activities.

Mapping out the supply chain

The supply chain map (Figure 1 in Annex) gives a snapshot of the main actors and the organization of the distribution channels for the PICS bags. The PICS bags are supplied by two manufacturers: Lela Agro of Nigeria and Fasoplast from Burkina Faso. Fasoplast was initially granted the contract in 2007 to manufacture PICS bags, but after difficulties with Fasoplast, Lela Agro received the manufacturing agreement in 2008. Since 2011, Fasoplast started manufacturing bags again. In Burkina Faso, PICS bags are channeled to end users principally through the commercial sector. Mr. Ablassé Ilboudo, the current president of the National Association of Agro-Dealers (AGRODIA), is the national distributor who obtained the rights to handle the distribution of the bags in Burkina Faso in 2011. He works with a network of semi-wholesalers and retailers, mainly members of AGRODIA. Another key wholesaler is Mr. Tera Salifou, who is involved in the marketing of the PICS bags to farmers and other end users. Salifou was the first national distributor of PICS bags but lost the contract because of his failure to meet his financial obligations with the project. In addition to the commercial sector, the government has been distributing entirely subsidized PICS bags to women associations storing cowpea in order to meet the national food security objective. NGOs, the national research institution Institut de l'Environnement et de Recherches Agricoles (INERA), and the business consultant have also played key roles in facilitating the distribution of the PICS bags to farmers.

Supply chain actors

The current stakeholders in the supply chain in Burkina Faso include the manufacturer Fasoplast, the national distributor Ilboudo, the former distributor Salifou, numerous semi-wholesalers, retailers, cowpea traders, farmers, institutions such as INERA, NGOs, the Ministry of Agriculture, and the current business consultant Mr. Issaka Sankara.

The Manufacturer: Fasoplast

Fasoplast is the current manufacturer of the PICS bags in Burkina Faso. This manufacturer is a member of the group Industrial Promotion Services (IPS), with other plants in Cote d'Ivoire, Mali, and Senegal; it is linked to the Aga Khan group based in France. This company has specialized in manufacturing plastic conditioners, polypropylene, and polyethylene bags for more than 20 years in Burkina Faso.

Partnership between Fasoplast and the PICS project started in 2007 but was interrupted after the pilot phase because of Fasoplast's inability to produce the specified bags requirement and its price non-competitiveness relative to Lela Agro from Nigeria. In February 2011, collaboration between Fasoplast and the PICS project was renewed, and Fasoplast was awarded the contract for manufacturing the PICS bags in Burkina Faso for the 2011 harvest. After a month of discussion, the PICS team at Purdue authorized Fasoplast to place its logo on the PICS bags in addition to the PICS logo.

For the 2011 cowpea season, Fasoplast produced 10,000 PICS bags for the national distributor Ablassé. This enterprise placed a bid offer of 170,000 bags launched by the Projet d'Amélioration de la Productivité Agricole et de la Sécurité Alimentaire (PAPSA). Fasoplast believes its bid is very good compared to the other bidders, but they are still waiting for the result. The bid offer of Fasoplast was 116,000,000 FCFA for 170,000 bags. From this bid offer, the product cost derived is estimated at 670 FCFA/bag of 100 kg.

Fasoplast has a production capacity of 2 million bags per month. Fasoplast does not have any problem in responding to urgent demands.

Concerning the wholesale price and cost structure, a preferential wholesale price of 850 FCFA/bag is set for BOUTAPA (Ilboudo's enterprise), but for the other customers, the wholesale price is 900 FCFA/bag. These prices include the TTC, which includes the VAT (18%) and a flat annual tax rate (2%). Fasoplast estimates the cost to import raw materials for the production of the triple bags at 1,100 FCFA/kg. In the cost of production of the PICS bags, the raw materials represent 60%, electricity represents 25%, the labor cost 10-15%, and the depreciation rate is estimated at 10 %. The margin in the selling price is about 10 to 12% and includes the deduction of all costs and margin from the 850 FCFA/bag wholesale price.

Fasoplast faces different challenges. One such challenge is the high cost of raw material; this high cost represents a very large proportion of the manufacturing cost. Another problem is the high cost of tariffs and VAT paid at the border. An import tariff of 46 % is applied to the value of the raw commodity. This import tariff includes the VAT (18%) and other custom taxes (28%). There aer also challenges in marketing efforts to ensure sustainability of the supply chain. Much marketing efforts to diffuse the PICS bags have been done by the PICS project. Since the project is ending, Fasoplast faces a challenge to be more involved in the development of a marketing strategy to expand the supply chain.

The National Distributor: Ablassé Ilboudo

Ilboudo is an agro-dealer owner of the enterprise BOUTAPA, which specializes in the distribution of agricultural inputs, including seeds, fertilizer, pesticides, and agricultural

equipment in Burkina Faso. BOUTAPA features four retail outlets, with one in the capital city Ouagadougou and three in the towns of Ziniare, Sabou, and Leo. In May 2011, Ilboudo signed a contract with Purdue as the national distributor of PICS bags after being sensitized on the PICS technology by his friend Mr. Kofi Nyantakyi from Ghana in 2010. The same year, Nyantakyi shipped some PICS bags from Ghana to Ilboudo in Burkina Faso. For the 2011 cowpea season, Ilboudo ordered 10,000 bags from Fasoplast. The initial plan was to buy 20,000 bags, but due to the poor cowpea season, he ordered 10,000 bags at the wholesale price of 850 FCFA/bag. By the end of the cowpea season (January 2012), only half of those bags had been sold at a semi-wholesale price of 925 FCFA/bag. This price is applied to buyers purchasing more than one bale. Flexibility is allowed to those buyers to purchase the bale on a credit basis. For less than one bale purchased, the bags are sold cash at a retail price of 950 FCFA/bag.

Ilboudo uses the distribution network of BOUTAPA to channel the bags to buyers. This network is comprised of 41 vendors. Among those vendors, only eight behaved as semi-wholesalers for the PICS bags (i.e., they purchased more than one bale). The remaining vendors were retailers. BOUTAPA distribution network is confined mainly in the center, east and southern part of Burkina Faso (see Figure 2 in Annex). To be able to distribute PICS bags in the western part of Burkina Faso, Ilboudo works with one of his friends: Mr. Sawadogo Boukaré, member of the Agrodia association. Ilboudo and Boukaré have a very strong, long-term relationship which is no longer business-oriented, but friendship-oriented. In 2011, Boukaré received 3,000 bags from Ilboudo at the wholesale price of 900 FCFA/bag and was able to sell almost all of them (2,700 bags), with only 300 bags remaining in storage by January 2012. Boukaré was very effective in selling the PICS bags despite the poorer cowpea season in the regions covered by his network[2] than in those covered by Ilboudo. This reflects a good marketing strategy that deserves to be detailed below.

Boukaré sold principally to semi-wholesalers members of his network of merchants at a price of 950 FCFA/bag. The semi-wholesalers bring a 50% down payment of the value of the bags when they place their orders. End users buy the bags cash at a retail price of 1,100 FCFA/bag. According to Boukaré, this retail price has been fixed set in agreement with the PICS project to limit speculation on the price of the bags. Boukaré is very selective of his partners for the distribution of the PICS bags; he works only with agro-dealers from his own network of ag-inputs distribution. In his network, Boukaré selects his vendors for the PICS bags based on the following criteria: (1) he must know those vendors for at least 2 to 3 years; (2) they must have a shop; and, (3) he must have a good relationship with them. Loyalty and long-term relationships are the main criteria used by Boukaré to work on a credit basis with his vendors and to minimize the risk of default in payment. Boukaré said, "When I have confidence in my partners, I am very comfortable in making diverse types of arrangements for the payment of the goods." In addition to using his network of agro-dealers, Boukaré has one employee that is sent regularly to monitor the activities of his network of agro-dealers (especially the price at which they sell the PICS bags) and to sell the PICS bags in the villages not covered by his network of vendors. The retail price of the PICS bags in those villages is 1,100 FCFA/bag.

Some extension agents from the Ministry of Agriculture play the role of intermediaries in linking Boukaré to some producers, but he works on a cash and carry system with those agents. They collect the money for the PICS bags with producers, purchase the bags with Boukaré and send them back to producers. Boukaré affirmed to be against

[2] Production of cowpea in the western part of Burkina Faso was 53,000 T compared to more than 200,000 T in the center, southern and eastern parts of the country.

working with the extension agents on a stock on consignment approach for many reasons. First, the extension agents are not stable; they can be assigned to another village/region for a new position at short notice. Second, they are not business people and they do not care often about selling the ag inputs. Third, from past experiences, it has often been reported some problems of default in payment with the extension agents. Boukaré declared that "they collect the ag input for sales, but when it is time to pay back the value of the inputs, you see neither the money nor the good."

The challenge met by the national distributor in developing the supply chain is the riskiness of the PICS market. The national distributor had some concerns about placing future orders because of poor harvest, and consequently expected low demand for the PICS bags. The 2011 cowpea season has been anemic due to poor rainfall, and at the end of the cowpea season, Ilboudo had a large stock of 5,000 bags in his warehouse over the 10,000 ordered that was unsold.

The threats to the supply chain development from the national distributor side include the low production of cowpea during the 2011 harvest season, which has negatively impacted the number of bags sold, as well as the high use of insecticide among farmers. Although the PICS bags have been introduced since 2007 in Burkina Faso, the use of insecticide to store cowpea is still significantly prevalent among farmers. As such, there is still a great need to build awareness for PICS technology.

Wholesaler ETS Tera Salifou

ETS Tera Salifou was the first distributor of PICS bags in Burkina Faso selected in 2008. He was introduced to the PICS project by the first business consultant Mr. Dramane Konaté. Salifou is a businessman who has several assets, including a bakery in Ouagadougou. He has been involved in the marketing of cereals and ordinary bags for years. He has sourced his PICS bags from Lela Agro since 2008 and Fasoplast since 2010. Salifou has been working with Lela Agro and Fasoplast for years with regards to the business of ordinary bags and has built a strong relationship with them in terms of products purchases and delivery.

His marketing strategy is based on cash and carry system for customers who are not part of his traditional business network. The business practices are informal with no written agreement. With respect to his network, he has vendors (semi-wholesalers or retailers) in the majority of provinces in Burkina-Faso (see Image 2 in the annex). 28 vendors from Salifou's network was reported mainly based in the center, northern, and western parts of the country. These vendors consist of direct employees or independent retailers. In Ouagadongon, Salifou has three vendors. He uses three modes of payment with his vendors: credit, partial cash/partial credit, and consignment stock. The main mode of payment is consignment stock (60%), and credit represents the lowest proportion (10%). Stocks are generally placed on consignment with retailers, while the mode of payment is very flexible with semi-wholesalers. Salfiou acknowledged occasional delays in payment of the bags sold on credit or placed on consignment, but he was always able to recover the due amount. Salifou has an agent that tracks the delivery system by recording the quantity supplied to his vendors, the proportion of the total amount paid, and the inventory of the previous delivery.

The wholesale price is 900 FCFA/bag and the retail price is set at 1000 FCFA/bag. When the bags are placed on consignment, vendors receive a margin of 10 FCFA/bag on each bag sold.

The contract between the PICS project and Salifou as the national distributor ended in 2010 because of the non-reimbursement of financing that the project provided to help him with his first order of PICS bags; however, Salifou continues to be involved in the PICS business by sourcing bags from Lela Agro and Fasoplast. Most of his orders come from Lela Agro because Lela Agro's price is more competitive than Fasoplast's. In 2010 and 2011, he purchased 4,000 bags and 1,000 bags respectively with Fasoplast and more than 10,000 bags with Lela Agro.

There is one main challenge faced by Salifou in the distribution of PICS bags. This challenge is related to the high cost of transport and tax paid to import the bags from Lela Agro to Burkina Faso. The bags imported from Nigeria pass through the Nigerien border to enter in Burkina Faso. From the Nigerian border to Salifou's warehouse in Ouagadougou, the transportation cost and other fees payment is evaluated at 17,500 FCFA/bale.

The National Distributor: Ablassé Ilboudo

Most of the current semi-wholesalers are agro-dealers who source from BOUTAPA. These vendors are distributed in the center part of the country, which is the largest area of cowpea production in Burkina Faso and the western areas. There are currently 24 semi-wholesalers involved in the distribution of the PICS bags. Their locations are as follows: one in plateau-central, three in center-north, one in center south, one on Boucle du Mouhon, one in the north, and sixteen in the western part of the country controlled by Boukaré.

Salifou's network is mainly represented by ordinary bags traders, but very few members of Salifou's network are still selling PICS bags because of the decline in Salifou's PICS business due to the non-payment of his debt vis-à-vis the PICS project.

The semi-wholesalers' demand in PICS bags is estimated right at harvest based on the state of cowpea production. In 2011, low quantities of PICS bales had been purchased by the semi-wholesalers from the national distributor because of the poor cowpea season. Semi-wholesalers ordered, on average, one bale of 500 bags at the semi-wholesale price of 925 FCFA/bag, but most of them did not sell half of this order because of the poor cowpea production. Transport from Ouagadougou to the semi-wholesaler location is generally supported by the semi-wholesaler and varies from 5 FCFA/bag to 15 FCFA/bag depending on the distance traveled. This cost is low and not a main issue for semi-wholesalers.

Producers are the main buyers of the bags. They represent more than 70 percent of the semi-wholesalers' customers; the remaining portion of buyers is represented by retailers and NGOs. The price paid by buyers depends more on their qualification than on the quantities purchased. For example, the price set to retailers is 1,000 FCFA/bag independently of the quantity purchased, whereas end buyers, including farmers and NGOs, buy the bags at 1,100 FCFA/bag. The lower price paid by retailers is to allow them to capture some benefits when they sell their bags to end users. Semi-wholesalers sell at their shop and often travel to neighboring markets to sell their bags. Despite supporting the transportation costs to channel their bags to neighboring markets, semi-wholesalers sell at the retail price fixed at 1,100 FCFA/bag.

Many strategies are used by semi-wholesalers to expand their distribution network and increase bag sales. BF1, Salifou's semi-wholesaler in Tougan, relies on his extensive distribution network and investment in radio advertisement. BF1 has three retail outlets respectively in Tougan, Tueni, and Lanfiera and has children going to the weekly markets of

Bai and Koundogo near the Malian Border to sell the bags. He is planning to extend his network in two other localities (Nouna and Borani), where he knows some merchants. By using his network, BF1 was able to sell 30 bales of 300 bags in 2009 and only ten bales in 2010 because of the rupture in Salifou's stock. In 2010, BF1 invested money (6000 FCFA, 4 times) to air messages in the local radios. Messages were broadcasted in Samo, Moore, and Dioula.

Some semi-wholesalers use a word-of-mouth advertising and in-person networking to build more awareness for their bags and expand their business. They spread messages from person to person in order to reach buyers. This is an effective strategy as BF2, semi-wholesaler in Ziniare, declared that with the implementation of this marketing strategy, he does no longer travel to sell his bags. Rather, purchases are made at his shop gate. One semi-wholesaler, BF3 in Kaya touched base with volume buyers to sell his stock of bags. These volume buyers are NGOs such as Organisation Catholique pour le Développement et la Solidarité (OCADES), Fondation pour l'Epanouissement et le Renouveau de la Terre (FERT), and Action Pour la Promotion des Initiatives Locales (APIL).

Many semi-wholesalers have access to credit, and are able to request small loans from microfinance institutions for their overall business, including the PICS bags. In the context of the project, Professionalization of Agro-Input Dealers in Burkina (PRODIB), implemented by the International Fertilizer Development Center (IFDC) and financed by Alliance for Green Revolution in Africa (AGRA), is a guarantee fund will be provided to some agro-dealers to assist them in their business activities. Some semi-wholesalers are planning to use these funds to expand their PICS business activities.

One challenge faced by the semi-wholesalers was the lack of financial capital; some semi-wholesalers are financially poorly equipped, which prevents them from ordering larger quantities of bags and meeting the demand of large volume buyers. Most semi-wholesalers do have access to credit. Another challenge is the low margin at the retail level because of "price fixing". The first year price fixation mechanism of the PICS bags across the supply chain did not allow many vendors to get higher margins and incentives from the sales of the bags. Some semi-wholesalers had weak marketing skills and are unaware of the marketing strategies that are needed to improve their business. For example, a significant number of semi-wholesalers do not display any poster or PICS bags before their shops for advertisement. Some vendors had poor technical training; this was observed with one PICS bags vendor of Salifou. He did not know the techniques of using the PICS bags.

There are threats faced by semi-wholesalers and vendors in expanding the PICS network and bag sales. One such threat is fake bags; some semi-wholesalers are concerned about the emergence of fake triple bags in the market that can pull buyers out of the PICS bags market and lead to significant loss of market shares for vendors. Those fake bags might be found in regions that share borders with neighboring countries, such as Ghana or Togo. There is a big concern of monitoring and guaranteeing the quality of the PICS bags to not deceive buyers and reduce the market share of vendors of PICS bags. Other threats include the still-high demand for insecticide for cowpea storage, the poor cowpea production in 2011, and the subsidized triple bags distributed by the government and PAPSA to farmers in 2011 and 2011.

There were a few weaknesses reported. For one, the vendors report that, for some of their more cash constrained buyers, the price of the PICS bags is high. There is also no product diversification. Some buyers are willing to purchase smaller size of bags even if the

price is not very different from the price of the 100 kg PICS bags. There was also the rupture in supply, especially during peak demand season. In 2010, there was a rupture in the supply of PICS bags when the contract with Tera Salifou stopped with the PICS project

Retailers

There are numerous retailers in the PICS supply chain. The distributors Ilboudo and Boukaré have 25 retailers sourcing from them. Semi-wholesalers also have multiple retailers in their network. In addition to the PICS bag business, retailers are involved in several types of activities, including farming and the marketing of agricultural inputs (i.e., fertilizer, seeds, pesticides). Quantities purchased with upstream suppliers are usually very small--less than 100 bags. For some retailers, these purchases of small quantities are strategies to minimize the risk of business failure, as the PICS bags were a new business activity for majority of them. As opposed to the semi-wholesalers, some retailers do not have a shop; they are just mobile traders going from market to market to sell their bags. The retail price set by the national distributor is lower than the one fixed by the semi-wholesalers. Ilboudo sells the PICS bags at a retail price of 950 FCFA/bag on cash basis. The semi-wholesaler's retail price is set at on average at 1000 FCFA/bag; however, retailers have more flexibility in payment with the semi-wholesalers. They can either pay their bags cash or on credit depending on their relationship with the semi-wholesalers. The selling price of the retailers ranged from 1025 FCFA/bag when sold to other retailers to 1,100 FCFA/bag when the bags are sold to end buyers generally represented by farmers.

The marketing strategy developed by retailers to expand their business is to increase the number of advertisements through radio, poster publicity, word of mouth, extension agents, etc. BF4, a retailer in Tienkodogo, used extension agents as private vendors to mainstream the PICS bags in villages. She sold on a cash and carry system to those extension agents who resold the bags for their own account to farmers in villages. The margins could be up to 36 % of the price at which they bought the bags with BF4.

The constraints to the development of the supply chain are identical to those met by the semi-wholesalers. The major challenges facing retailers are the low margins driven by the price fixing at the retail level, the cash constraint to buy larger quantities of bags and the lack of product diversification.

Volume Buyers

The volume buyers for the PICS bags in Burkina Faso include NGOs and cowpea traders.

NGOs are also involved in the distribution of the PICS bags in several regions, including Kaya, Soum, and Houet. In the region of Kaya, Catholic Relief Services (CRS), based in Ouaga, contracted with OCADES in Kaya to execute the CRS program on the promotional sales of the PICS bags. These promotional sales are part of a larger program called the FASO ("Fatherland" in local language) program, which consists in improving agricultural production and farmers' incomes. The crop year 2010/2011 was the first year of promotional sales of triple bags organized by OCADES. The bags were subsidized at a rate of 50 % by using vouchers. OCADES organized promotional sales of triple bags during market days and invited four triple bags traders and farmers to attend this manifestation.

Farmers received vouchers of subsidized triple bags in exchange of 500 FCFA/voucher. Those vouchers were then redeemed with the agro-dealers who were compensated later for the remaining amount by OCADES. In 2010/2011, OCADES was planning to sell 5,600 coupons but sold only 1,600 triple bags because farmers' awareness for this new product was not well developed. The goal of these subsidized sales of triple bags was to stimulate a large demand for the triple bags and assist both farmers and agro-dealers. Farmers bought their bags at affordable price and agro-dealers had access to new markets. A progressive reduction of the subsidy up to complete removal is planned for the coming cowpea seasons.

OCADES experienced some difficulties in working with agro-dealers. Despite the fact that OCADES initiated those promotional sales to promote the local potential of agro-dealers, most of the agro-dealers did not understand this objective and did not take opportunity of these promotional sales to develop their network. Vendors showed a lack of marketing and business skills. They waited for buyers instead of reaching out to them.

Cowpea traders constitute a market segment that has not been the initial and main target of the efforts of sensitization and awareness developed by the project. This segment of buyers is interested in the PICS technology but is always looking for cost minimizing alternatives to maximize their profit. Insight to this assertion is provided by BF5, a cowpea trader in the province of Fada. She has been involved in cowpea storage since her childhood. In 2007, she received training by INERA concerning the storage of cowpea with PICS bags. She started using the triple bags in 2009 for the storage of cowpea. Due to her dynamism in cowpea storage in the province, she has been selected in 2009 by the Programme d'Appui au Développement du Secteur Agricole au Burkina, phase II (PADAB 2) to benefit from a storage building. She was also financially supported by the project for the purchase of storage equipment, including triple bags. Thus, in 2009, she purchased 500 bags at Fasoplast shop in Sankaryaré at the price of 900 FCFA/bag. In 2010, she made additional purchase of 300 triple bags. She purchased the bags on a cash and carry system. For the 2011 cowpea season, she did not purchase any triple bags because of the poor harvest. Nevertheless, she stored 50 bags of cowpea using ordinary bags and insecticides.

The switch to the insecticide storage technology when the project (PADAB 2) funds were no longer available reveals that the use of PICS bags might be not a profitable and viable option for BF5. When she had to invest her own financially resources, she was more inclined to use insecticides, as this technology apparently minimizes her expenses.

BF5's buyers are cowpea retailers and Société Nationale de Gestion des Stocks et de Sécurité (SONAGESS) in the province of Fada. She was able to get a contract with SONAGESS through a local NGO "Afrique Verte". The merchants who buy her stock of cowpea come from different places in Fada, Pouytengua, Ouaga etc.

BF5 noted that buyers do not price differentiate between cowpea stored in PICS bags and cowpea stored with insecticide. BF5 does not rebag cowpea when she sells cowpea with the PICS bags. She fears bad handling and breaches of the bags during the process of rebagging. Yet, she does not charge additional cost for the PICS bags for selling cowpea in the PICS bags because buyers will not be willing to pay for this additional cost. Thus, with this lack of price differentiation and rebagging, BF5 loses money by selling cowpea in PICS bags.

Farmers

Farmers are end buyers of PICS bags. They have been the first and principal target of the PICS project. Farmers purchase the bags individually or in associations. They purchased the bags at the retail price of 1,100 FCFA/bag with vendors and do not often get a discount in the price of the PICS bags regardless of the quantities purchased. The Coopérative Agricole du Passoré in Ouahigouya, member of the union of coopérative Fédération des Producteurs Agricoles du Burkina (FEPA-B) illustrates this assertion. In 2010, this cooperative purchased 480 PICS bags with a semi-wholesaler in Ouahigouya at 1,100 FCFA/bag. The bags were used to store cowpea, and the stock of cowpea was sold to the World Food Program (WFP). This latter institution expressed a need of 172 T of cowpea but the association was able to supply only 48 T of cowpea in triple bags. To expand its business, this association benefited from the training and the market demonstration provided by the business consultants and is planning to extend it activities to several villages of the province. In the context of the PAPSA initiative, women associations in most of the 45 provinces of Burkina received the bags in 2011 free of charge.

The challenges faced by farmers include: (1) not being well-informed on the use of the PICS bags (for example, some farmers stored their cowpea in the PICS bags but added insecticide to the PICS bags); (2) underdeveloped retailed networks for PICS bags (many farmers have to travel long distance, sometimes more than 20 km, to purchase PICS bags; and, (3) product diversification: some farmers with low cowpea production are interested in buying smaller PICS bags of 50 kg. WFP also manifested an interest for the 50 kg bags because they are easier to carry and handle.

INERA

INERA has been the leading institution of the PICS project in Burkina Faso. This institution has been involved since the beginning of the project in 2007 and has trained many technicians working in the Ministry of Agriculture, NGOs such as CRS, Conseil Regional des Unions du Sahel (CRUS), Cathwell, sensitized and built awareness for the adoption of the PICS technology. INERA has worked to diffuse the PICS technology in almost 39 provinces of the total number of 45 provinces in Burkina. INERA continues to provide technical assistance on a demand/fee basis to various organizations for projects across Burkina Faso that want to use PICS bags. INERA keeps supporting the PICS supply chain by pursuing awareness activities and responding to demand expressed by NGOs for the training of technicians or farmers' associations.

One challenge met by INERA is a poor level of communication among the local PICS partners. Working as a group and be able to communicate with the other local PICS partners is identified as a challenge for INERA--for instance, the new business consultant, Sankara, is not known by Dr. Clémentine Dabiré; she only knows Ilboudo, the new national distributor. There is also an increasing need for extension and advertisement efforts. Although there is large demand for the PICS bags, there are many villages not yet covered by the extension activities and many farmers who do not know the PICS technology. As such, there is need to keep training, and advertising efforts through TV, radios, etc. There is work to be done to extend the PICS technology to other crops. INERA is pursuing research to adapt the technology to the other cereals such as maize, but INERA has not been associated with the PICS 2 project and is conducting those research activities at INERA's own expenses and account.

Business consultant

Sankara is the business consultant for the supply chain hired recently in May 2011. His role, according to the terms of reference of his contract, is to develop and follow-up the PICS bags distribution network. For this aim, he organizes training of stakeholders, demonstrations in markets, media activities, and meetings with actors involved in the supply chain. In August 2011, he trained 25 vendors in Bobo Dioulasso and 30 vendors in Ouagadougou. Many vendors acknowledged that Sankara has been very helpful in building awareness of the PICS bags in the region through the diffusion of the messages to the local radios, market demonstrations and translation in several languages, monitoring of the distributors on the field.

Two difficulties were specified by the business consultant with respect to his assignments. The first was a lack of a relationship with INERA. Sankara regretted to have never met Dabiré to discuss PICS activities since taking up the position in May/June 2011. The second was a lack of private transportation vehicle. Sankara does not have a private vehicle. It is often very difficult for him to cover many rural markets efficiently as they are very sparse and public transportation is not very reliable in rural areas.

Ministry of Agriculture/PAPSA

PAPSA is a project of the Ministry of Agriculture funded by the World Bank and launched in July 2010. The project's objectives include developing a national strategy to increase production and improve farmers' market access and livelihoods, among other efforts. Since 2008, the Government of Burkina Faso has been subsidizing seeds, fertilizers and other inputs at subsidized rates to farmers in a range of priority/strategic agriculture products. In 2010, for cowpeas, the project decided to focus on giving technical and other assistance to women-driven farmer organizations. Since improving storage was one of the priorities, the project took the decision to distribute PICS bags to 1,000 women cowpea producers in each of the 45 provinces via these organizations.

In July 2011, the project released a tender for the supply of 34,500 PICS bags. The bags were produced with the PAPSA logo. In 2012-13, PAPSA plans to distribute an additional 170,000 bags which is expected to be delivered by the end of January 2013. The following year, it plans to distribute 200,000 bags.

One challenge reported with respect to the PICS bags procurement was the failure of the importer in meeting the quality requirement. Following the 2011 award, the bags supplied by the selected supplier who imported them from an Ivorian manufacturer failed to meet the specifications needed, according to INERA who inspected the bags. The supplier then requested a two-month extension to rectify the problem. This caused a delay in the delivery of the bags. Once reordered, the new bags were distributed via the Direction Régionales d'Agriculture (DRA) across Burkina Faso where they were to be distributed. Another challenge reported was a lack of competitiveness of the private sector. Despite hampering the growth of the private sector in the short run, the imports and the subsidies were necessary because the private sector was limited in helping the government to achieve the food security goal for all populations in the country.

Evolution of the supply chain and major milestones

The evolution of the supply chain is the timeline (see figure 3 in the annex) of the major events that took place during the development of the supply chain.

The PICS project activities in Burkina Faso were established in 2007. During this first year, contracts were signed with the manufacturer identified for the PICS bags production, the local partner in charge of leading the PICS extension efforts in Burkina Faso, and the business consultant, Konaté, mandated to supervise the dissemination of the PICS bags. Hence, in May 2007, Fasoplast was selected as the manufacturer of the PICS bags in Burkina Faso, and, in June, Konaté was hired as the business consultant for an initial contract year (June 2007-June 2008). In August 2007, PICS signed an agreement of partnership with INERA to conduct research for testing the technology in Burkina Faso and leading the first extension activities for the diffusion of the PICS bags. The same month, Fasoplast produced 40,000 PICS bags of 50 kg that were used during the pilot phase (2007) of the project in Burkina Faso and Niger. These bags served as demo bags and to test the quality of the PICS bags before mainstreaming the technology.

From August 8-10, 2007, a best practices workshop was held in Ouagadougou with various partners to determine the most effective extension delivery method to disseminate the hermetic storage technology (PICS bags). Following this workshop, 100 villages in Burkina Faso benefited from the village level demonstration during the 2007 harvest, and radio messages were broadcast in 50 villages. In December 2007, a triple bag prototype was developed and forwarded to the Bill and Melinda Gates Foundation. In March 2008, Purdue-based PICS staff members reported after a tour of villages that farmers preferred 100 kg bags instead of 50 kg bags because of its cost effectiveness.

At the beginning of the second year of the project in May 2008, the first OBC was launched on 5 May 2008 in Komki Ipala. Local PICS partners (Konaté, INERA and field technicians), the Minister of Agriculture, the Minister of Promotion of Women, as well as local officials, were represented at this ceremony. Surprisingly, Fasoplast was not invited to this ceremony, but the Marketing Director, Mr André Pare, managed to be present. In fact, the PICS leaders had decided to shift away from Fasoplast for the production of PICS bags for year two because of the non-competitiveness of Fasoplast prices compared to Lela Agro in Nigeria—and the fact that Fasoplast did not have the required equipment to produce the 100 kg bags. INERA officials (Dabiré and the Directeur General of INERA) expressed concerns about the movement away from Fasoplast because they feared the lower quality of bags coming from Nigeria and socio-economic impact created by the dislocation of a business from a local firm to a foreign firm. Yet, the PICS project worked with Lela Agro to manufacture the PICS bags for the market in Burkina; hence, 95,000 bags were produced by Lela Agro for the 2008 harvest.

Negotiations were conducted with some NGOs to help INERA with the extension activities as 3,000 villages were targeted to receive training for PICS technology. In May 2008, INERA and PICS project subcontracted with CRS/Cathwell to perform extension activities in 150 villages. Africare was also used as a partner to train farmers in 108 villages in the Gourcy region. In June 2008, the PICS project made an agreement with ETS Tera Salifou for the distribution of PICS bags in Burkina Faso and Niger with the project paying 25% of the bags procurement. The project also helped pay 25% of the down payment for the bags that Salifou purchased with Lela Agro and he was supposed to reimburse the project after sales.

Although Fasoplast was not awarded a contract to produce triple bags with PICS logo for Burkina Faso, this manufacturer developed its own marketing channel and, in August 2008, Fasoplast had a contract with Office des Produits Vivriers du Niger (OPVN)/Niger for the production of 400,000 bags of 50 kg.

In the third year of the PICS project, large scale sales were negotiated with institutions such as the Food and Agriculture Organization (FAO; 17,000 bags), Africare (15,000 bags) and the Projet d'Appui aux Filière Agro-Sylvo Pastorale (PAFASP; 10,000 bags). The Comité Inter professionnel des Céréales du Burkina (CIC-B) purchased 1,000 bags with Salifou. Discussions also emerged about strengthening commercial PICS activities with market day demonstrations, PICS bags vendor information, and TV advertisement. Besides the sponsorship of the bags, payment shifted from 100% supported by the project to a 50% down payment by Salifou.

During the 2009 harvest season, there was a shortage of bags in Burkina Faso that led Fasoplast to manufacture some triple bags with Fasoplast and INERA logos (no PICS logo) and sold at a price 5% lower than that of the PICS bags. In addition to producing triple bags for the market in Burkina Faso, Fasoplast produced 100,000 triple bags for OPVN/Niger labeled with the OPVN logo and 3,000 bags for CRS in Senegal. This enterprise also started producing polyethylene bags for PICS bags in Mali.

Throughout the fourth year of PICS project in Burkina (May 2010-June 2011), no major extension activities were carried out by INERA because of the funds still owed to Purdue by Salifou. In May 2010, PICS leaders initiated a judicial procedure against Salifou and requested the services of a lawyer cabinet Kera Avocat for the reimbursement of the funds owed by Salifou, estimated at 50,000,000 FCFA.

In the context of the FASO program led by the NGO CRS, vouchers program of 50% subsidized PICS bags were implemented in three provinces of Burkina Faso (Gnagna, Namintegua, and Sanmatengua) to stimulate more demand for the PICS technology; thus, in Kaya (province of Sanmatengua), the NGO OCADES/CRS was able to distribute 1,600 vouchers of PICS bags to farmers during the harvest season 2010/2011.

High participation of farmers' organizations in the PICS market is also remarkable. Indeed, Cooperative du Passore, a member of farmers'union FEPAB, purchased 480 PICS bags with a private vendor and the association of women named "Koom" in Ouahigouya was able to acquire 2,000 PICS bags for cowpea storage.

The fourth year of the project was also used to reorganize the leadership of the supply chain given the sluggishness in the commercial activities and in the repayment of Salifou's debt. In February 2011, the PICS project renewed the contract with Fasoplast for the production of 100 kg PICS bags. In May 2011, a new national distributor, Ilboudo, was hired. In June 2011, a contract between Fasoplast and Ilboudo's enterprise BOUTAPA was signed for the distribution of the PICS bags in Burkina Faso. The same month, a new business consultant, Sankara, was hired to guide the PICS distribution network. This consultant trained 56 private vendors in Ouagadougou and Bobo in August 2011. By December 2011, the PICS training organized by the business consultant staged in 25 markets across Burkina Faso. For the 2011 harvest, the Ministry of Agriculture, through the PAPSA project, distributed 34,500 PICS bags at 100 % subsidized price to women-driven

associations in the 45 provinces of Burkina to give them assistance. Those bags had been acquired by the Ministry of Agriculture in July 2011 through a bid process.

Challenges faced by in developing the supply chain

Lack of collaboration and communication among the technical team in charge of the implementation of the PICS project in Burkina Faso.

This was an essential issue among the technical team that included INERA; the business consultant, Konaté; and the national distributor, Salifou. There were many personality conflicts among the PICS team which led to a number of misunderstandings and friction between the PICS partners. In addition to those personality conflicts, some members of the PICS team had selfish interests and opportunistic behavior in their willingness to take advantage of the project. Those behavior issues were apparent with Dabiré and Konaté, the former business consultant. Konaté was working for a company belonging to the same Aga Khan group as Fasoplast and had lost his job with this company. This might explain his difficult collaboration with Fasoplast. Dabiré was essentially in charge of leading the extension efforts for the PICS bags but allegedly she overstepped her primary responsibilities and tried to lead the supply chain efforts. This led to much friction with the business consultants assigned for this latter responsibility.

The non-reimbursement of the credit by Salifou.

Salifou had many difficulties reimbursing the initial credit for the bags procurement; he still owes $48,000 USD to Purdue. It is still unclear whether Salifou's failure to reimburse his debt is led by an opportunistic behavior to milk the project or by a misunderstanding of the terms of the contract. Indeed, there was apparently a problem of misunderstanding of the terms of the contract by Salifou, who is illiterate. This distributor thought that he was not accountable for tracking the payment of the bags distributed in the DRA under the instructions of Dabiré. Also, the bags distributed by Salifou included bags for sale and demonstrations, and this might have participated in creating some confusion. Salifou made clear that, in general, the problem of non-payment arose when INERA (Dabiré) asked him to distribute bags to individuals working in regional directions of agriculture that were not part of his network; otherwise, the initial selection of Salifou as the national distributor was not a bad choice based on his experience, his existing business, product line, and a network of distributors.

Issue of parallel market of triple bags produced by Fasoplast

In 2010, with increasing demand for the PICS bags and weak supply of these bags in the market, Fasoplast decided to produce triple bags named Sosso Boro. These bags were labeled with Fasoplast and INERA logos. The texture of the inner plastic was slightly drier than that of the PICS bags, but the thickness was equal (80 microns) as the PICS bags. The Fasoplast bags were sold at a price lower than the PICS bags by 50 FCFA/bag and were competing with the PICS bags in the market; however, poor sales of Fasoplast bags were recorded because buyers considered those bags as fake bags given the absence of PICS logo.

Social issues

After having participated in the pilot phase of the project to identify the triple bags with the quality specifications that could address the issue of cowpea storage, the PICS

project decided to source out Fasoplast and import the bags from Lela Agro. The selection of Lela Agro as the sole supplier of PICS bags in Burkina Faso, when other manufacturers such as Fasoplast were available in the country, has been misunderstood by local partners, including Fasoplast and INERA, and led to some friction. The PICS partners in Burkina Faso remained unconvinced of the argument of lack of competitiveness developed by the PICS leaders to justify the shift away from Fasoplast.

Non availability of bags at national level due to supply ruptures

The non-availability of bags at the national level during the first years of the project was due to the delay in ordering bags or shipping bags to Burkina Faso because bags were produced by Lela Agro. The bags were generally received after October when farmers needed them right at harvest in August or September. The bags should reach farmers by August or September because in October, farmers start storing their cowpea. This was not often the case.

Lack of a tangible distribution network down in the chain

The lack of vendors downstream the supply chain has led to some unmet demand for farmers interested in buying the bags. The distribution network was limited at the district level and producers had to travel to the district to purchase the bags.

Strategies developed to encourage the private sector investment

Several strategies were developed by the project to stimulate investment by the private sector. The investments were made to stimulate both supply of the PICS bags by the vendors and demand of the bags by the end buyers. On the supply side, in the initial phase of the project in 2007, the project financed 100% of the bag procurement for the village demonstrations. Then, in 2008, the project supported 25% of the bag purchased from Lela Agro by Salifou; however, this strategy ended up not working as intended because of the non-payment of the due amount by Salifou. More recently, in 2011, through the business consultant, the PICS project organized several market demonstrations and vendors' trainings. These demonstrations had a sound impact in stimulating vendors' participation in PICS business.

On the demand side, the PICS project worked with the local partner INERA and various NGOs, including CRS and Africare, to build awareness for the PICS technology and enhance demand for the PICS bags. Messages were broadcast on radio stations in the official language (French) and different local languages, including Moore, Dioula and Fulani. Advertising was developed on TV and many women's contests were organized in several regions of the country.

If village demonstrations and radio advertisements were key instruments to stimulate demand for the PICS bags, market demonstrations were strong incentives to enhance private vendors' participation in the supply chain of the PICS bags. Many private vendors acknowledged that market demonstrations performed by the business consultant Sankara helped them learn the technical aspects of the PICS bag and developed their interest for the PICS bags business. Those vendors were very appreciative of the business consultant's work.

Challenges and opportunities to supply chain sustainability

Key constraints hampering the development of the supply chain are discussed and strategies to address these difficulties are identified below.

Constraint 4.3.1.1: The pursuit of personal interest instead of collective interest among PICS partners. This constraint has already been discussed above.
Strategy 4.3.1.1.1: When selecting PICS partners, ensure that they are driven by the collective social benefit rather than by the personal benefits they can withdraw from the project. Create a team spirit through regular meetings, communication and reports.

Constraint 4.3.1.2: Rupture in the supply of PICS bags. The rupture in the supply of bags, particularly during the peak demand period which corresponds to the first months of harvest (August to November), is a major constraint hindering the development of the supply chain. The rupture in PICS bags gives rise to the emergence of a parallel market of fake bags, as was the case with the Sosso Boro triple bags produced by Fasoplast.
Strategy 4.3.1.2.1: Work with extension agents and forecasting institutions to have reliable estimates of cowpea harvest and the derived demand in PICS bags. Monitor the orders of bags by the national distributor to ensure that there are always enough PICS bags available in the market especially during the peak demand.

Constraint 4.3.1.2: Low price incentive in the bags. The retail price, fixed at 1,100 FCFA/bag regardless of the distance travelled and search costs incurred to find buyers, reduce the incentive of lower stream vendors and limits market development. This is particularly true when buyers are willing and able to pay for higher price to afford the PICS bags.
Strategy 4.3.1.2.1: A price orientation should be kept to the first year of the project just to stimulate demand, avoid price speculation, and ensure affordability of the bags by farmers. Over time, this price orientation should be avoided to provide higher incentive to lower stream stakeholders who channel the bags in distant villages and increase the availability of the bags at the farm level. The market should be able to dictate the price at which buyers are willing to buy the PICS bags.

Constraint 4.3.1.3: Government subsidy on the PICS bags. The government 100% subsidy on the triple bags should be avoided in the medium- or long-run because they are often inefficient (do not often reach the targeted beneficiaries), and they hamper the development of the private sector (provide disincentive to buy from private vendors).

Strategies 4.3.1.3.1: A first alternative strategy to the 100% subsidy on the PICS bags every year can be a progressive reduction of the subsidy up to a complete removal.

Strategies 4.3.1.3.2: Another alternative is to provide smart subsidies as performed by the NGOs. Instead of being widespread to women's associations and farmers in majority of provinces, these subsidies can be targeted to a specific group of farmers meeting some specific criteria (for instance, farmers having few assets and low income)

Strategies 4.3.1.3.3: The third alternative resides in a partnership between public and private sector by reallocating the subsidy fund to a guarantee fund to support the private sector involved in the supply chain of the PICS bags.

Strategies 4.3.1.3.4: The government is often aware of all those strategies mentioned above to ensure sustainability of the private sector, yet does not adopt these measures; thus, what is needed is a strong political will, triggered by powerful advocacy from the private sector and the PICS partners.

Constraint 4.3.1.4: High tariffs and VAT payment at the border. The high tariffs and VAT payment at the border for the raw material imported increase the manufacturing cost of the PICS bags reduce the their competitiveness

Strategies 4.3.1.3.1: Exempt the raw material from VAT payment and lobby to include the PICS bags in the list of agricultural inputs

Opportunities to expand the supply chain via increased private sector investments

Several opportunities are available in Burkina Faso to stimulate the growth of the commercial PICS supply chain. One such opportunity is the strong interest of the government for the development of the supply chain. The government, through the Ministry of Agriculture, has invested several million FCFA for imports of PICS bags in 2010 and 2011. This denotes of the high interest and importance that the government places on the adoption of the PICS bags as effective technology to store cowpea; hence, this is an opportunity for the private sector to lobby before the government to take some decisions that will stimulate participation of the private sector in channeling the PICS technology to farmers and other end users.

Another opportunity is the fact that the PICS bag is a unique and revolutionary technology to effectively store cowpea. The PICS bag is recognized by all actors of the supply chain as a very effective technology to store cowpea. There was no report of quality failure in storing cowpea. Thus, there is a growing awareness and adoption of the PICS bags among farmers who were reluctant initially to adopt this technology and became convinced of its effectiveness. In addition, a semi-wholesaler (BF3) reported that the uptake of PICS technology is having an impact on farmers' planting decision-making and drives the emergence of new farmers' organizations. Despite the issues of repayment that Salifou had with the PICS project and the decision not to renew his annual contract, he is planning to order 24,000 PICS bags for the 2012 cowpea season. This reveals the strong market potential of the PICS bags.

After Nigeria and Niger, Burkina Faso is the third largest cowpea producing area in West Africa, with more than 460,000 T of cowpea produced for the 2011 crop season, which was considered as an anemic cowpea season. Production of cowpea is spread in all provinces of Burkina Faso, with the largest producing areas in the center part of the country. Assuming that only 1/5 of the cowpea production is stored in PICS bags will result in a demand for around 90,000 PICS bags during the poorest years of production. Yet, this latter number is way above the 10,000 bags ordered by the national distributor in 2011. This analysis implies that there are enormous unexplored opportunities to develop a viable market of PICS bags and expand the supply chain.

There is a market potential with large cowpea traders. Cowpea traders storing large quantities of cowpea represent strong market potential for the development of the supply chain. The majority of the project's initial investment has targeted small farmers who have limited market surplus and are often forced to sell at harvest in order to have some cash to pay for their debts or provide for their household expenditures. Very few large cowpea farmers exist that could purchase sizable quantities of bags and stimulate supply chain development. The market segment that offers opportunities to expand sales and distribution of the bags—and is yet to be penetrated—is represented by cowpea traders. Those traders are spread in all provinces of Burkina Faso and transact on a regular basis large volume of cowpea. Their decision making is based on profit maximization, so they are always looking

for cost minimizing technologies. As such, the use of insecticide for cowpea storage for a short period of time is a common practice adopted; thus, their entry in the PICS bags market will depend on the benefit/cost ratio of the PICS bags compared to the alternative storage technologies or on any law that the government will implement to prohibit cowpea storage with insecticide and enforce the use of the PICS bags as a safe technology.

Key Lessons Learned

Numerous lessons are derived from the analysis of the supply chain of the PICS bags in Burkina Faso. The first is that good communication among PICS partners is key for successful implementation of PICS activities. Promoting communication can occur through periodic meetings and sharing of reports among PICS partners. A good working environment among PICS partners, with no overlapping in the execution of each partner activities, is essential to guarantee a sustainability of the activities.

Avoid direct financial support to vendors. This is related to the inability of the first national distributor to reimburse the funds that were lent to him on credit.

The existence of a distribution network is an asset, but it is not the only one for mainstreaming the technology. Entrepreneurial and business skills are very important as well.

Credit access is not a central constraint that hinders vendors' participation in the supply chain. Despite widespread belief that access to credit is poor and hampers investments in the supply chain, insights from Burkina Faso reveal that the majority of vendors interviewed work with credit institutions with reasonable interest rates.

Social capital, in the form of long-term relationships, trust, and commitment, is fundamental for the development of a distribution network in the presence of weak legal institutions.

Marketing efforts led by the project through radio advertisement and village demonstrations were capital to stimulate demands for the bags from farmers; however, market demonstrations led recently by the business consultant were powerful instruments to stimulate supply, building technical knowhow of vendors and enhance their participation in the PICS bags market.

Dealing with national manufacturers when they have the necessary equipment to produce the PICS bags will prevent any social frictions and is vital for sustainability of the bags procurement.

Using vouchers to build awareness for the PICS bags in the provinces where the agro-dealer network is not well developed is an important strategy to stimulate demand for the PICS bags and enhance bag availability in marginalized areas

Agro-dealer is not the only model for supply chain development. Many types of vendors can be used for the distribution of the PICS bags. This will depend mostly on the specificities of every region; for instance, agro-dealers are sparse in the northern provinces compared to the western regions of Burkina Faso, where more inputs are used to grow cotton and maize. In the Sahel region, using ordinary bags vendors to distribute PICS bags might be more effective in reaching farmers than agro-dealers. On the other hand, in the western part of the country, working with an agro-dealers network might be more successful.

Working with extension agents of the Ministry of Agriculture on stock on consignment basis was not a good strategy for supply chain development; however, making connections with vendors and extension agents as private businesspeople is a more viable strategy.

Before investing a very sizable amount of money to launch the supply chain, the project ideally should ensure that maximum amount of guarantees (i.e., assets, savings) are taken to avoid risk of defaulting in payment. In an environment depicted by a weak legal system, the project took a fair amount of risk by injecting several million FCFA to procure the PICS bags on credit for Salifou. These risks were taken without making sure that all parties understood the details of the contract and verified that Salifou had enough savings and assets to safeguard the credit loan.

Good supply chain management is critical. Communication with extension agents and information about rainfall is important for good forecasting of the demand for PICS bags.

The PICS trademark is a mark of quality/credibility. The PICS logo was seen as a mark of quality by many buyers who did not purchase the Fasoplast bags despite its lower price and the 80 microns thickness of the inner layer bags.

ANNEX

Figure 1: Supply Chain Map of PICS Bags in Burkina Faso

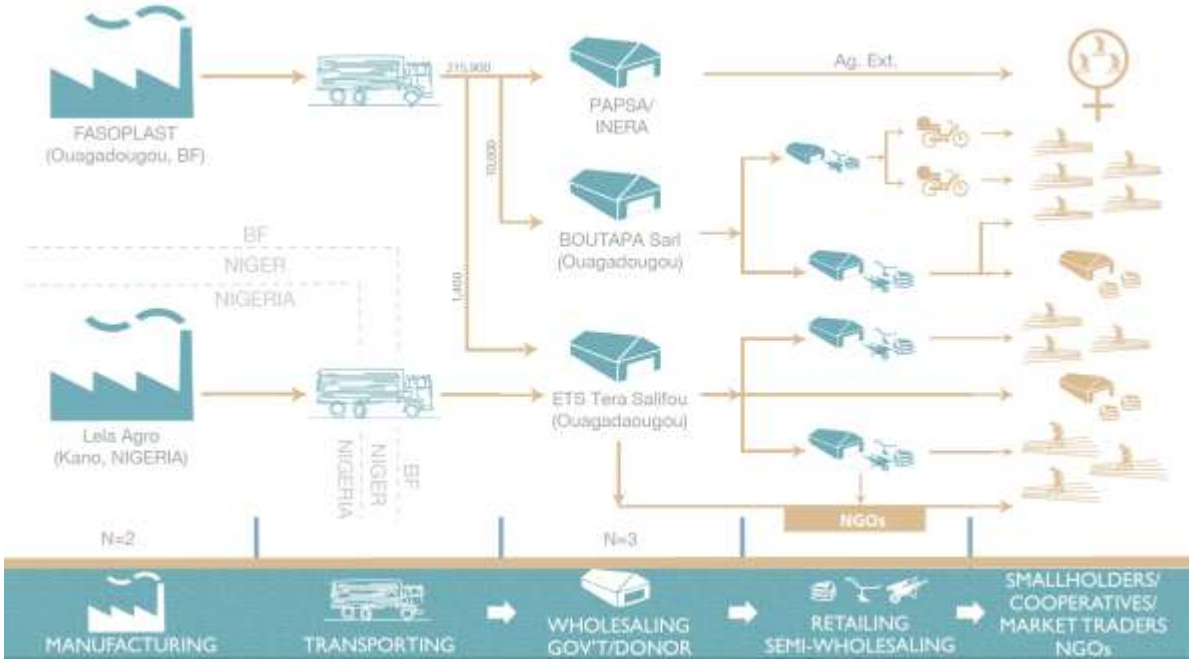
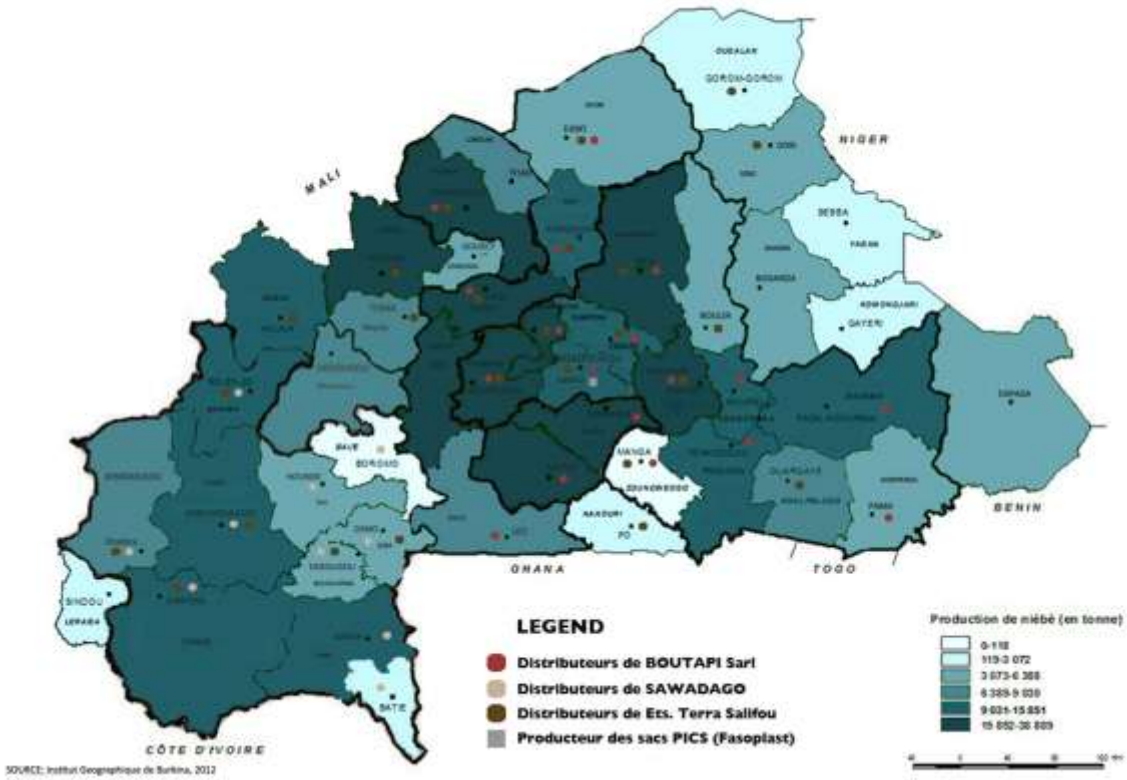
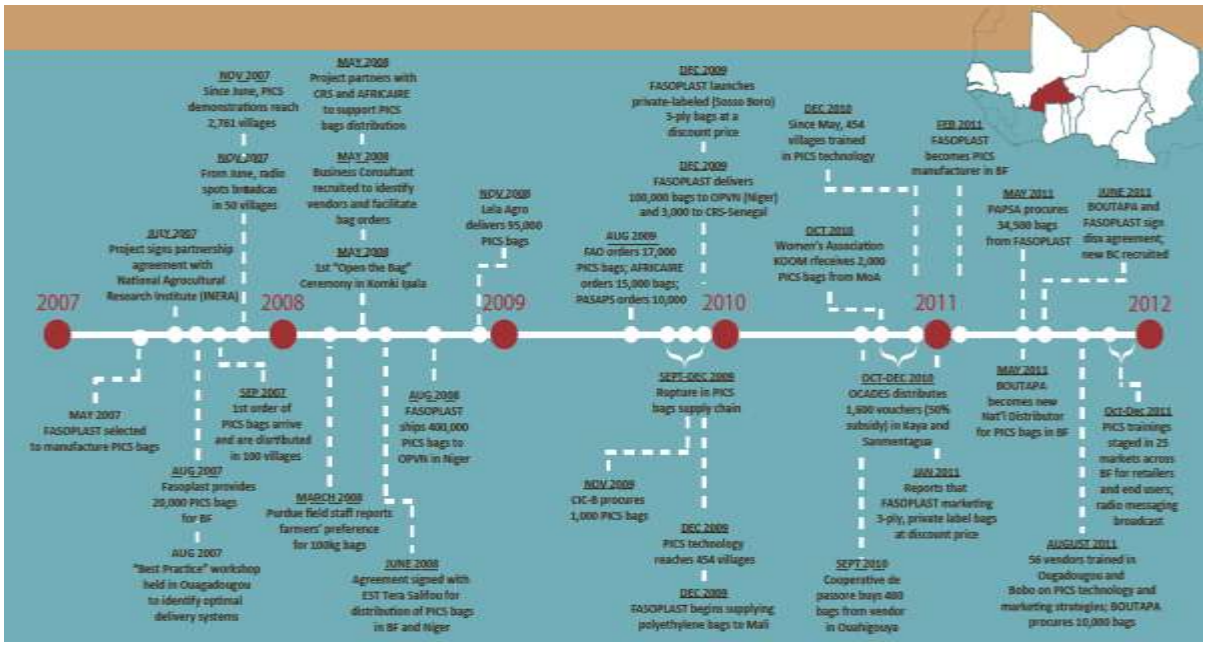


Figure 2: Distribution Network of the PICS Bags relatively to the Cowpea Production Areas



<u>Figure 3</u>: Timeline of Major Milestones



CAMEROON

Presentation of PICS supply chain case study

Cameroon is a cowpea producing country (mostly in the northern and extreme north regions), with an annual production representing approximately one percent of the total cowpea production of West and Central Africa. Cameroon is an important share of the cowpea market in Africa and exports cowpea to Nigeria, Tchad, Central African Republic, and Gabon. Because of these factors, Purdue University selected Cameroon as one of the ten countries where the PICS project would be implemented.

Implementation of the PICS project in Cameroon began in 2010. The project comprises three major components: technical; marketing and communication; and distribution. The technical component is carried out by the Agricultural Research for Development Institute (IRAD), and overseen by IITA. This component consists of building public awareness, conducting public demonstrations, monitoring famers who have stored cowpea in PICS bags, and organizing public OBCs. The marketing and communication component was carried out by a business consultant; and distribution was led by a national distributor (GIC-DEMRI), with the support of the business consultant, this component features the distribution and sale of the bags.

The outreach activities are overseen by IRAD during the 2010-2011 and 2011-2012 cropping seasons, under a sub-contract from IITA.

Current situation

Mapping out the supply chain

(see figure 1 in Annex)

GIC-DEMRI is the unique distributor (wholesaler) of PICS bags in Cameroon. It sources the bags from Lela Agro, the manufacturer of PICS bags in Nigeria. In 2010-2011, 30,000 bags were procured, and 15,000 bags were procured in 2011-2012. PICS bags are distributed through the existing agricultural inputs network composed of GIC-DEMRI agencies and some traders who are GIC-DEMRI customers. GIC-DEMRI is headquartered in Garoua in northern Cameroon, with some branches in Adamaou (Ngaoundere), the North (Guider, Pitoa, Touboro, Kaélé, Yagoua Miganga), and the upper North (Maroua, Kousséri Mokolo).

In areas where GIC-DEMRI has no active agency, it works with private partners (often their long-term customers). These private partners have functioning outlets. The PICS bags manufactured in Nigeria by Lela Agro are shipped directly to GIC-DEMRI's headquarters in Garoua and stored in the central warehouse. From the central warehouse, PICS bags are distributed to GIC-DEMRI agencies, branches, and to other outlets composed of former GIC-DEMRI customers using a pickup truck. GIC-DEMRI has two main branches located in Garoua and Maroua, with other small agencies in some other localities. Each agency features paid staff. GIC-DEMRI supplies PICS bags to private partners in a cash and

carry basis or with a down payment of 50% at order and the remaining 50% paid after the sale. Initially, GIC-DEMRI placed the bags on consignment to private partners, but, over time, this marketing strategy was not a viable one. Retailers purchase the bags at 1000 FCFA/bag each and sell at 1,200 FCFA/bag. In addition, GIC-DEMRI has some roaming vendors who go to weekly markets to sell the bags. GIC-DEMRI also supplies PICS bags to wholesalers and semi-wholesalers in Tchad. The Tchad distributors are:

1. Mr. Martin Kongobé: He ordered PICS bags twice (his first order was for 2,000 bags, while his second order was for 1,500 bags) from GIC-DEMRI at 875 FCFA/bag. The bags were shipped at the Tchad border (Touboro).
2. Centre Chretien D'Appui au Developpement Communautaire (CECADEC): A Lutheran organization located at Guider, 30km away from the Tchad border, CECADEC bought 1000 bags at 1000 FCFA per bag. The bags were delivered at the doorstep of CECADEC.
3. Mr. Moustapha: A Tchad Merchant based in Lere, he bought 100 bags at 1,000 FCFA/bag. The bags were delivered at Guider.

Other products commercialized by GIC-DEMRI include insecticides, herbicides, fertilizers, seeds, phytosanitary devices, and regular bags, among others. Suppliers of these products are Agrochem-AC, FIMEX Inter ltd, and ADER (multi-national, Group IDC). GIC-DEMRI observed an attempt to introduce PICS bags in Central African Republic (CAR) by certain Tchadian grain traders. According to GIC-DEMRI, the distribution of PICS bags is an additional activity which allows them to fill the gap of idleness starting from September until December.

With respect to the 30,000 bags ordered from Lela Agro in 2010 and 2011, the unit price at the factory is 710 FCFA in 2010 and 730 FCFA in 2011. The transaction costs for the 30,000 bags, including customs fees, transport fees, handling, and transit, are estimated at 2.5 million FCFA--or 83 FCFA/bag. The selling price is 950 FCFA/bag at the wholesaler's level and 1200 FCFA at the retailers' level.

When ordering PICS bags, Lela Agro had initially asked for a down payment of 100%, which was not possible for GIC-DEMRI. The feasible mode of payment in 2010 is 25% at order, 25% at delivery, and the remaining 50% paid sixty days after the delivery. The total amount paid was 21,500,000 FCFA in 2010. In 2011, the payment terms were 25% fifteen days after delivery and the remaining 75% one month later. The total amount paid was 17,000,000 FCFA. Since 2010, the trust between Lela Agro and GIC-DEMRI has been strengthening.

The implementation of PICS project in Cameroon began in November 2009 with the visit of Baributsa, followed by a visit in February 2010 with Baributsa and Lowenberg-DeBoer. The objective of this mission was to identify the villages for PICS activities, select radio stations to broadcast PICS messages, and identify distributors to distribute the bags to end users. In June 2010, partners and villages were selected. From July 27 to August 10, 2010, PICS field technicians and extension agents from the National Agricultural Extension and Research Program (PNVRA) were trained. In total, 197 technicians and extension agent were trained, including 14 Tchadian and one Central African Republic (CAR), and 1,465 were villages covered. The training was organized in six locations: Garoua: 40 technicians (29-30 July 2010); Guider: 27 technicians (2-3 August 2010); Maroua: 28 technicians (27-28

July 2010); Kaélé: 46 technicians (4-5 August 2010); Mokolo: 26 technicians (6-7 August 2010); and, Mora: 30 technicians (9-10 August 2010).

The activities planned for 2010-2011 included awareness building (15 September to 15 October 2010); demonstrations (16 October 2010 to 31 Jan 2011); monitoring (February to March 2011); and OBCs (April 2011).

The selection of distributors was made with the assistance of the PICS team at Purdue in November 2009. They visited the input dealers in the Maroua and Garoua markets. When meeting with each potential distributor, the Purdue team presented the project, its objectives, and the opportunities associated with it. The team was looking for reliable and capable distributors that meet certain specific requirements and who were able to invest in order to achieve the project goal. Among dealers visited, GIC-DEMRI was the one that matched with the required characteristics as a distributor for PICS bags. In February 2010, the coordinator of PICS Cameroon suggested GIC-DEMRI to the PICS team from Purdue (Lowenberg-DeBoer and Baributsa). The PICS team met with Mr. Boubakari and his team from GIC-DEMRI at Garoua to discuss in detail the scope of the project and bag procurement arrangements with the manufacturer Lela Agro. Initial contact with Lela Agro was facilitated by the project team at Purdue. Further discussions about the order of the bags were led by GIC-DEMRI.

For the public demonstrations, the PICS project bought 10,172 bags from GIC-DEMRI at 1,200 FCFA/bag. Certain bags received from Lela Agro presented some manufacturing defects. The defective bags were gathered and shipped back to Lela Agro for replacement. There were also a few missing bags in bales (about three to five) reported by the vendors. In all cases, defective or missing bags were replaced by GIC-DEMRI. To increase the awareness of PICS bags, GIC-DEMRI and IRAD organized caravans in some markets. They also manufactured T-shirts with PICS logo on them.

GIC-DEMRI agencies or outlets were not represented at the demonstration villages; therefore, they were not able to efficiently reach farmers and meet the demand for PICS bags in these villages. Field technicians sometimes were forced to take money from famers and procure the bags for them.

Regarding the communication component of the PICS project, IRAD drafted the PICS messages with the assistance of GIC-DEMRI, and the National Confederation of Cotton Producers of Cameroon (CNPC-C) aired the messages through community radios. Messages broadcasted focused on project activities such as outreach, demonstrations, monitoring, open-the-bag events, and other marketing of PICS bags.

After a year of partnership with CNPC-C, it was observed that there were notable delays between message construction and the message being presented over radio. One reason for this was the fact that many actors were involved in this process, including Purdue University, IRAD, CNPC-C, and community radio stations. This eventually led to the situation where the messages being aired were not relevant with respect to ongoing activities. For the 2011-2012 campaign, CNPC-C was no longer involved in PICS messages; instead, IRAD signed contracts directly with community radio stations. PICS messages were

recorded on CD by IRAD and given directly to community radios for broadcast. About seven radios were contracted by IRAD to broadcast PICS messages.

During 2010-2011, initial contact with eight community radios was made (September-October 2011); 23 supply chain actors from NGOs and farmers' organizations were trained in Maroua (14-15 November 2011); 50 markets were selected for demonstrations (September-October 2011); journalists and bag vendors were trained (December, 2011); eight community radio and national television companies were contracted; and 22 PICS bag vendors from GIC-DEMRI distribution network were trained. Along with these accomplishments, demonstrations were organized in 50 markets from November to December 2011.

In Cameroon, the government, through IRAD, already contributes to the technical component of the PICS project. The government may also play an important role, for example, by subsidizing the PICS bags as it is already the case for fertilizers. The radio can help raise awareness by airing interactive shows on PICS. For the 2011-2012 cropping season, the Ministry of Agriculture has included the technical component (i.e., sensitization, demos) in their extension program. Technicians from IRAD trained in 2010 continued the training of their peers in other locations, such as Mayo-Rey district.

The role of each actor (IRAD, GIC-DEMRI, media) needs to be clearly defined for further effective continuation of PICS activities. An approach to involve the government in making decisions aimed to protect the consumer needs to be refined as well. It is expected that GIC-DEMRI must participate to some TVs and radios shows to raise the level of awareness of bags users.

Supply chain actors

Purdue University—International Coordination

In an effort to increase private sector's interest in PICS activities in Cameroon, Purdue University incentivized distributors at the early stage of the project. First, it acted as a moral guarantee for the wholesaler vis-à-vis the manufacturer Lela Agro. Purdue University brought wholesalers and the manufacturer together in a business relationship. To strengthen this business relationship, the sales representative of Lela Agro, Kaumi, visited GIC-DEMRI in 2010 to discuss partnership and the possible arrangements for PICS bags orders. Secondly, the PICS project itself is a volume buyer of PICS bags. To incentivize supply chain actors and to strengthen the development of the chain, the PICS project purchased about 34% of the first order (10,172 bags) at retail prices (1200 FCFA/bag) from the wholesaler for public demonstrations.

Through IITA and IRAD, Purdue funded the technical components of the project (i.e., outreach, demonstrations, OBCs, training) to create and stimulate downstream demand of PICS bags. Similarly, several media activities were initiated and financed by the PICS project, such as radio spots, media coverage of the OBCs, and caravan.

Purdue led the overall coordination of the project, including monitoring and evaluating the development of the supply chain. Numerous visits undertaken by Baributsa and Lowenberg-DeBoer to Cameroon helped Purdue be efficient in this role.

IITA—Regional Coordination

IITA led PICS project activities across West and Central Africa (including Benin, Togo, Nigeria and Cameroon). This coordination is overseen by Dr. Tahirou Abdoulaye.

IRAD--Maroua

IRAD signed a contract with IITA to carry out the outreach activities, the demonstrations, and the OBCs. A total of 1,465 villages were covered over the two years of project activities in Cameroon. The technical support of IRAD was essential for the continuation of the training at the end of the project and for the sustainability of the supply chain.

Business Consultant

Mr. Christophe Lontchi was recruited in April 2010 during the visit of Lowenberg-DeBoer, Baributsa, and Mr. Gonne Sobda. There were several reasons why Lontchi was selected as a business consultant. Lontchi met Lowneberg-DeBoer in the 1990s within the framework of cowpea research in Cameroon. Lontchi was aware of the problems associated with cowpea storage, and Lowenberg-DeBoer was aware of the work performed by Lontchi on cowpea post-harvest research. As such, Lowenberg-DeBoer contacted Lontchi to participate in the PICS project. Lontchi had conducted some trials on triple bagging with the use of ordinary plastic bags to store cowpea, but this experiment had some limitations. He also worked with Dr. Wilfried Hammond (FAO Consultant) on the cowpea-FAO project. As a business consultant for PICS, he introduced PICS bags to institutions and projects such as FAO and WFP, explaining the proper use of bags to achieve an efficient result through the information in the PICS posters.

Lontchi was also involved in the training carried out by IRAD team for technicians, semi-wholesalers, and journalists. Lontchi kept track of sales of the semi-wholesalers GIC-DEMRI. It also helped GIC-DEMRI expand the distribution network. Lontchi mentioned the good cooperation between himself and GIC-DEMRI. With the team of IRAD, he provided strong support to the national coordinator of the project, particularly in the organizing trainings, the identification of trainees, and providing technical advice. 210 technicians from the Ministry of Agriculture and PNVRA were trained in July and August 2010 in five localities including Garoua, Maroua, Kaélé, Mora, and Mokolo. Twenty semi-wholesalers, ten journalists and some leaders of farmers' organizations and NGOs trained in December 2010. Forty leaders of farmers' organizations and ten leaders from NGOs involved in the production and storage of cowpea were trained in October 2011.

Regarding the distribution of PICS bags, PICS bags are manufactured by Lela Agro and shipped to Garoua, Cameroon. GIC-DEMRI stores the bags in a central warehouse in Garoua. GIC-DEMRI staff distributes bags, using a pickup truck, to GIC-DEMRI branches and retailer outlets. The GIC-DEMRI agency in Garoua dispatches the bags to GIC-DEMRI selling points in Maroua, Ngaoudéré, Guider, Pitoa, Touboro, Kaélé, and Yagoua. The GIC-DEMRI agency in Maroua dispatches the bags to Mora, Kousséri and Mokolo. Major buyers are retailers who initially received the bags on credit or consignment. Because of the risk of

nonpayment associated with this selling strategy, Lontchi proposed two roaming vendors he knows well—C1, based in Mémé; and C2, based in Bourha—to lead the sale of the bags in weekly markets.

Some potential volume buyers include the WFP (Garoua), the CNPCC (Garoua), the Cereal Office of Garoua, FAO in Youandé, Christian organizations (Maroua-Mokolo), CARITAS (a confederation of Catholic relief, development and social service organisations) (Yagoua), and Diocesan Development Committee of Maroua-Mokolo.

Wholesaler: GIC-DEMRI

Interview with GIC-DEMRI team: Cameroon Delegate (C3) and Business Manager (C4)

Each GIC-DEMRI agency is composed of an agency head (generally an agricultural technician), recruited based on a proposal of an agronomist; a salesman (hired by the agency head); and a driver (hired by the agency head). In Ngaoundere, the head of Agency is a former client of GIC-DEMRI who, in turn, hired a driver and a seller. For Kousseri, they used a commercial agent of Garoua and a seller.

The staff of GIC-DEMRI in Garoua in composed of the delegate represented by CDG1 who is elected by the general assembly for a two year-period, renewable several times; the commercial director, appointed by the delegate as a close collaborator for two years, renewable; the finance officer, elected for two years, renewable; the accountant, recruited by GIC-DEMRI; the secretary, also a recruited staff; and a consultant who is an agronomist and acts as an advisor. The GIC-DEMRI is composed of ten members (including two women) who are shareholders and therefore receive dividends from activities carried out. The president of the Board of GIC-DEMRI is a large farmer and lives at Pitoa. At Garoua, GIC-DEMRI is composed of an office (headquarters), a central agency for sale, a selling shop in the market, a large central store which may take up to 100,000 PICS bags.

According to CDG1, the distribution of PICS bags allows GIC-DEMRI to work twelve months a year. Before PICS bag distribution, the sale of agricultural inputs such as fertilizer chemicals keeps GIC-DEMRI busy from January to August. The distribution of PICS bags takes place from September to December. In addition, PICS bags distribution is a new product line that added new vendors to the GIC-DEMRI clients. These new vendors are commercial agents who go to weekly markets to sell the bags against commission. Inventory of the bags are done on a daily basis by the agency head, and the commission is also paid on daily basis. For now, this approach is effective and allows GIC-DEMRI to increase its sales volume. The volume of bags ordered, along with the procurement price of the bags, the transaction costs, and the selling price, were described previously.

GIC-DEMRI had opened some outlets in several cities, including Touboro, Yagoua, and Guider. The bottleneck of this initiative is who to find reliable distributors to take over the distribution of bags in those cities.

GIC-DEMRI is satisfied overall with PICS bags distribution. However, they are aware that some challenges remain, such as defective and missing bags, which has been reported by their customers. In fact, GIC-DEMRI itself does not check the bales after delivery. To overcome these issues, Lela Agro suggested tracing each bale delivered. In addition to PICS bags, GIC-DEMRI ordered other products from Lela Agro, such as 30,000

of ordinary bags of 100kg and 10,000 other types of bags. Kaumi visited GIC-DEMRI twice to monitor the sale of the bags and to receive feedback about the bags manufactured.

For the first year (2010-2011), GIC-DEMRI ordered PICS bags based the following considerations: (1) the estimation of the demand for bags before the implementation of the project; (2) the quantity of bags needed for the demonstrations; and, (3) the estimation of the production and storage of cowpea (i.e., potential demand).

In the second year, they ordered 15,000 PICS bags because 13,000 PICS bags remained in stock in the first year. The main element that guided the quantity ordered in year two was the level of sale during the 2010-2011 campaign. Bags are procured by GIC-DEMRI's own funds.

In 2010-2011, 9,500 bags were sold for demonstrations to PICS project at 1200 FCFA/bag. Three thousand bags were sold at costs between 1,050-1,200 FCFA/bag by the semi-wholesaler, retailers, and producers, and 1,500 bags sold at 1,000 FCFA/bag to traders, collectors, and storekeepers.

Some bags were sold to wholesalers from Tchad in December 2011 because the Tchadians encountered some difficulties in buying directly from Kano, Nigeria. This suggestion was made by Baributsa. With Baributsa, they studied the possibility of obtaining the bags from GIC-DEMRI in Cameroon. The price of the bags, including transportation costs, is estimated at 1050 FCFA at the Cameroon border (Touboro). They studied the feasibility, including cost, comparing Kano Moundou to Garoua-Moundou. GIC-DEMRI gave them a quote to the border 1050 FCFA/bag in Touboro, Cameroon. This price is perceived to be higher by the Tchadian wholesalers. After negotiations, the final price agreed upon was 875 FCFA/bag for bags delivered at the Touboro border and 850 FCFA/bag for bags delivered at Figuil border. Kongobe had made two orders of 2,000 and 1,500 PICS bags from GIC-DEMRI at 875 FCFA/bag. Mr. Joseph Gandar, a Tchadian wholesaler and a retired nurse, has not yet made an order but was planning to do so. CECADEC bought 1,000 bags at 1,000 FCFA/bag; these bags were delivered at Guider, located 30 km from the Tchad border. Tchad Merchant 1 (TR1), based in Lere, bought 100 bags at 1,000 FCFA/bag, delivered at Guider. There were some potential buyers from Central African Republic; one of them, from Réseau National des Associations des Tantines (RENATA), has participated in the training organized for Cameroon and Tchad facilitators.

Semi-wholesaler and GIC-DEMRI Agencies

C5 is the GIC-DEMRI-Maroua manager. He is a paid staff member of GIC-DEMRI. GIC-DEMRI-Maroua leads the distribution of inputs (pesticides, fertilizers, and seeds) in the upper north. It has outlets in provinces and districts composed of semi-wholesalers, retailers, and private partners of GIC-DEMRI. GIC-DEMRI-Maroua has been involved in selling PICS bags since 2010. The bags are sold through the inputs distribution network. The network is in continual expansion due to the entry of new private partners. GIC-DEMRI-Maroua is comprised of five branches (Kaélé, Yagoua, Mokolo, Kousseri, and Mora) and 250 retailers. Usually inputs are sold using cash, but certain new customers receive products on consignment.

C6 has been the branch manager of GIC-DEMRI-Mokolo since June 2011. She keeps inventories and works with two commercial vendors that go to markets and villages to sell chemicals, fertilizers, and PICS bags. She participated in the marketing training in Maroua. Generally she sells PICS bags at the store but sometimes goes to markets and villages. Major

markets frequented by the vendors on daily basis are Zamai (Monday), Roua (Tuesday), Mokolo centre (Wednesday), Tourou (Thusday), Mougodé (Friday), Souléde (Saturday), and Rhunzu (Sunday). Since November 2011, she operates alone because one of the vendors went to Maroua and the second one is not reliable anymore.

C7 is the agricultural extension officer of the Ministry of Agriculture and is also a new vendor of PICS bags in Mora. He was proposed by Lontchi. C7 was one of the facilitators of the PICS project in the area of Mora. He was trained by Lontchi's team and has participated in outreach activities, awareness building, demonstrations, and OBCs. C7 became a bag vendor because farmers were consistently asking for the bags. He sold around 200 bags during the 2010-2011 cropping season and 120 bags during the 2011-2012 cropping season. He sourced the bags from the semi-wholesaler of Mora (C12), who delivers the bag at his office at 1200 FCFA/bag. The bags are sold at the same price because according to him, he works for the farmers and it is his job to ensure that farmers get the bags on time. In the near future, he is exploring the possibility of becoming a vendor as part of his private business. To this end he has already met with GIC-DEMRI-Maroua to negotiate terms of having the stock on consignment.

C9 is a trader in the Ngong market. He has a warehouse and a shop in the market. He rents his warehouse to other grains merchants at 100 FCFA/bag (100kg) per month. Usually, the grains stored in his warehouse are conveyed to southern Cameroon (Douala, Bafoussam, Bameda) and re-exported to Gabon and Central African Republic. In his shop, C9 sells regular bags, insecticides, fertilizers, PICS bags, and other goods. His main clients are merchants and traders (grains and legumes). In his shop, the regular 100kg bags (commonly called "Baba Gana") are sold at 300 FCFA/bag, with PICS bags being sold at 1,200 FCFA/bag. In 2011, he bought 300 bags and sold 280 of them.

C10 is a member and the President General Director of GIC-DEMRI. He is a farmer and merchant. He grows onion (2 hectares), okra (1 hectare), millet, cowpeas (3 hectares), peanuts, and cotton (15 hectares). He began only growing millet and has expanded progressively to other crops. Gradually, he started producing cotton because it is easier to get inputs on credit. Part of the inputs obtained for cotton production is used to grow onions. C10 has shops where he sells phone cards (MTN, Orange), pesticides, PICS bags, and soft drinks, among other things. He invested 50% of his capital in the PICS bags business because he is a member of GIC-DEMRI; otherwise, he would not have made such a decision. For him, it was necessary to support GIC-DEMRI. According to him, the turnover rate of PICS bags is low; PICS bags are not profitable because it requires a huge investment of capital. There is also a communication problem: the producers do not know where to buy the bags. The message broadcast on radio did not mention where to source the bags from. He ordered 100 bags at 1,000 FCFA/bag, with 50% as down payment. The bags are sold at 1,200 FCFA/bag. Since 2011, only 70 bags were sold. He said, "I invest 50,000 FCFA a week to buy soft drink and gain 5,000 FCFA a week. Since two years ago, I invested 50,000 FCFA [in PICS bags] and some are still unsold. The bags are not well known."

C11 has a shop in the central market. He is a wholesaler of PICS bags and received the bags on consignment from GIC-DEMRI-Mora. He is an independent merchant; he shares his shop with his brother. He does not buy the bags in bulk and often buy up to ten bags at each order. He worked with extension agents (AVZ) at Mokio, Tokombéré, Warba/Mémé, Megdemé, and Moyo Plata. He receives the bags directly from the GIC-DEMRI store on consignment at 1,050 FCFA/bag and sells them at 1,200 FCFA/bag. He has no signed contract with GIC-DEMRI. Markets frequented by C11 are Godigon (Monday), Tokoumbéré (Tuesday), Zourlfo (Wednesday), Meme (Friday), Plata and Koumgui (Saturday), and Mora centrale (Sunday).

C12 is the Kaélé branch manager of GIC-DEMRI and the owner of the store in visited. He was absent, so the interview was conducted with his assistant. Products sold include fertilizers, cottonseeds, animal feed, gasoline and PICS bags (2010-2011). He received 1,000 PICS bags but has sold only 56 bags. GIC-DEMRI took back 894 bags and the 50 bags remaining are kept in his store. Bags are delivered at 1,050 FCFA/bag and sold at 1,200 FCFA/bag. Bags are sold in the store and in local markets such as Doumourou (Monday), Garai (Wednesday), Moulvouday (Friday), Lara (Saturday), and Guidiguis (Sunday). The bags are brought in the markets by C12 himself. He has two roaming vendors who go place to place to sell the bags and receive a commission proportionally to the volume of bags sold.

C13 is an extension agent and a semi-wholesaler of PICS bags based in the central market of Yagoua. He is the owner of two stores in the market. He has placed some bags on consignment in the stores of some of his friends at "Bec du Canard" at the Cameroon-Tchad border: Kalfou (a retailer) and Doukoula (another retailer). He received the information about PICS through an extension agent in 2010. This extension agent selected him as a distributor of bags. He has been working with GIC-DEMRI for five years in the field of agricultural inputs. He was contacted by GIC-DEMRI, which placed some bags on consignment at 1,100 FCFA/bag. In 2010, he received 1,081 bags and in 2011, 600 bags. Bags are sold at 1,125 FCFA/bag. C13 also supplies bags to retailers on a consignment basis at 1,150 FCFA/bag. Most of his customers are cowpea and grains producers. Some traders buy the bags; however, they do not purchase them in bulk as they don't store cowpea for a long period because the Tchadians travel to the "Bec de Canard" to buy the cowpea. Retailers sell the bags at 1,500 FCFA/bag to Tchadians. To allow people to test the effectiveness of the PICS bags, C13 gave out around 100 bags for free to farmers. The value of these bags is 100,000 FCFA. Later on, most of them came back to buy the bags. He has experienced a rupture problem at the beginning of the cropping season of 2011-2012. While there appeared to be some bags on stock, retailers had already sold all their bags. Some have sold on credit, others on cash, but the money was used to buy other goods. This situation blocked the supply chain. To resolve this issue, C13 personally paid back GIC-DEMRI in order to receive additional bags. After the payment, he received 600 bags from GIC-DEMRI.

PICS project partners

Team of CNPC-C /SODECOTON

The interview was conducted with Mr. Hamadou Nouhou, the Executive Director of CNPC-C. The CNPC-C works twoards the professionalization for sustainable agriculture. The main objectives of CNPC-C are: (1) representing and defending the interests of cotton and food crops growers; (2) ensuring the supply of quality agricultural inputs and equipment; (3) ensuring the professionalization of producers; (4) promoting the development of cereals banks or grain storage; and, (5) developing any other activities that can improve producers' livelihoods.

The organization is structured as one confederation composed of nine federations of GIC unions, nine federations of GIC unions of cotton and food crops producers (FUGPCV), 48 GIC unions of cotton and food crops producers (UGPCV), and 2048 GIC unions of cotton and food crops producer at the base (GPCV).

CNPC-C is a nonprofit organization, but it deals with important economic activities, particularly in the area of input supply (i.e., herbicides, fungicides, fertilizers, insecticides,

small agricultural equipment) for its members. The inputs the organization buys are given on a credit basis to its members without interest—and at prices much lower than the current market prices. To better understand the food security situation in the upper north of Cameroon, the CNPC-C finances the grain storage and supervises cotton farmers' associations in the northern and upper north of Cameroon. Currently, the CNPC-C is helping to promote some subsectors such as maize, soybean, peanut, cowpea, and sunflower. The maize subsector, which is subject to constant price fluctuations, tends to become a non-profitable one. The role of CNPC-C is also to assist farmers in efficient use of production factors and locating good market opportunities.

Through six radio stations and CNPC-C news, it is also involved in the animation, backstopping, counseling, hotline information, training, and control of fraud and information for the well-being of its members. To improve farmers' level of literacy, CNPC-C includes a literacy and post-literacy program in Fulfulde (the language most spoken by producers) and French in its activity portfolio.

With respect to PICS activities in 2010, CNPC-C has contracts with rural radio stations and the state radio to broadcast message on PICS bags. The radio messages are broadcasted in several languages, focused on outreach, awareness building, demonstrations, monitoring, and OBCs. CNPC-C wants to include PICS bags in the group of the ag inputs in order to benefit from credit given to other ag inputs. The bottleneck is that CNPC-C does not want to buy PICS bags from GIC-DEMRI because GIC-DEMRI is acting as a for-profit organization and therefore will seek to make profit from the bags sold. CNPC-C instead prefers to directly source the bags from Lela Agro.

Diocesan Development Committee (CDD)

C14 and C15 are (respectively) General Secretary and Agronomist, in charge of the agricultural component of CDD. CDD is a Catholic NGO of the Diocese of Maroua-Mokolo, which aims at facilitating and promoting development activities for the benefit of the entire population of the Diocese, regardless of race, ethnicity, region, or gender. Created in May 1982 by the Catholic Church, the CDD was created by the parishioner of the diocese to support the poor population in the improvement of their living conditions. To do this, CDD supports people in eleven areas, including promoting women, health, drinking water supply in rural areas, education, assistance to people in emergency situations, education for citizenship, youth support, agriculture and livestock development, adult literacy, improvement of incomes, and desertification control. CDD is the coordination committee that set priorities of the targeted group before initiating actions. CDD has received funds from Canada after the famine of 1987-89 from the Foundation Emil Paul LEGER.

The agricultural component of CDD's work includes technical training for farmers; facilitating access to certain basic inputs, including seeds, phytosanitary products, and animal feed; and food security with the promotion of community granaries and storage to secure the crops. Farmers store the amount of food necessary for the lean period. The community granaries are managed by the villagers. CDD also provides funds to procure food from farmers at harvest and resell to the community at an affordable price during the lean period. CDD also works on the development of soybean and sorghum subsector, including: the promotion of sales groups; searching for market opportunities; release of information; creating links between CDD and partners; and looking for buyers. The objective is to help

producers keep their products and sell when the price is good. CDD promotes and supports the processing of agricultural products as well as promotes the production of onions.

For cowpea production, CDD faces a serious postharvest infestation problem. They are in touch with seven technicians in seven production zones: one technician for seven parishes, two to three facilitators or coaches in each parish, twenty parish leaders, and five to ten local leaders at village level. They have a training center for farmers called "Jericho Center", which was created in 1998 and is located in the province of Diamaré in the Meri district and in the village of Waza, 30km away from Maroua. PICS bags were tested in this center with the technical support of IRAD. CDD sent three facilitators to the training organized by the PICS project in Maroua in 2010. These three people constitute the nucleus around which the community granary team was trained and informed, who in turn inform the facilitators and the entire community. Before PICS, CDD supplied chemicals (deltamethrin) for storage to farmers but since PICS bags were discovered, they are used in place of deltamethrin. In 2010, CDD received five PICS bags for demonstrations at the Jericho Center. CDD was informed about the availability and the purchase of the PICS bags.

La Maison du Paysan

"La Maison du Paysan" is an NGO based in Tonkombéré. C16 and C17 are the Director and a facilitator of the NGO respectively. "La Maison du Paysan" is the social work of the Diocese of Maroua-Mokolo. This is a training center and meeting place for capacity and awareness building in regards to agricultural production and livestock. Major activities of this center include training, developing nurseries and expanding orchards for environment protection, monitoring of farmer organizations, monitoring of cereal banks and granaries, monitoring the supply of agricultural inputs, animal care, the implementation of farmer field school, and outreach activities of new agricultural practices, such as direct seeding.

This center is a diffusion center of PICS technology with the technical support of IRAD. In 2010, fifteen PICS bags were bought to store cowpea seeds. In 2011, fifteen additional bags were procured to store cowpea seeds. Farmers were aware where to procure the bags. Technicians were instructed to help farmers to buy the bags by bringing them to the center. Together with IRAD, the NGO distributed free bags to women in 2010 and 2011 for public demonstrations. One question: is it possible for the government to subsidize PICS bags to help farmers?

Foundation of Mother Celestine

C18 is the priest of the Parish of Immaculate Conception of Lara, Diocese of Yagoua. This parish also runs the "Foundation of Mother Celestine", which aims at promoting agriculture, among other activities. C19, a development officer from Italy based in Lara, worked several years with producers and associations of men and women. He bought the PICS bags at Mora and distributed them for free to its groups to store cowpeas. The team could not meet him because he already went back to Italy, but the team was well-received by the parish priest. Activities carried out by this foundation include training, capacity building in cultural techniques, fertilization, management, and food processing.

Current major issues at each level of the chain

Manufacturing defects of PICS bags

Manufacturing defects of the PICS bags include torn bags, bags that were punched down or badly cut, and bags with only one inner lining instead of two. There were also missing bags in bales of 300 bags sent by the manufacturer.

High dependency of GIC-DEMRI on the PICS project team

GIC-DEMRI barely takes initiative, apart from those taken by the project team. The lack of initiative taken by the distributor may hinder the expansion and sustainability of the supply chain.

Unavailability of bags in some outlets

Some people complain that GIC-DEMRI does not want to go villages to sell small amounts of bags (two or three bags) to farmers. This was a cause of the localized rupture in some places.

Insufficient geogaphical coverage

There was insufficient geographical coverage of GIC-DEMRI in major production and commercialization of cowpea.

Reliance on chemicals

Large cowpea traders rely on chemicals for cowpea storage rather than using PICS bags because of cost effectiveness (for example, 4,000 FCFA of chemicals suffices to treat 50 100kg PICS bags).

Low cowpea production

The low production of cowpea during the 2011-2012 cropping season due to low rainfall (rain stopped earlier than planned) was a challenge. Because of this, there was not enough cowpea to store.

Communication and marketing problems

The radio broadcast messages did not provide the contact information, such as phone numbers and places where the bags can be found. This is a weakness of the collaboration between GIC-DEMRI, NCPC-C and radio.

Nigerian cowpea market

The vicinity of Nigerian cowpea market makes the estimation of PICS bags needed difficult. For example, in 2010-2011, Nigeria sent about 1000 PICS bags of cowpea per month on the Cameroon markets from March to July 2011. The price of cowpea was very cheap compared to cowpea produced and stored in Cameroon.

Counterfeit bags

Counterfeit plastic bags were sold at the Nigerian-Cameroon border (Rhumzu markets, Tourou, Mokolo Mougode) at 400 FCFA. For farmers, these bags are cheaper than PICS bags.

Lack of research

Another challenge was the decline of research work on the renewal of certified seeds of cowpea.

Strategies developed to encourage private actors' investments

There were several strategies developed to encourage private actor investment. One strategy was purchasing bulk amounts of PICS bags from the wholesaler for demonstration. Around 1,468 villages were selected for awareness building, demonstrations, monitoring, and OBCs in the north and upper north. Another strategy was the hiring of a business consultant to help the wholesaler develop and expand the distribution chain. Signing of contracts with CNPC-C and radios to organize and handle the communications component of the PICS project was another strategy, along with the organizing of training seminars for semi-wholesalers. Several training courses were organized in 2010 and 2011 for semi-wholesalers under the PICS project. Organizing technical activities for the project, such as awareness building, demonstrations in the villages and markets, opening ceremonies, and training of NGOs and journalists, helped create and stimulate potential demand for PICS bags in 2010 and 2011, along with the media effort to spread the PICS message to a larger public. Another successful strategy was the organization of caravans by GIC-DEMRI and IRAD to enhance the sale of PICS bags in the weekly market.

Solutions to expand the supply chain via increased private sector investments

Awareness building in southern Cameroon is very important to compel big grain collectors and traders to use PICS bags for cowpea storage. The south of Cameroon and Nigeria also constitute potential markets for cowpea.

To avoid rupture problems, the GIC-DEMRI should make a new PICS bag order with Lela Agro when 50% of the stock is sold.

Encouraging GIC-DEMRI to expand its network beyond the current size by seeking new customers or going to villages to bring the bags to farmers in all the major production areas of cowpea would be an asset for the sustainability of the chain.

Strengthening radio ads with the financial support of GIC-DEMRI and Lela Agro may help sustain the supply chain. Other incentives to chain actors may include rewards to the best PICS bags sellers.

Strengthening public awareness to better inform people to understand the usefulness of the bags is important to sustain the supply chain.

Involving the government, potentially by exempting PICS bags from taxes in order to enhance their usage by farmers and to protect consumers and encourage the private sector, is a potential incentive.

Another potential strategy is to strengthen the research work on the renewal of cowpea certified seeds.

Key lessons learned from country experience

An organized and pre-established distribution network of agricultural inputs (i.e., GIC-DEMRI) is an asset for the development and sustainability of the distribution chain of PICS bags in Cameroon; however, this network must expand continually to reach areas not yet covered.

Volume buyers such as Tchadian wholesalers, NGOs, and other projects contribute significantly to the evolution of the chain and a source of incentives for the supply chain actors regarding the volume of sale and the turnover rate. They are very important for the sustainability of the chain.

The involvement of roaming vendors in the chain (i.e., commercial agents) who sell the bags in the weekly markets significantly increases the volume of sales and the return on investment.

An effective mechanism of coordination, monitoring/evaluation, and planning (as was the case between Purdue, IRAD, GIC-DEMRI, media, and the business consultant) is a key element for the success of the supply chain.

Personal motivation, a good perception about PICS bags, a good understanding of input markets by the national distributor GIC-DEMRI, and a long-term relationship between network actors is a key factor for the success and sustainability of the PICS bags supply chain.

The moral guarantee of the PICS project by Purdue is an important support to the national distributor GIC-DEMRI vis-à-vis the manufacturer.

The strong dependence of the national distributor (GIC-DEMRI) vis-à-vis the PICS project team at Purdue is a weakness and need to be overcome for the sustainability of the supply chain because it hinders GIC-DEMRI initiatives to expand the distribution network.

The technical support provided by the Ministry of Agriculture or any partners is essential for further training and the promotion of the bags when the project phases out to help ensure the sustainability of the distribution chain.

ANNEX

Image 1: Distribution network of PICS bags in Cameroon

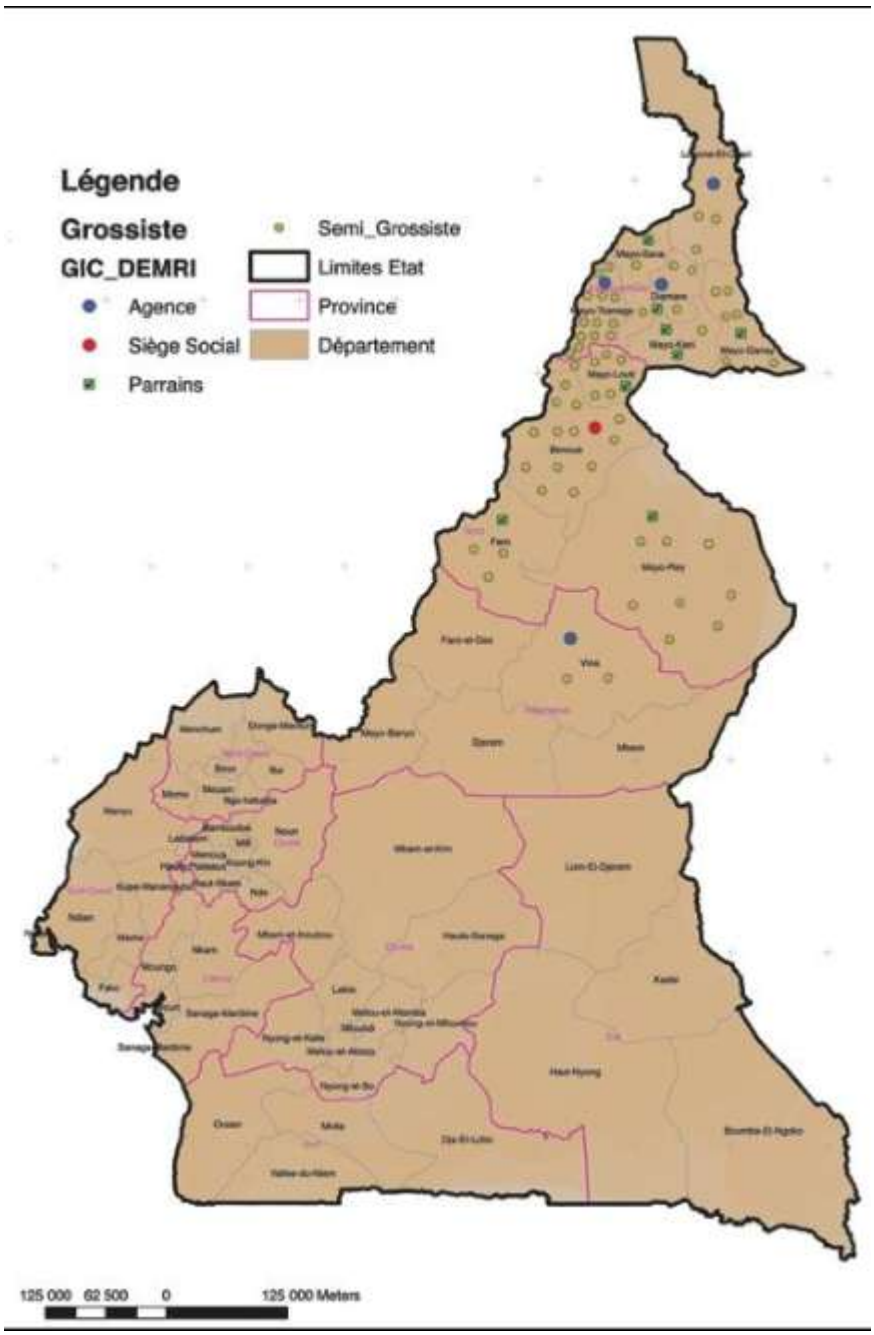


Image 2: **PICS Bag Supply Chain in Cameroon**

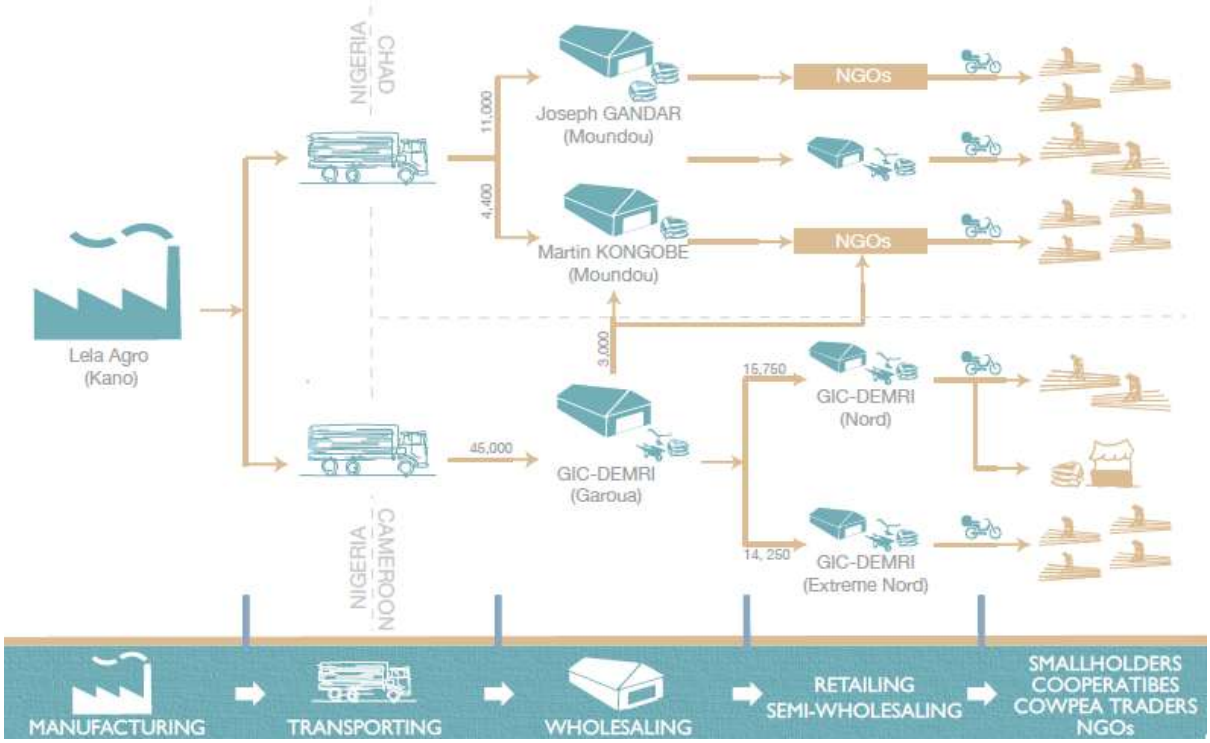
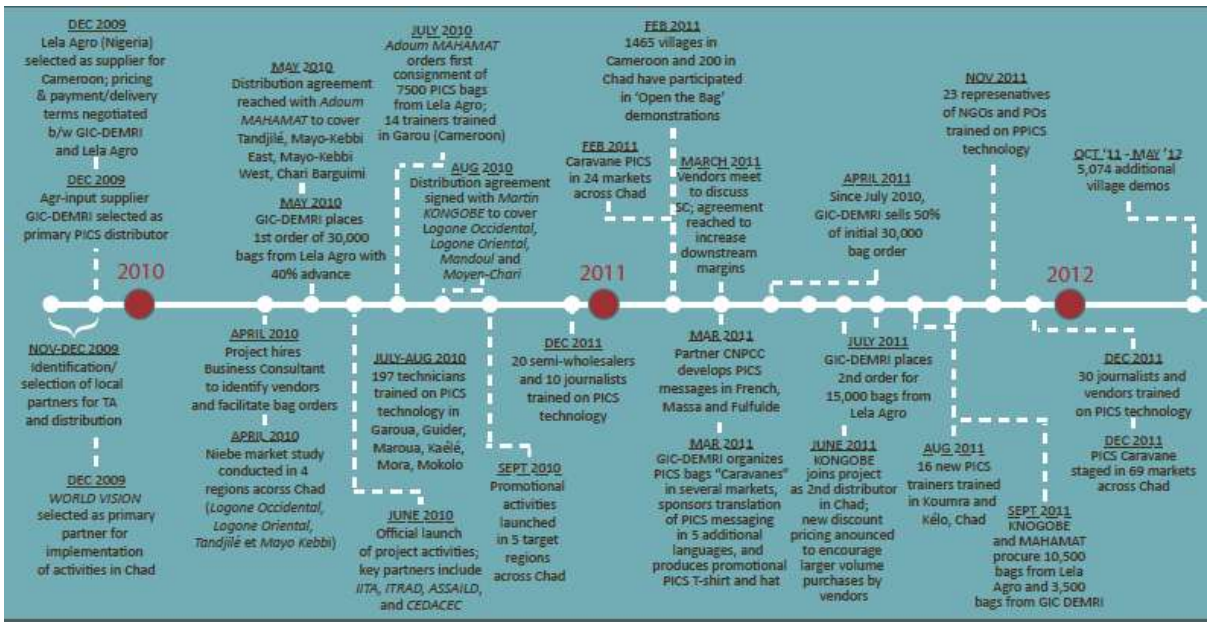


Image 3: **Timeline of PICS Project in Cameroon (2010-2012)**



GHANA

Presentation of PICS supply chain study

The PICS project was implemented in Ghana in December 2009. Prior to the implementation, the project leader at Purdue attended the US-Africa Conference on Higher Education on Development (HED) in August 2009 in Accra, Ghana. Lowenberg-DeBoer used this opportunity to seek potential NGOs to partner with the PICS project in Ghana. On August 26, 2009, he made some initial contacts with some potential partners, including Kofi Debrah of the International Fertilizer Development Center (IFDC) and Dr. Issoufou Kapran of Alliance for a Green Revolution in Africa (AGRA), who suggested contacting Edo Lin of the West African Seed Alliance of Ghana (WASA-Ghana). Lowenberg-DeBoer also met with Nick Railston-Brown of Technoserve-Ghana, who also suggested working with IFDC because Technoserve-Ghana had used the hermetic storage for an inventory credit but this program collapsed because of the high transaction costs. Debrah proposed Afia Nyantakyi, the vice president of Ghana Agro-Dealer Association (GAIDA) and owner of Seedshop Company in Ghana. On August 27, 2009, Lowenberg-DeBoer met with Kofi and Afia Nyantakyi to discuss the possibility of leading PICS bag distribution in Ghana. Seedshop has experience with hermetic storage bags and was contracted by the Millennium Development Authority to produce 50kg for maize, seeds and fertilizer. With respect to the technical component, Lowenberg-DeBoer also met with Dr. A. B. Salifu, Director of the Council of Scientific and Industrial Research (CSIR) to discuss the possibility of CSIR leading certain activities of PICS in Ghana, such as training of field technicians, baseline adoption survey, and impact assessment studies. Other partners were also explored, such as Isaac Kwadwo Asare from Ghana Agro-Dealer Development (GADD); the GrainPro bags for the production of the bags (though the cost of bags proposed by this manufacturer is expensive); and the Adventist Development and Relief Agency (ADRA), represented by Asante Mensah, who is also the responsible for the Millennium Challenge Corporation (MCC) agricultural project in the middle regions of Ghana. Discussions with Mensah focused on some technical issues, such as TV broadcasts, bag manufacturing, cowpea production system, and some statistics data on cowpea. Mensah mentioned that ADRA works closely with World Vision-Ghana (WV-Ghana), which was later selected to coordinate PICS activities in Ghana. Regarding the production of the bags, Polybags Ghana was suggested to Lowenberg-DeBoer given its production capacity and its experience in Ghana.

In December 2009, the PICS project was officially implemented. Baributsa met with potential PICS in-country partners, including WV-Ghana, Polybags, and Seedshop. Discussions with WV-Ghana focused on the implementation of the project—in particular, the commercial message for the bags on radios and televisions, the choice of districts and villages for PICS activities, and the field technician training. Discussions with Seedshop focused on the quality issue of the bags and the content agreement between Purdue and Seedshop. Seedshop has contacted Polybags and had discussed the price of the production of the PICS bags, using samples from Mali provided by Lowenberg-DeBoer. The meeting with Polybags was about the specifications of the bags and the quality compliance. Early in 2010, PICS activities were launched in Ghana. The following section explains the roles and challenges faced by each actor during the implementation of the activities and in the development and expansion of the supply chain.

Supply chain actors

The key actors that constitute the supply chain of PICS bags in Ghana are the manufacturer Poly Sack, along with the national distributors and their respective retail outlets as shown in Figure 1 in the Annex.

Poly Sacks Ghana Ltd.: Manufacturer

Poly Sacks Ghana Ltd (Poly Sacks) is a joint Indian-Ghanaian company located in the North Industrial Zone of Accra and experienced in the production of bags with liners for more than 25 years in Ghana. It is part of the Poly Group, which encompasses other companies such as Polytank, Poly Products, and Polycraft. Poly Group is specialized in the production of plastic bags, PVC bottle containers caps, polypropylene, bags, plastic water tanks, jerry cans, all forms of carrier bags, plastic bottles, mineral bottles, and blue band containers for West Africa. According to the marketing director, Poly Group is financially secure. The company sources raw materials from the Middle East, Asia, and South Africa. It also supplies raw materials to other small companies in Ghana. The company can manufacture about 65,000 bags a day. It takes roughly six weeks to produce 100,000 PICS bags; this is due to the specifications of PICS bags, other ongoing activities, and the fact that the inner plastic bags are produced by another branch of the company (Polytank). The credit facilities are available, but they often go by the overdrafts even though some banks are highly interested in giving credit. Poly Group does not have a distribution network. The company has a regional depot in Kumasi. Its customers are composed of 85% other companies, 10% individuals, and 5% trustworthy retail outlets selected by the manufacturer to distribute their products.

Poly Sacks manufactured PICS bags for the first time in 2010 and has produced and delivered 27,000 bags to the former national distributor, Seedshop. To facilitate the order of this volume of bags, Poly Sacks asked for a down payment of 50%. Generally, the company does not give credit to new a distributor; credit comes after a certain amount of transactions and time necessary to strengthening the relationship among the two parties. According to Poly Sacks, the incentives for giving credit to the PICS distributor is first and foremost the humanitarian and the health-related issues (i.e., reduction of the use of chemicals during the storage; the increase of farmers' income) associated with the use of PICS bags; secondly, credit is given because of the promoters of the project (Purdue University). To date, there is an unpaid balance of 20,855.48 GHC from Seedshop. The PICS project at Purdue cancelled the agreement that allowed Seedshop to act as the national distributor in order to allow distributors who wished to invest in PICS bags business to do so. In 2011, Poly Sacks decided not to produce the bags unless the debt is cleared. After long discussions with the PICS business consultant and the regional distributors, Poly Sacks finally decided to manufacture the bags but on a cash-and-carry basis to the three regional distributors in the Northern, Upper West, and Upper East regions at 2.25 GHC/bag. This meant that the regional distributors had to pay the full production cost up front at order before the bags could be manufactured. The decision to produce bags in 2011 was subject to the business consultant working with the former national distributor (Seedshop) to clear his debt at the earliest time. Kofi Nyantakyi sent a letter to Poly Sacks in November 2011 indicating how he is going to pay his debt. By the time of our interview (February 2012), he neither showed up nor tried to wire the money as he stated he would in his letter. The factory, disappointed, is not willing to manufacture the bags for the coming season unless the debt is cleared. For the factory, Seedshop has the necessary resources to pay but it is less committed to clear the

debt. Given the current status, the current question is if it would be possible for the regional distributors to procure the bags for the coming cropping season even if they pay the full production cost at order.

One of the major challenges encountered by Poly Sacks is the price fluctuation of raw materials, as PICS bags are a petroleum-based product. The second most important challenge is the volatility of the exchange rate of Ghana currency in the market. The fluctuation could be lessened if the price of the PICS bags is dollarized. To overcome this fluctuation, Poly Sacks plans to increase the cost of the bags by 10% for the next season. Another challenge mentioned is the low volume of bags ordered. The quantity demanded is not high (10,000), which is not cost-efficient. Poly Sack also reported the late order by the distributor and suggests order be made on time to avoid delays in the delivery.

Seedshop Company: National Distributor (2010)

The distribution of the bags was led in 2010 by Seedshop, which acted as the national distributor and the regional distributors in the Brong-Ahafo, Northern, Upper West, and Upper East regions. The bags were procured through Seedshop's direct fund, with a down payment of 50% at order. A total of 27,000 bags were procured. WV-Ghana took 17,000 bags for the demonstrations, and the remaining 10,000 bags were distributed on consignment to the regional distributors. The regional distributors, as well as the national distributor Seedshop, belong to the same association, Ghanaian Agro-Inputs Dealers Association (GAIDA). The regional distributors have paid almost all the money, but, according to Seedshop, the flow of the payment was slow because the regional distributors did not make bulk payment. Seedshop affirmed that it was not easy to put all the money together and to pay back the manufacturer. Kofi Nyantakyi of Seedshop recognized that he still owes the manufacturer 20,855.48 GHC (an equivalent of around $13,000 USD). The nature of the relationship within the GAIDA network is partially formal and partially informal; it is a sort of an inter-relationship because members are not prepared to pay cash. Most of the transactions are done in-kind; for example, one can provide insecticides to another and receive back other inputs like seeds.

The first major challenge Seedshop faced in PICS bags distribution is the nature of the relationship seen in the GAIDA network. In the GAIDA network, input dealers depend on each other, and any misconduct by a member of GAIDA is costly because the dependence is perceived as a strategy to mitigate risks associated with the ag input business. To maintain and strengthen this social network, patience is a key element to consider. When an outside supplier like Poly Sacks demands the money on-time, the type of the relationship seen in the GAIDA network does not help at all because of the long delay in payment. The long delay of payment was aggravated by the fact that PICS bags are new products; as such, the demand at the farmers' level is low at the beginning. The farmers need first to be convinced to buy the bags. With respect to the debt, the unpaid balance is explained by some logistics problems. Four bales of bags (about 1,200 bags) were damaged because the bags were dropped at the road side for days and were exposed to sun and rain. The bags got spoiled by the water and dust. Some of them were given away almost for free. Another logistic constraint was the delivery of the bags to the different regions, especially in the WA district in the Upper West region, where the cost of transportation is high. According to Seedshop, the high transportation cost absorbed most of the margin earned in distributing the bags.

Seedshop says it planned to clear the debt by the end of July 2012, but this has not happened. Seedshop envisions ordering the bags and distributing them through the Agricultural Business Centers (ABC) network because the company is currently involved in ABC's projects in ten regions for food processing. ABC's network is as strong as GAIDA's network. The goal of ABC is to store grains (i.e., sorghum, maize, millet) for processing. For Seedshop, the ABCs are potential volume buyers. Regarding PICS business, Kofi Nyantakyi of Seedshop said "we all have gone through a learning curve" and the experience of PICS bags distribution with GAIDA network will be used to efficiently tackle the distribution of the bags in ABC's network.

Regional Wholesalers and Retailers

Currently, the distribution of PICS bags is led by the regional wholesalers; the former national distributor dropped off because of nonpayment. Today, there are three regional wholesalers, including one in the Upper East (Bolga and Bawku), one in Upper West (Wa), and one in Northern region (Techiman). All the wholesalers belong to the GAIDA network.

Wholesaler: Simple Prince Enterprise

In the Upper East region, the distribution of PICS bags is led by Simple Prince Enterprise (represented by Prince Yao Korvey) and Dauda Entreprise (represented by Usman Daouda), wholesaler of the bags in Bolgatanga and semi-wholesaler in Bawku, respectively. Prince entered the PICS business in 2010. He is an ag inputs dealer, supplying ag inputs since 1991. He has a good ag inputs supply network and four retail outlets at Zebila, Binaba, Walewale, and Fumbissi. Within the outlets, bags are either placed on consignment for some of them (the ones he trusts) or are sold on a cash-and-carry basis. He has credit lines with UT bank and Stanbic bank. The annual interest rate is 23% for group credit and about 40% for individuals. In 2011, he received 15 bales (3,000 bags), and all the bags were sold. He took 100 bags from another vendor and, by the time of the interview, 42 remained. According to him, Wa (Upper West) was asking for bags; he collected two bales from the distributor of the Northern region and shipped them to Wa. As a marketing strategy, when a customer asks for bags, he directs him to the closest selling point, no matter whether the selling point belongs to him or to another distributor. As a marketing strategy, he purposely kept some cowpea he stored with PICS bags in 2010 in his store and shows people who come to buy chemicals for storage. This strategy convinces customers of the quality of the bags. Taking a credit for this business is not appropriate because PICS bags sale is seasonal and because of the high interest rate of the bank. Considering the current turnover of the bags, the return on investments of PICS bags is not sufficient to offset the interest rate.

Retailer: G1

G1 is an ag inputs dealer located at Bolga (Upper East Region) and a retailer of PICS bags. He started supplying the bags in October 2011 as a retailer because farmers asked for them at his shop when buying other ag inputs. He attended the training workshop organized by the project. He purchased one bale (200 bags) from the wholesaler Prince at 3 GHC/bag and sold them at a rate of 3.50 GCH/bag to farmers. All the bags were sold within a month, and there are currently no bags in his store. He wanted to purchase an additional bale, but the bags were not available at the wholesaler's store. Buyers of the bags are predominantly

farmers who stop by at his store to buy other ag inputs. He reported that some bought the bags in bulk to supply their fellow farmers in the villages. For farmers who do not know about the bags, he markets for the sack by presenting its health advantages and showing them how to use the bags. Some of these farmers buy the bags after the demos but also buy some phostoxin because they are not sure about the effectiveness of the bags. The bags are sold uniquely in his store and he does not have any retail outlets.

Wholesaler: Antika Enterprise

In the Upper West of Ghana, the distribution of the bags is led jointly by Antika Enterprise and Seyan Chemicals Enterprise. These two distributors are also ag inputs dealers. According to them, the PICS bags are good and the farmers are patronizing them already, but the project is still at the introductory level and more sensitization is needed. Antiku Enterprise is composed of forty retail outlets in nine districts of the Upper West region. There are also some extension agents who pick the bags and sell them to farmers. Seyan Enterprise has five retail outlets. Both wholesalers have huge warehouses and have a good relationship with banks such as the National Investment Bank and Stambic; however, they don't rely on bank credit because of the high interest rate (40%). They prefer to use an overdraw approach instead and pay back within a week to avoid any charge. With respect to the sale of the bags, in 2010, ten bales were purchased and in 2011, twenty bales were purchased and all sold. Bags are used for cowpea and other grains. One potential volume buyer is TechnoServe. The current buyers of the bags are farmers and Savannah Agricultural Research Institute (SARI). SARI bought 700 bags for their farmers to store maize and cowpea. SARI leads block farming across the country. Block farming is a program implemented by the government to increase food security and to reduce rural migration. There are also some extension agents who buy in bulk and retail to farmers and the women in the market (traders of grain). These women store grains and they bought some bags last year to store their products.

Wholesaler: Wumpini Agro Chemicals

In the Northern region, the distribution is led by Wunpini Agro Chemicals. This wholesaler is an ag inputs dealer located at Tamale. He started with PICS at the beginning and became the wholesaler of the Northern region in 2011 when the national distributor was not able to supply the bags to him. There are some volume buyers, such as Presby Farm and the Ministry of Agriculture (MOFA) that purchase the bags to store seeds and grains. In 2010, eight bales were purchased and in 2011, fifteen bales were purchased and sold. Wunpini Agro Chemicals has a credit line with some banks and some retail outlets in Tamale and some others across the entire northern region**.**

Retailer: G2

G2 is an ag inputs dealers located in Tamale and a retailer of PICS bags. He sources bags from Wumpini. One of the constraints he faced in the first year of the project is that the media said the bags are only good for cowpea. This limited farmers at the beginning in purchasing the bags. He sold all the bags on a cash and carry basis. MOFA had planned to order 30,000 bags from him, but this project did not come to a final decision. At the beginning of the project, it was difficult for him to advertise for a new product. Farmers did

not believe to the effectiveness of the bags. As a strategy, demonstrations and sensitization are important to persuade farmers about the advantage of the bags. For him, there some potential volume buyers like the ABCs which are not yet aware of the bags. The retail outlets of G2 are composed of ten selling points, including Yendi, Salaga, Bibinla, Damango, Sola, Gambage, Walewale, Chereponi, Buipi, and Tolong. In addition, he brought some bags to his village for demos.

Wholesaler: Yeboah Enterprise

In the Brong Ahafo region, the distribution was led by Yeboah Enterprise, based in Techiman, which specializes in the supply of ag inputs. The company has about ten retail outlets. With respect to PICS, the bags are good and farmers are aware about them and are willing to buy, but the bags are not available. Most farmers prefer the bags to the use of insecticides to store foodstuffs in ordinary bags. He has started with the PICS in 2010. Sales that year were not good because the bags were not known. But later on, all the bags they have were sold at 3.00 GHC/bag. Major buyers are farmers and traders. The bags are used for different crops such as cowpea, soybeans, and cereals. Access to credit is not an issue because he has good relationships with banks. Given the high demand, the bags should be available, otherwise other manufacturers or business men may start producing bags which do not meet the quality requirement. Yeboah Enterprise supplies PICS bags to one semi-wholesaler in Ejura, one of the best niches of cowpea in Ghana. In 2011, because of the non-payment issue between Seedshop and Polytank, Yeboah was not able to procure the bags on the cash basis from the manufacturer. Wumpini Enterprise, the regional distributor in the Northern region, became the principal distributor of the Brong Ahafo region and therefore took over the distribution of the bags.

Semi-Wholesaler: G3

G3 started with PICS in December 2010. In 2010, he sold around 820 bags. In 2011, no bags were purchased because the Yeboah Enterprise in 2011 did not supply bags to the entire Ashanti and Brong-Ahafo region. The bags were received at 2.20 GHC/bag in 2010 and sold to farmers at 3.00 GHC/bag. G3's retail outlets are composed of three selling points at Ejura. He has a warehouse of where he can keep about 200 bales. As other distributors, he highlighted the issue of the length of the bags, which he says needs to be increased by one to two cm. According to him, the district of Ejura needs at least 500 bales of bags (10,000 bags) to meet the demand.

Volume Buyer: G4

G3 supplies bags to G4, a volume buyer and one of the farmers selected in 2010 who received a sack for the demos. She lives in Hiawanwou in Ejura district. She is also a trader of grain, and she supplies cowpea to the school feeding program, a program initiated by the government of Ghana that provides lunches to more than one million primary school children in more than 2,900 schools. This program aims at contributing to poverty reduction and increased food security in Ghana by providing all primary and kindergarten students in beneficiary schools a nutritious meal each school day in order to increase school enrollment, attendance, and retention and to boost domestic food production by sourcing meals locally, and providing a sustainable market for local food producers in the community. In addition,

she supplies grains to other traders coming from various regions of Ghana such as Tamale, Kumassi, Accra, Tarkoradi, and various NGOs. She is an aggregator in the town; she buys farm products from farmers. She also has contracts with some farmers, where she provides all necessary ag inputs at the beginning of the cropping season and, in return, gets paid back in-kind, by receiving the amount of product corresponding to the value of inputs she sold to them. She estimated the number of contracting farmers at about 150. The farmers grow various products including maize and beans. She bought 50 bags in 2010 to store cowpea at 2.50 GHC/bag from the G3. According to her, the bags are good. She still has in her store cowpea she stored in PICS bags two years ago. She said the bags can keep cowpea for more than two years. She has three stores for cowpea and maize where she can store about 360 bags filled with grains, along with two other stores for yams and maize, which can contain at least 400 bags filled with grain. If bags are available, she plans to buy ten bales for sale. She also reported that the cowpea stored in the bags has a good germination. "The cowpea looks fresh when you open the bags," she said. At school, the cooks appreciate the quality of the cowpea. In 2011, bags were not available. Farmers from the vicinity have expressed their desire to buy the bags in 2011. She collected the money from them to order the bags but there was no sack with G3. She reported, "I went more than ten times to the semi-wholesaler's store to get bags, but the bags were not available". For the future, she wants to become a distributor of the bags. She reported that the plastic bags tear when she wants to use them again in the second year. The condition under which the bags should be kept after the first usage to allow for further use should be explained to farmers and other end users.

Evolution of the supply chain and major milestones

As mentioned earlier, PICS activities started in Ghana in December 2009 with a preliminary meeting with some local manufacturers, including SAM plastic and Polygroup which encompasses Poly Sack and Polytex, WV-Ghana, and Seedshop. The outcome of this meeting was the selection of WV-Ghana to coordinate PICS activities in Ghana, SARI of the MOFA to provide extension agents for training and monitoring of PICS activities, Poly Sacks to manufacture the bags, Seedshop Company to be the national distributor, and Wumpini Issaka and Prince Yao Korveh to be the regional distributors in the Northern and Upper East regions. In January 2010, an agreement was signed with Seedshop. In March 2010, a Memorandum of Understanding (MoU) was signed between the PICS project at Purdue, WV-Ghana, and African Livestock Security (ALS). A total of 2,300 villages were selected for the demos. In May 2010, the PICS project at Purdue contracted the business consultant (Erick Korankye) to help the regional distributors build the distribution chain by identifying new vendors and volume buyers. In June 2010, Seedshop ordered 27,000 of bags from Polytank, among which 13,800 bags were used for demos in the villages and about 14,000 sold. Posters were designed in English and local languages and distributed across the PICS villages in July and December 2010 to build awareness on the efficient use of the bags.

2011 was a challenging year for PICS activities in Ghana, particularly for the distribution of the bags. It was also characterized by some achievements at the awareness-building side. As mentioned, the national distributor SeedShop was not able to order the bags because it did not reimburse Polytank. To avoid a rupture of bags in 2011, the regional distributors took over the distribution of the bags by directly ordering the bags from the manufacturer with the assistance of the business consultant. Because 100% down payment was required by the manufacturer at order due to the nonpayment issue, only 10,000 bags (the minimum required by the manufacturer) were procured. The two regional distributors were

not able to provide such an amount. The Antika Enterprise, located in Wa in the upper West Region, joined the two regional distributors (Wumpini and Prince) and provided money for the order. To make sure that the bags were dispatched to the areas covered in 2010, Wunpini Agrochemical, initially the regional distributor in the Northern Region in Tamale, also became the principal distributor for Brong-Ahafo and Ashanti regions. An agreement was also signed between Polytank and Prince Korveh to lead the distribution in the Upper regions. Today, both the supply and distribution of the bags are led jointly by the three regional distributors: Wumpini, Prince, and Antika Enterprises. The unpaid balance of the former national distributor (Seedshop) remains the major bottleneck for the procurement and supply of the bags in Ghana.

With respect to awareness building and achievements, a video was developed for a remarkable cowpea farmer and trader Hannah Nsiah in Hiawanwou in Ejura district in April 2011 because of her commitment and interest for PICS bags. PICS vendors were trained in marketing skills in May 2011. The project also shared cost with partners to air radio spots in both English and local languages. The OBCs were held in the upper region in May 2011. About 2300 villages participated in this event. In August 2011, the project continued its effort to build the awareness of farmers by launching cell phone videos, which allowed some farmers who have this technology on their cell phones to learn about the PICS bags.

Challenges faced in developing the supply chain

Poor cowpea production

The poor cowpea production dampens the demand for PICS bags. The poor cowpea production is caused by a poor rainfall, which is perceived as a threat for most farmers and bags vendors and increases the risk for making bag orders in advance.

Fluctuation of the price at the manufacturer level

The changes in prices make the sale of bags difficult for vendors because farmers are used to the price set in Year 1.

The supply of the bags

The mode of payment required by the manufacturer constrains wholesalers to order a large quantity of the bags. The manufacturer asked to be paid in cash at the order because the first national distributor defaulted. The unpaid balance of the national distributor blocks the supply chain upstream. This significantly reduces the volume to order because of the inability of the wholesalers to pay the full cost of production in front.

The inability to supply bags to new volume buyers

Certain volume buyers (grains farmers) from Cape Cost wanted to buy the bags to store maize in 2011, but because of the shortage of the bags, the wholesalers were not able to supply them.

Size of the bags

The actual size of the bags does not allow farmers to store the forty bowls of cowpea used by vendors to fill the ordinary 100kg of bags for grain in Ghana. There is a need to increase the length of the bags by one or two inches.

Transportation issue

Some bags tear during handling. Bags are put in the same truck with other mechanical appliances, which tear the bales and perforate the bags. It is necessary to have an appropriate means of transport for the bags--not in general transport. Public transport is not good or reliable.

Continued use of pesticides

Some new buyers continued to harbor reluctances about the effectiveness of the bags: They continue to use insecticides like phostoxin when storing cowpea in PICS bags.

Challenges faced and strategies developed to encourage actors' investments

Some challenges were observed which may hinder the development of the supply chain.

Margin for the bags

According to WV-Ghana, PICS should avoid setting the price at each level of the chain during the first year of the project. As more farmers are become aware of the technology, the price of the bags should be set according to the market in order to permit each actor to see the opportunity of doing the business.

Unknown demand for PICS bags

Estimate the total demand of the bags across the country, what is the current capacity of the distributors? Do they have the capacity to distribute? What is the proportion of the total demand of the bags the current distributors are able to order and distribute in order to know whether or not new distributors are needed? Are the present distributors are able to meet this demand. What is the current capacity of the actual distributors? Their portfolio? How fast is the sale of the bags going?

The poor involvement of MOFA in PICS activity

MOFA, in general, is not involved in ag inputs distribution for food crop, except for cash crops such as cocoa which have received special attention. The continuation of farmers' awareness building of PICS technology by MOFA can improve the adoption and sustain and expand the use of the bags.

Lack of storage space

Usually, cowpea is stored in metallic tanks, and the tanks can be left in the yard of somewhere in the compound. When stored in PICS bags, there is a need to find a safe place

away from rodent attacks. During the demos, it was observed that some farmers kept the cowpea stored in PICS bags in their living room, exposing the bags to rodent attacks.

Strategies developed to encourage actors' investments

The main strategies developed by PICS partners to encourage private sector investments in the development of the supply chain are mainly the increasing efforts in investing in media, the bulk purchase of bags for the village demos, the recruitment of field technicians through WV-Ghana to train farmers and vendors, and the recruitment of the business consultant to help the distributors build the supply chain network. For instance, in 2010, the use of community mobile vans on top of the radio broadcasts and television spots to air PICS messages was used because all the target areas were not getting coverage by the radio messages. Spreading the message through mobile vans had greatly helped because most of the people did not know about PICS project apart from those who were involved in sensitization and demos at village levels. In 2011, the use of television to broadcast PICS messages helped build and strengthen farmers' awareness because most of the villages covered have electricity, and people are more inclined to watch television rather than listen to the radio. The television spots include testimonies from people about the advantages of the bags. The demos then follow, and, at the end, contact information for where the bags can be found is provided. The messages are displayed three times a week for five weeks. The TV messages helped other areas not covered by the project to be aware of the PICS project. Some farmers from these remote areas call frequently to ask for the bags.

The bulk purchase of PICS bags for demos (13,800 bags from the total of 28,000 manufactured) at the downstream of the chain constituted a remarkable boost for the sale of the bags, which incentivized chain actors' investments. For the better use of bags given to farmers for the demonstrations, and to show how effective the bags are in protecting cowpea from postharvest insects, the PICS project, through WV-Ghana, has trained field technicians from MOFA to build farmers' awareness about PICS technology, monitor demo farmers until the OBCs. These ceremonies were organized across the project locations with the participation of various partners, including the supply chain actors, farmers from different villages, public, and private decision-makers, and authorities from local, regional, and national levels were vital in convincing farmers, partners, and other private/public sector actors about the effectiveness of the bags. The goal of the ceremonies was to boost the demand of the bags across the supply chain, particularly from the downstream; yet, WV-Ghana has already integrated PICS activities in its program and has continued to carrying out demos for PICS bags with its Agricultural Development Program (APD) as its effort to strengthen and expand the PICS technology.

Moreover, the recruitment of the business consultant (Eric Korankye) was a great help in assisting the regional distributors for the timely procurement of the bags, monitoring the sale across PICS villages, tracking the inventory along the chain, seeking new partners for the bags distribution, and looking for new buyers of the bags. The support of the business consultant was very useful, as reported by the regional distributors, in convincing the manufacturer to produce PICS bags in 2011 despite the unpaid balance of the 2010 procurement by the former national distributor (Seedshop). Furthermore, apart from the serious rupture experienced in 2011, the role of the business consultant in linking up downstream bags vendors and users to the closest upstream distributors has helped reduce the high transaction costs associated with the procurement of the bags.

Other strategies developed to increase private sector investment are the vendors training and the video developed for a cowpea farmer and grain trader (Hannah Nsia) in Ejura district to showcase.

Challenges and opportunities to supply chain sustainability

For manufacturers

Fluctuation of the price

A dollarization of the price of the bags may help offset partially this fluctuation. Negotiating a fixed price with the manufacturer over a certain period of time may be an alternative since farmers are sensitive to price fluctuation. The only bottleneck is that the manufacturer may tend to set the price high to make sure it is well off over the specified period of time.

Low volume of bags ordered

As the demand for bags is growing, paying the full production cost in front will be challenging to the wholesalers. A strategy like a down payment of 30% or 50% at order and the balance paid at delivery or a month after delivery could be a solution to help wholesalers order more bags. Another strategy is to find another factory to discuss options about the possibility of the bags as is the case of Embalmali and Emballage Miankala (EM) in Mali.

Delay in ordering the bags

Regional wholesalers may meet with the manufacturer to inquire about the timeline necessary to manufacture and deliver a certain quantity of the bags and the deadline for the manufacturer to receive an order to allow timely delivery in the different regions.

For wholesalers

The supply of the bags

Discuss with the former wholesaler options to clear his debt with the manufacturer. Secondly, the initiation of a partnership between the regional distributors and the manufacturer, as is the case in Senegal, may help strengthen the relationship between both parties and may be a way to find suitable mode of payments, as is the case in Senegal and Mali.

Transportation/Handling

Some bags tear during handling. Bags are put in the same truck with other goods, such as irrigation system tools and other mechanical appliances, which tear the bales and perforate the bags.

Low margin

As the bags are grounding in the ag production system, chain actors should be able the set the price at a competitive rate ,which takes into consideration the transaction costs, along with the supply and demand in the location they are operating.

Downstream rupture

The distribution of the bags at district level is weakened because of the few retail outlets. Bags buyers have to travel a long distance to get the bags, especially those from Ejura in the Brong-Ahafo region and in most districts of the Northern region, in particular Savulugu. The downstream distribution of the bags is not yet well established in these regions, even though the demand for the bags is currently high. Where to get the bags remains a constraint to farmers. This rupture issue arises because the use of the bags has been widened as the bags are also used for other crops.

Size of the bags

A solution to overcome this issue can be found when the manufacturer and the regional distributors are in good relationship and often meet to discuss challenges of the chain.

Technical constraints

Good coordination between the technical team (MOFA) and the supply chain actors

It is necessary for bag vendors and the technical team to meet and discuss options for a good management of the supply chain, particularly how to distribute the bags and the quantity of bags to send in each location given the level of production. The use of the yearly report about the production of cowpea across the country from the MOFA could add significant to the management and the distribution of the bags in the chain. As WV-Ghana is including the sensitization of PICS bags in the portfolio of their activities, the wholesalers may discuss with WV-Ghana possibilities to obtain any technical data that can help plan the distribution of the bags and overcome rupture issue.

Opportunities to expand the supply chain

In the WV's perspective, trust between distributors (i.e., regional distributors, the district vendors, and the community) is a key factor to sustain the distribution of the bags. Some vendors complained that they gave out some bags on consignment, but the persons to whom the bags were given to did not pay back. This attitude may hinder the expansion of the chain.

The regional distributor should be able to liaise with MOFA so that some of the bags will be given to the MOFA department at the district level and at the custody of the MOFA director. In that way, extension agents can pick some and sell them to farmers during their regular meeting. In Upper West (in Wa), there are four extension agents who are doing this business with the distributor and in Upper East, there is only one extension agent involved in PICS bag sales.

Given the current status of the supply chain, mainly downstream, finding new vendors to distribute the bags at the community level is paramount. The ADPs can play this role by buying the bags and distributing them to farmers since they are present in almost all farming areas. Find new regional distributors (two or three) so that it would be easier to gather the required money to order the minimum quantity of bags.

To avoid a rupture issue and to allow fair margin along the chain, a possibility to discuss with another manufacture about the production of bags will help find a smooth arrangement and to give more flexibility to chain actors in the procurement and sale of the bags.

In the manufacturer's perspective, there are some impediments in involving the government in the production of the bags because of the bureaucracy. Private sector participation in agricultural-funded projects is more viable than involving the government. The only time we might need the government is when we are importing raw materials, for which we ask for waiver of duties and other indirect costs to lower the production costs of the bags.

For the bags vendors, there is a need for the business consultant to arrange for the order and help dispatch the bags to the distributors and vendors.

To sustain the supply chain, it is crucial to continue with the radio messages and television spots to inform and reassure farmers about the availability of the bags. The retailers may continue to sensitize and to show farmers and buyers of the bags how to use the bags.

Key Lessons Learned

A good understanding of the social dynamic and its contribution in building the social capital in ag inputs network such as GAIDA is determinant for the development and sustainability of the supply chain because it helps be aware of how stakeholders in the network make decision for ag inputs procurement and distribution.

The strong social relationship characterizing members in the GAIDA ag inputs network is an asset for the sustainability of the supply chain because of the trust, but can also significantly affect the efficiency of the chain actors, particularly in the upstream.

The lack of trust between the manufacturer and the wholesalers at the beginning of the business continues to affect the viability of the supply chain.

The absence of another cost-efficient manufacturer and the lack of good coordination among multiple wholesalers in procuring PICS bags can be severely disruptive to the supply chain.

The mainstreaming of PICS activities in NGO activities like WV-Ghana is an advantage for increasing the downstream demand for the bags and is key for the sustainability and expansion of the supply chain.

ANNEX

Figure 1: PICS Bag Supply Chain in Ghana

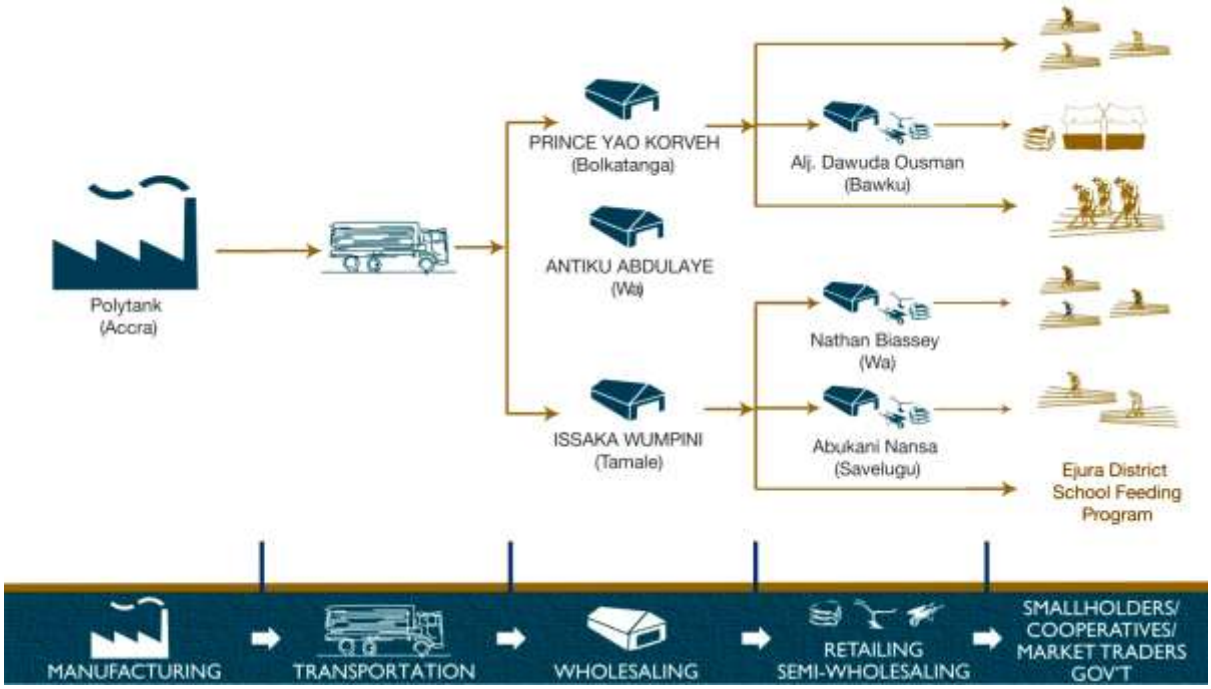


Figure 2: Distribution network of PICS bags

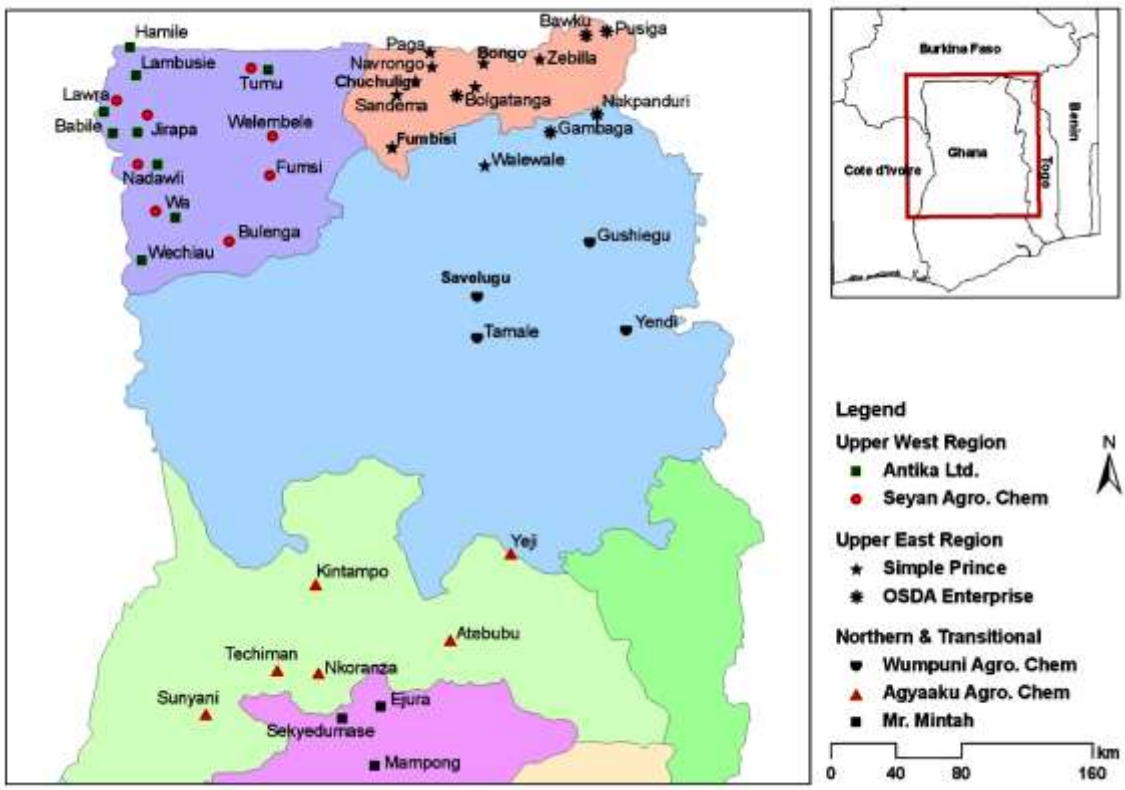
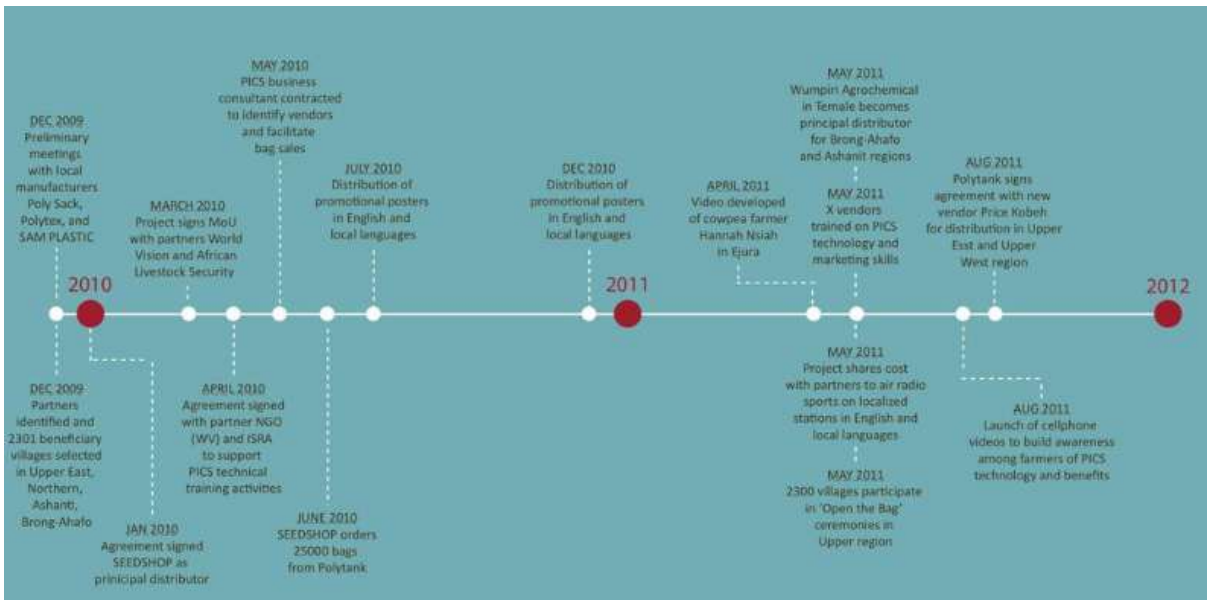


Figure 3: Timeline of PICS project in Ghana (2010-2012)



MALI

Presentation of PICS supply chain study

The Purdue Improved Cowpea technology (PICS) was launched in 2009 in Mali. Prior to the implementation of the project, an inception workshop was organized in February 2009 between partners, including the PICS project leader (Lowenberg-DeBoer) and the in-country coordination team, which is comprised of World Vision (WV-Mali) and the Malian research institution Institut d'Economie Rural (IER), to discuss technical aspects of the project, the major cowpea production areas, the coverage of PICS activities in Mali, and the roles and tasks of in-country partners during the implementation of the project. Purdue and the in-country coordination teams contacted manufacturers, including EmbalMali, a company owned by Aga Khan Group; Sai International Tading Company (SITCO), the Lebanese-owned company; and various other companies to discuss the technical features associated with the production of the PICS bags. A business consultant, Mamary Bagayoko, was recruited by the PICS project to assist national distributors in the development of the sales network, to ensure the availability and accessibility of the bags to farmers, to track the PICS bags price each month, to spread PICS message through television and radios, and to be in permanent contact with the in-country coordination and liaise it with the commercial component of the bags. The project also had media support activities, such as television shows and broadcasts of PICS messages on community radios. Information about PICS was recorded on audio support (CD and K7) and distributed to local radios to sensitize farmers about the technology, where to get the bags, and how to use them. The project team at Purdue, along with the business consultant, had also visited the three wholesalers selected to lead the distribution of PICS bags and discussed about the PICS project in Mali. They include: Faso Kaba in Bamako, Agri Sahel in Segou, and Kene-Agri in Sikasso. The role of the wholesalers (national distributors) was to arrange for production of PICS bags and ensure that the bags meet the specified requirements, work with their retail outlets in distributing the bags, and encourage their network to participate in project's events (i.e., demonstrations, sensitization, training, OBCs). WV-Mali recruited 180 field technicians, partly composed by IER technicians and WV-Mali technicians. The role of the technicians was to lead the sensitization, the demos and the OBCs. At the implementation of the project in July 2009, the National Department of Agriculture (DNA), the Regional Departments of Agriculture (DRA) of the five regions selected for the PICS project, as well as their local representatives also partnered in PICS activities in Mali. Embalmali was selected to produce the bags. PICS activities covered 2,250 villages in the five regions where cowpea is mostly produced in Mali. In each village, five farmers (men/women), plus the chief of the village, were selected to hold the Demos, 13,500 cowpea producers in total. Sensitization, monitoring, and OBCs were overseen by field technicians.

Current situation

The PICS bags supply chain actors have evolved since the implementation of the project. Currently, actors involved in the distribution of PICS bags include: the current manufacturer Emballage Miankala, located at Koutiala; the former manufacturer Embalmali (even though it did not produce bags in 2011, it still interested in the production of PICS bags); two active national distributors, including Faso Kaba in Bamako and Agri Sahel in Segou; one inactive distributor, Kene-Agri, who dropped out; and some semi-wholesalers and retailers. Each national distributor has its own distribution network. Some of the extension

agents who led the outreach activities at the implementation of the project actually are involved in the distribution of the bags. The following section maps the supply chain and describes the roles and challenges faced by each actor in the distribution of the bags.

Mapping out the supply chain

The supply chain in Mali is currently composed of two manufacturers, two wholesalers, and some semi-wholesalers across Kayes, Koulikoro, Sikasso, Mopti, and Segou, who supply the bags to farmers, seed producers, the research institution (IER), and the NGO Projet de Renforcement des Capacités pour une Agriculture Durable (PRECAD) as a volume buyer. Embalmali and Emballage Miankala supplied the bags in 2010 and 2011, respectively. Each of the wholesalers has a direct relationship with the manufacturers. The wholesalers can either order the bags together (if the quantity each want to order is not up to minimum order quantity) or separately. The orders were made with the assistance of the business consultant, who can check whether the bags met the specifications, such as thickness. The manufacturers' price varies between 925 FCFA and 950 FCFA; the wholesalers sell the bags to semi-wholesalers at 1,050 FCFA to 1,100 FCFA, depending on whether the bags are picked up by the semi-wholesaler or delivered by the wholesaler at the semi-wholesaler's doorstep. The minimum volume of bags required for semi-wholesalers is one bale (250 bags). The semi-wholesalers, in turn, deliver the bags at 1,150 FCFA to retailers who sell the bags to farmers at 1,250 FCFA or 1,300 FCFA. Figure 1 in the Annex illustrates the supply chain of PICS bags in Mali.

Supply chain actors

Former Manufacturer: Embalmali

Founded in 1999 in Mali by Industrial Promotion Service—West Africa (IPS-WA), Embalmali is a member of the Aga Khan network and specializes in the production of polypropylene (PP) bags for grains storage other bags (for onion and potato storage) in Mali. Other goods manufactured include the production of cans, bottles, and pots. With a social capital of about 2.2 billion FCFA (the equivalent of $4.5 million USD) in 1999, IPS-WA contributed to 53% of this capital, with contributions of 20% by the government of Mali, 10% by the Huicome, and 17% by Malians partners. The production capacity is estimated at about 24 million PP bags a year, with a possible upgrade to 50 million PP bags per year by 2015. Embalmali sources the raw materials from Russia and South Africa. The total cross-border fees are estimated at 30% of the freight on board (FOB) cost, including 18% of VAT.

With respect to PICS bag production, Embalmali was the first manufacturer contacted in Mali in 2009 to produce PICS bags. The company produced 25,000 bags in 2009 and shipped to the three wholesalers in Bamako (Fasokaba), Segou (Agri-Sahel) and Sikasso (Kene-Agri). Since then, no more bags were manufactured for PICS. The relationship with the business consultant and other PICS partners has eroded since the first order. Given its current production capacity, Embalmali is able to manufacture 100,000 PP bags a day. The production cost of manufacturing the bags is estimated at 810 FCFA without VAT and 955.80 FCFA including the VAT (18%). The manufacturing cost depends on the volume of the order. For example, the analytical budget shows that the total production cost in manufacturing 250,000 bags is estimated at 162,110,861 FCFA (648.44 FCFA/bag), while for 30,000 bags the production cost is estimated at 28,790,254 FCFA (or 959.68 FCFA/bag).

As the quantity increases, the per-unit production cost decreases. Figure 2 in the Annex shows a scenario of the share of cost for different large quantities.

Before manufacturing the bags, the company and the wholesalers agreed on the price at which the bags should be manufactured through a pro-forma invoice. When both parties agreed with the price, an agreement specifying the conditions of delivery and the mode of payment is signed. After, the company requires a down payment of 50% up front, and the balance is paid once the bags are delivered. Sometimes, given the long-term relationship with certain clients (i.e., Fasokaba), a grace period of 30 to 45 days is given to clear the remaining balance.

With respect to the distribution network, Embalmali has outlets in most regions in Mali (two in Segou, three in Niono, five in Mopti, one in Kaye, and more than ten in Bamako). At these points, products are placed on consignment. Each selling point has its own distribution network. The mode of delivery and payment is defined by a formal agreement. The company has a monitoring unit for inventory that circulates twice a month (and sometime more than twice a month) to record inventories.

Embalmali is in good relationship with several banks in Mali which support its activities. Embalmali is willing to support PICS activities by being flexible in the mode of payment; reinforcing the relationship with PICS bags distributors; supporting the sales of the bags through television advertisements, radio messages, and technical notes on how to use PICS bags; and,offering a more competitive price. However, the company wishes the government would provide subsidies for PICS bags as is already the case of other ag inputs.

There are several challenges. One such challenge is the production of the polyethylene bags by Fasoplast**;** the production of polyethylene by Fasoplast is estimated at 195 FCFA per unit, which is costly according to Embalmali. Along with this, the quantity of bags ordered is quite low compared to the production capacity of the company. This increases the production cost. Another challenge was that Embalmali did not receive feedback from the users of the bags. The company would like to receive information about the bags from the business consultant.

Current Manufacturer: Emballage Miankala

Emballage Miankala is one of the factories of the “COMPAGNIE BADENYA”, which encompasses two major plants: oil mill Yaya Kone (HYK), which produces cooking oil and animal feed; and Emballage Miankala (EM). It is implemented in Koutiala, located about 280 km away from Bamako. Emballage Miankala is a woven bags plant specialized in the production of all sorts of PP bags. The plant is built on an area of 4 hectares with an investment of about 1.33 billion FCFA ($2.8 million USD), coming largely from funds of some Malian traders and the rest provided by the other partners. The production capacity of the plant is estimated at 13.2 million bags per year. The factory employs over 102 permanent and temporary staff. It takes roughly three days to manufacture 100,000 bags. In the absence of other activities, one day suffices to manufacture the 100,000 bags.

With respect to the production of PICS bags production, Emballage Miankalla was first contacted in early 2010, one year after the implementation of the project in Mali. This

factory was identified by the business consultant when searching for another factory that could produce the bags at a competitive price. According to the bag wholesalers, the price proposed by Embalmali is high. Emballage Miankala was able to manufacture the bags at 925 FCFA/bag compared to 955.80 FCFA offered by Embalmali. The production cost of manufacturing the bags with the margin is estimated at 783 FCFA/bag without VAT or 925 FCFA/bag including VAT. This cost also includes the shipping cost: the bags are delivered to the wholesalers shops in Bamako and Segou by the manufacturer at this price (925 FCFA). The margin per bag at the manufacturer level was estimated at about 10% of the manufacturing cost. The production cost is estimated at 834 FCFA/bag. Figure 3 in the Annex depicts the manufacturing cost structure using one metric ton (1MT) of raw materials. Approximately 7,525 woven bags can be manufactured from this quantity of raw materials. For a larger quantity, the per-unit production cost may decrease.

The proportion of plastic bags (polyethylene bags) represents 51% of the manufacturing price because the polyethylene bags are manufactured by FASOPLAST located in Burkina Faso. The cost of the two inner liner plastic bags (500 FCFA for two) was added to the production cost of the woven bags. The share of cost of these plastic bags in this graph includes the manufacturing cost, tariffs, and the shipping cost. Currently, Emballage Miankala has acquired new equipment for the production of the polyethylene bags to overcome the high cost associated with the imports of these bags from Burkina Faso. Emballage Miankala is aware about the thickness specifications of the polyethylene bags (80 µ) and is able to produce PICS bags in the coming season. The raw materials, as well as the VAT, each represent 16% of the production cost. Figure 4 shows the price markup at each level of the chain.

With respect to PICS bags delivered to the national distributors, Emballage Miankala manufactured 35,000 bags for Faso Kaba, the PICS bags wholesaler located in Bamako in 2010. In 2011, 9,500 bags were manufactured for Agri Sahel, the PICS bags wholesaler located in Segou. From this time to today, the relationship between Emballage Miankala and the PICS business consultant has been strengthened through regular phone calls about the order, the delivery, and the evolution of the sale of the bags. The business seems to have a good future with this company compared to Embalmali where the communication between the business consultants/wholesalers has weakened since the first order in 2009. However, Emballage Miankala did not receive feedback about the sale of the bags and the perceptions and quality of bags from users at the downstream level of the chain. To overcome this situation, the company plans to monitor the chain actors in the near future to inquire about the sale of the bags and to receive feedback from the actors. Also, it is committed to producing PICS bags that meet the thickness requirements and at a reasonable price.

Emballage Miankala has some volume buyers such as WFP, Compagnie Malienne pour le Développement du Textile (CMDT), cereal cooperatives, and NGOs who purchase other types of bags. These institutions and agencies are also potential volume buyers for PICS bags. Currently, Emballage Miankala is not directly involved in the distribution of the bags but can handle it if required. Emballage Miankala also has some selling points across the country, especially in Bougouni, Karangana, Sikasso, and Koutiala in Sikasso; Douentza in Gao; San, Niono, Segou in Segou; and Bamako in Koulikoro. In some of these outlets, bags are placed on consignment. In addition, the company has other selling points in neighboring countries, such as Cote d'Ivoire (Abidjan) and Burkina Faso (Bobo).

For a typical order of PICS bags, the factory sends a pro forma invoice to the wholesaler about the quantity of bags to manufacture. If both parties agree on the price and conditions of payment, a down payment of 50% is required by the manufacturer. This amount is generally wired in the manufacturer's bank account or given directly to the marketing director of the manufacturer as a check. For a large quantity of bags (100,000 to 300,000 bags), the manufacturer is willing to reduce the down payment to about 30%. Multiple delivery options are also possible, and the balance is paid according to the volume of bags delivered. For PICS bags production, the bags are generally delivered within three weeks. For its activities, Emballage Miankala is in good relationship with some banks but generally the factory does not rely on credit.

The major challenge faced by the factory is the production of the polyethylene bags. The polyethylene bags were sourced from Fasoplast in Burkina Faso which, according to the marketing director, is not cost efficient. These bags are shipped to Emballage Miankala at 250 FCFA per unit, or 500 FCFA for the two needed per PICS bag. Another bottleneck for Emballage Miankala is the delay in delivering the bags to wholesalers because the polyethylene bags were not shipped on time. A third challenge is that the energy supply is subject to frequent outages. The factory runs on a generator as an alternative source of energy supply. This impacts the price of the bags. Related, the factory reported that the production cost may increase for the coming year, given the increasing price of gas used to operate the generator. Lastly, Emballage Miankala sources raw materials from Middle East (Saudi Arabia), Asia (India), Europe (France), and Africa (South Africa). Taxes and tariffs at the border can go up to 25%. The government is making efforts to lessen import duties on raw materials these recent years to support local factories.

Emballage Miankala has currently purchased equipment for the manufacturing of the polyethylene bags, which means there will be no need to order these bags from FASOPLAST in the future. As such, there is a potential reduction of the production cost and increase of the production capacity.

Wholesaler: Faso Kaba Sarl Ltd.

Faso Kaba is a Malian seed company located in Bamako and led by Maimouna Coulibaly. The company supplies quality seeds to farmers across the country and trains them on good agricultural practices. Starting as an informal seed dealer in 1997, Faso Kaba became a registered company in 2008 as Faso Kaba Sarl (Ltd). With an initial focus on maize improved seeds, the company expanded to other crops such as rice, millet, sorghum, legumes (i.e., cowpea, groundnuts), and vegetables (i.e., okra, potato). Faso Kaba also supplies other ag inputs to farmers across the country. The network of Faso Kaba is composed of selling points located in Koulikoro, Kayes, and Sikasso, with more than eighteen selling points (see Table 1 in the Annex for more details). The network is currently composed of about 100 people who sell ag inputs across the selling points. In 2007, the company received an award for the amount of $208,000 USD from Alliance for a Green Revolution in Africa (AGRA) to produce and commercialize improved seeds. Faso Kaba works with farmers' cooperatives in rural areas for the production of certified seeds. Some of the farmers or farmers' organizations have a formal contract with Faso Kaba for the production of certified seeds. In addition, the company employs around ten people, including the technical staff who oversee field work (seed multiplication, stockers, workers) and the managerial staff who take care of the management of the company.

M. Coulibaly started with PICS at the implementation of the project in Mali in 2009. Her business, Faso Kaba, was identified by Bagayoko as a potential distributor for PICS bags and proposed to Lowenberg-DeBoer at Purdue. He also inquired about the scope of Faso Kaba's distribution network. Faso Kaba is well known in Mali as an ag inputs supplier, with more than a decade of experience in ag inputs distribution in Mali. The PICS project leader selected M. Coulibaly to lead the distribution of PICS bags, and an agreement was signed with Purdue explaining roles and responsibilities in leading PICS bags distribution. Faso Kaba involves some distributors of its network, and in areas where it does not have outlets, Faso Kaba relies on the extension agents (selected by WV-Mali to carry out sensitizations activities and the demos) to lead the sack distribution. These extension agents were chosen from volunteers by Faso Kaba during the training organized by the project partners to technicians on how to handle the outreach activities and the demos at village levels. Faso Kaba argued that it was advised to do so. The structure of the Faso Kaba distribution network for PICS bags is composed mainly of six functional PICS semi-wholesalers located in Kolokani, Kati, Kita, Nassoubougou, Salida, and Djara-Koroba. These semi-wholesalers are divided in two groups: the first group is composed of actors that belong to the Faso Kaba ag inputs distribution network, and the second group is constituted of technicians or extension agents who led the outreach and demos activities. Most of the semi-wholesalers fall in this second group. Figure 5 in the Annex shows the distribution network.

With the manufacturers, a 50% down payment is paid at order, with the remaining 50% paid at delivery or one month after delivery with Embalmali because of the long-term relationship the wholesaler has with Embalmali. During the delivery, Faso Kaba pays the loading and unloading cost of 50 FCFA/bag, bringing the purchasing price to 1,000 FCFA/bag for bags manufactured by Embalmali and 975 FCFA/bags for bags produced by Emballage Miankala. The bags are sold at 1,050 FCFA to semi-wholesalers at Faso Kaba's shop or 1,100 FCFA/bag if the semi-wholesaler requires that the bags be delivered at its store. The transport cost is estimated at about 50 FCFA/bag. For large volume, the unit price can reduce slightly to 1,075 FCFA/bag. Bags are also sold at the retail price at the wholesaler's shop at 1,250 FCFA/bag.

For semi-wholesalers operating with Faso Kaba, a down payment of 50% of the price is required either in cash or through bank transfer into Faso Kaba's account. The remaining 50% is paid after selling the bags. For others, bags are just placed on consignment. The payment is made as long as the bags are sold. Semi-wholesalers sell the bags at 1,150 FCFA/bag to retailers who, in turn, sell the bags at 1,250 FCFA or 1,300 FCFA depending on the supply and demand.

There are a few challenges that Faso Kaba faces. The first was the delay in delivering the bags to Faso Kaba in 2011 because the polyethylene bags manufactured by Fasoplast, the manufacturer in Burkina Faso, was not delivered on time to Emballage Miankala, the manufacturer selected in 2011 to supply PICS bags to wholesalers in Mali . This situation could be resolved if the orders are placed earlier as the distributors are aware of the time required to receive the polyethylene bags from Fasoplast. Second, there is the problem of non-payment, which constitutes the major challenge faced by Faso Kaba, particularly for the bags sold by the technicians/extension agents. These technicians were selected by Faso Kaba during the technicians' training at the implementation of the project to lead the sale of bags in villages where Faso Kaba does not have retail outlets. As indicated in Table 2 in the Annex, the proportion of non-payment is estimated at 49% of the total amount due. The third

challenge noted is the Low sale of the bags in Koulikoro and Kayes. These two regions are not big production areas compared to Segou, Sikasso, and Mopti. In addition, the poor rainfall in 2011 has severely affected the volume of sales. Fourth, the delivery arrangement with Emballage Miankala is not suitable for Faso Kaba for many reasons. The bales of bags are often delivered overnight because the bags are not the sole good the delivery crew carries in the truck. Emballage Miankala is located in Koutiala, 300km from Bamako, where Faso Kaba is located. The delivery crew has other goods which need to be delivered to some localities and regions in Mali, as well as occasionally Senegal. PICS bags occupy a relatively small proportion of the truck container which, according to Faso Kaba, does not require much attention from the delivery crew. Sometime bags are loaded at the road side and it is difficult to bring them in the warehouse given the weight of the bales (1 bale = 250 bags; 1 bag weighs 450g). Lastly, some missing bags were reported by Faso Kaba for the order with Embalmali in 2010. In total, 60 bags were missing. These bags were replaced later by the manufacturer.

Faso Kaba fears that other wholesalers may enter in the supply chain in the future. The wholesaler is concerned about the future of the PICS bags sale and the possibility of facing new competitors to take over the distribution of the bags. This fear may be explained by the current status of the bag distribution in the network and the non-payment issues the company faces which may affect the supply of the bags if strategies are not developed for fund recovery. Faso Kaba suggests that the manufacturers should protect the wholesalers by supplying the bags to potential volume buyers at a price that makes Faso Kaba more competitive.

Faso Kaba has a credit line with La Banque Nationale de Développement Agricole (BNDA) for ag inputs. The maximum line of credit can reach 250,000,000 FCFA (the equivalent of $500,000). In case of a surge in demand (for example, the case with IER, which procured 33,000 PICS bags in 2011), Faso Kaba has the possibility to ask for financial support from its banks. The company has the capacity to store at least 30,000 PICS bags in its warehouse. The business consultant also has played a tremendous role in strengthening the supply chain. He helped the wholesalers in sensitizing clients and advised them (Faso Kaba, Agri Saheli) for the marketing of the bags. *"*We are in permanent contact with him and even for delay in some orders from manufacturers; we rely on him to have the bags delivered as soon as possible. We want him to help the semi-wholesalers and retailers in selling the bags and to help recovering the fund. We are willing to pay him a commission for this task" said the manager of Faso Kaba.

Semi-Wholesalers

Semi-wholesaler M1

This semi-wholesaler is the president of the farmers' cooperative that produces certified seeds to Faso Kaba. The cooperative is one of the partners with which Faso Kaba has a formal agreement with in the supply of certified seeds. In turn, Faso Kaba supplies the cooperative with other ag inputs such as fertilizers, insecticides, and sprayers for sale. The cooperative also buys the inputs for the production of certified seeds and for their own farming. The PICS bags business came as an additional activity which may strengthens this relationship, according to M1.

M1 was selected as one of the demo farmers in the first year of the PICS project. The cooperative, under the leadership of M1, received the first batch of PICS bags for sale in 2009. The bags were placed on consignment at 1,100 FCFA/bag and sold at 1,150 FCFA/bag to retailers who, in turn, sell them at 1,200 to 1,300 FCFA/bag. The cooperative also supplies bags to individuals but at a retail price (1,200-1,300 FCFA/bag). Generally, Faso Kaba delivers the bags to the cooperative, but sometimes the cooperative sends a member to Faso Kaba's store to pick the bags when there is a delay in the delivery. In 2011, only 150 bags were sold because of the poor distribution and rainfall.

The cooperative is composed of ten members, and its network covers ten districts in the Kita cercle (administrative district). In three of the districts (Massatola, Tioribougou, and Sebekoro), the cooperative has stores where ag inputs are displayed for sale and in the other districts, the cooperative has ag inputs dealers to whom it supplies products for sale. PICS bags are dispatched in the three selling points in addition to the main store in Kolokani. The cooperative deals with six retailers across the ten districts for the sale of ag inputs. With these retailers, the relationship is based on trust. Retailers can receive bags in credit or pay in cash. For retailers outside its network, the business is based on cash and carry. Figure 6 in the Annex portrays the relationship within the cooperative's network.

Challenges for M1 include the low margin, misuse of bags, and bad farmer practices. The margin is 50 FCFA per bag sold for the cooperative. The profit is low (50 FCFA per bag when sold to retailers and 100 FCFA when sold to farmers), which sometimes is not enough to cover the transportation cost. Farmers sometimes remove one plastic bag from the PICS bag and insert it in to another woven sack in order to have two bags. This may be due to many reasons including capital constraints, innovations, and lack of information about the technology. Other farmers do not remove crop residue and trash from the cowpea, which perforate the inner plastic bag.

There are several strengths and potential opportunities for M1. The first is available storage capacity. The cooperative has stores and can spare space for up to forty bales of bags (about 20,000 bags). Second, in a good production season, the potential demand for bags is roughly estimated at 10,000 bags per year because the bags initially developed for cowpea have a broad function and are used to store other grains and legumes. Moreover, because of the problem of insect attacks during the storage, some farmers have abandoned the production of cowpea. The cooperative thinks that with the bags farmers will come back. Third, the cooperative can receive bags on consignment from Faso Kaba. Fourth, the cooperative has access to credit; the cooperative has a credit from BNDA and from Réseau de Micro Institutions de Croissance de Revenus (RMCR)—a WV-Mali local micro-finance institution. Lastly, the bilateral business relationship with the wholesaler is capital in sustaining the supply chain.

Semi-wholesaler extension agents

This category of semi-wholesalers is the most important in the Faso Kaba's network for PICS bags. As mentioned above, Faso Kaba based its distribution network for PICS bags on extension agents because its ag inputs network is not present in some of the PICS project locations.

The extension agents are staff members of either of the Office de la Haute Vallée du Niger (OHVN), the Direction Régionale de l'Agriculture (DRA), Ministry of Agriculture (IER), or WV-Mali. They were selected by WV-Mali to lead the technical component of the project. In general, each extension agent leads a group of five animators and oversees the PICS activities in 25 villages; in each village, five farmers are selected to receive PICS bags "for free" for the demonstrations. The role of the extension agents and animators is to sensitize farmers about PICS technology, demonstrate to farmers how to fill the bags with cowpea and how to close the bags, and monitor the demos' farmers through regular check of the cowpea stored until the OBCs.

The extension agents selected by Faso Kaba received the bags on consignment during the first year of the project. The extension agents sell the bags directly to farmers during the visits. The extension-based distribution networks do not have retail outlets because their primary mission is to conduct outreach activities in villages. To distribute the bags, they often rely on the transport facilities of their office to ship the bags to remote villages. They also rely on colleagues to sell the bags. Figure 7 in the Annex shows the current and initial network of the extension agents- based distribution network.

Four of the extension agents involved in PICS bags sales were contacted during our interviews in Nassoubougou, Kita, Kati, and Doila. The extension agent of Nassoubougou, Adama Traoré, received 400 bags in 2009. Of these, 220 were sold at 1,100 FCFA each, including 170 bags for farmers and 50 to the NGO Adventist Development and Relief Agency (ADRA). The unsold inventory was brought back to Faso Kaba. In 2010, 400 bags were received and all was sold. In 2011, no bags were received on consignment because of the high transportation cost of the monitoring, which, according to Faso Kaba, offset its margin, and the non-payment issue was observed in the extension-led distribution network. Faso Kaba's policy, which began in 2011, is to sell the PICS bag to extension agents who want to continue with the distribution of the bags on a cash-and-carry basis. M2 purchased 45 bags (in January instead of November) because of the increasing pressure of the farmers. The extension agent of Kita, M3, sold 75 bags in 2009 and 575 bags in 2010 at 1,100 FCFA each. In 2011, no bags were received. The extension agent of Kati, M4 is a retired extension agent of OHVN who worked with Faso Kaba while on duty at OHVN. He has sold 150 bags in 2009/2010 and only sold 20 bags in 2011 at 1,250 FCFA because the quantity received was limited. In Doila, the extension agent M5 received 1,000 bags in 2009 and all were sold at 1,150 FCFA. In 2010, 230 bags were sold to cowpea vendors and processors. In 2011, he received no bags because of the change of Faso Kaba policy. All the extension agents were expecting to get the bags on consignment from Faso Kaba in 2011 but this was not the case. This situation was a cause of rupture observed at the extension-led distribution network.

Challenges for these wholesalers include the low margin; the extension agents complained about the margin of the bags. The price at which the bags should be sold to farmers was set by Faso Kaba at 1,150 FCFA; however, some of them sold the bags at 1,250 FCFA in 2011 when the Faso Kaba distribution network experienced a serious rupture issue. Most of the extension agents did not receive the bags that year. Another challenge for these wholesalers was liquidity constraints**.** In 2011, the distribution network led by the extension agents experienced a rupture because of the non-payment issue. The rupture was due to the fact the bags were not placed on consignment and most of the extension agents were not able to procure the bags because of lack of capital. A last challenge was the fact that starting from 2010, Faso Kaba required a down payment of 50% paid at order, which was challenging to

the extension agents since they are not businessmen and also were not prepared in advance for such a decision. This limited the sale of the bags in 2011.

There were several strengths of these wholesalers; one said strength was the OBCs; these convinced farmers about the effectiveness of the bags given the quality of cowpea observed when the bags were opened. Another advantage seen was the large increase in cowpea price. The price almost doubled during the ceremonies compared to the harvest period (275 FCFA/kg at the harvest time to 475 FCFA/kg at the ceremonies). The extension agents also reported that the bags constitute a good alternative to storing cowpea without the use of insecticide (Phostoxin). For them, most of the farmers are illiterate and are not really aware of the appropriate dose of Phostoxin to use to store cowpea and the persistence time required. Another strength was that the technology, according to the extension agents, may allow the availability of seeds for the next cropping season. Some farmers who stop producing cowpea because of the postharvest losses caused by insects decided to produce the cowpea after the ceremonies. One last advantage is that the bags are used not only for cowpea but also for other grains and legumes.

Semi-wholesaler: Agri Sahel

Agri Sahel is an ag inputs company led by Ousmane Thera in the town of Segou. He has supplied ag inputs and other ordinary bags to farmers in Segou and Mopti for years. Like M. Coulibaly, Thera was proposed by the business consultant to the project leader who, after discussing with him about his network, hired him in 2009 to lead the distribution of bags in the Segou and Mopti regions. Like other distributors, he participated in the training organized by WV-Mali to explain the goal of the project and how to handle the supply and the distribution of the PICS bags. In 2009, Agri Sahel received 10,000 bags. 20% of the total amount was paid as down payment, and the PICS project contributed 80% for this order, as was the case of Faso Kaba. The balance was already paid by Agri Sahel. Out of this volume, 5,000 bags were purchased for demos in the eight cercles selected in these two regions. The remaining 5,000 bags were distributed to some extension agents on consignment during the first year and through Agri Sahel's network later on. The publicity through radio and television initiated by the project pushed the sale of the bags during this first year of the project.

In 2009, about 3,000 bags were sold, and the inventory was kept in his store for the next season. In 2010, on top of his inventory, he received a batch of 2,400 unsold bags from Kene-Agri, the wholesaler from Sikasso, which discontinued handling PICS bags. This brought the total number of bags to about 4,400. Kene-Agri, the PICS bags distributor in Sikasso, dropped out from the PICS bags distribution network because of the low sale in 2009. Given the amount of bags sold in 2009, Agri Saheli found that it was more reasonable not to order additional bags in 2010.

In 2010, all the bags were sold within a couple of months while the demand was still high. Many farmers were asking for bags that year and Agri Saheli experienced a rupture problem. He said when the farmers showed up at his store, he simply told them there were no bags. He added that he could not order the bags at that time because he needs to order at least 1,000 bags and it will take at least two weeks to receive the bags. According to his calculation, after two weeks, the demand of bags would be low.

In 2011, 9,500 bags were ordered including 8,500 100kg bags and 1,000 50kg bags (a request from WFP). Some of the bags were sold to volume buyers, including WFP, IER, and Millennium Villages Project (PVM). WFP, through the Purchase for Progress (P4P) program, purchased 2,400 bags (1,400 100 kg bags and 1,000 50 kg bags) for PRECAD to store cowpea. Indeed, WFP has contracted PRECAD for the supply of grains and beans to feed the children in the school canteens in certain regions in Mali. The same year, Agri Sahel supplied IER with 500 bags for the storage of grains. In addition, he sold 100 bags to PVM. The number of bags he sold to farmers and his distribution network is about 1,000 bags. This number is quite low and this is due to the low rainfall. The remaining bags (about 4,500 bags) were kept in his store for the next season. Currently, the inventory may decrease a little bit because some farmers are still purchasing the bags for other purposes (e.g., to store grains for household consumption). During our interview, one client showed up to Agri Sahel store to purchase a couple of bags for rice storage for household consumption.

Agri Sahel's distribution network is composed of ag inputs dealers, agricultural extension agents, farmer's associations, and roaming vendors (called "forins") who circulate from one market to another. Agri Sahel also paid community radios to advertise for PICS bags. The advertisement message indicates where to find the bags by providing the name and contact information of the roaming vendors as well as the markets they frequent. The bags are delivered at the doorsteps of Agri Sahel store at 925 FCFA/bag and sold to semi-wholesalers at 1,100 FCFA/bag, to retailers at 1,150 FCFA/bag, and to farmers at 1,200 FCFA or 1,250 FCFA. Agri Sahel also has a retail shop where he sells the bags at the retail price to individual farmers, traders, and households who want to store grains (cowpea, rice, cereals) for household consumption. In addition to the retail shop, Agri Sahel has about a dozen selling points across Segou and Mopti regions including eight semi-wholesalers and four retailers (see Annex). The region of Mopti is where PICS bags are mostly sold, particularly in Bankas because this area is one of the niches for cowpea production. Figure 8 illustrates the distribution network of Agri Sahel:

Within the network of the Agri Sahel (semi-wholesaler and retailers), a down payment is paid, but there is no fixed percentage. The amount of money paid depends on the typical relationship he has with that specific buyer. The network is built after many years of experience in business. All actors in this network are also members of the same ag inputs network at Citizens Network for Foreign Affairs (CNFA). The reimbursement was not an issue. For PICS bags, Agri Sahel preferred placing the bags on consignment as a strategy to create incentives for the actors in the network to continue with the business. The reason is because PICS bags are new to farmers and to his network. When the bags become well known and highly demanded, a down payment may be required from actors in the network. Another strategy used to motivate PICS bags distributors is the monitoring of the sale. Every week, Agri Sahel calls the semi-wholesalers to inquire about the sale of the bags.

Challenges for Agri Sahel include rainfall fluctuations and missing bags. Low rainfall and bad rain distribution during the crop season affects the level of cowpea production, thus affecting the sale of PICS bags. For instance, in Bla, the amount of bags sold in 2010 was about 1,000 bags but in 2011, the amount collapsed to 30 bags because of the low rainfall. About 150 bags were missing from bales received by Agri Sahel (see Annex).

One main strength for Agri Sahel is financing. Agri Sahel has a good relationship with banks and can ask for credit if needed to order PICS bags. Currently, PICS bags are purchased without financing. The funds used comes from the sale of other ag inputs (i.e., fertilizer, insecticides) because other ag inputs were sold at the beginning of the cropping season while bags are sold at the harvested period. Agri Sahel has access to credit and has a good relationship with BNDA. This bank can support him up to 85% of the total amount required. Second, many bags can be sold; they can sell more than 50,000 bags in a good production season, especially Koro and Bankas in the region of Mopti. Third, Agri Sahel has space for more than 300-400 bales (75,000 to 100,000 bags). Fourth, the relationship with the business consultant is excellent and may help expand the sale network and strengthen the supply chain. Fifth, there are several volume buyers in the chain, such as research institutions and humanitarian organiazations, in addition to the primary users of the bags (farmers, traders), which is an indicator of sustainability in the chain. Lastly, the fact that the bags have currently multiple applications at the farmer level will increase the demand over time from the downstream of the chain which is determinant for sustainability of the chain.

Retailers and Vendors

Retailer: M6

M6 is a young vendor of ag inputs, including bags for cereals and order goods and various articles in the town of Segou. He heard about PICS bags through his bags buyers. He looked for the distributor Agri Sahel and arranged with him to have the bags in his store under consignment. He did not receive any training on how to use the PICS bags nor about the commodity PICS bags are supposed to hold. He said his customers demanded for the bags (downstream demand), and, as such, he tried to get the bags to keep his customers. In 2009, he received two bales (500 bags) at 1,100 FCFA/bag and sold all of them at 1,250 FCFA/bag under a cash and carry basis. In 2010, he received four bales (1,000 bags) and also sold all of them. In 2011, he only sold about fifty bags, and the rest were returned to Agri Sahel because of the low production level in that year. Bags are sold on a cash and carry basis. His customers are farmers and grain vendors. M6 did not experience any rupture problems since 2009 because his store is at a walking distance from the wholesaler's store. To bring bags to remote areas, M6 works with some roaming vendors ("forins") at the village level who move from markets to markets (forins) loading the bags on the bike of motorbike. He sells the PICS bags to these roaming vendors who in turn sell the bags at 1,500 FCFA/bag.

Roaming Vendor: M7

M7 is a roaming vendor (forin) moving from market to market to sell various products such as cereals, legumes, and vegetables. She was identified by the business consultant in 2011. She does not have a direct contact with Agri Sahel but orders the bags through the PICS business consultant at 1,100 FCFA per unit. She has the possibility to get the bags from the semi-wholesaler at Markala, located about 15 km away from her place at 1,150-1,200 FCFA/bag. Because of the price at the semi-wholesaler's store, she prefers to use the service of the business consultant to get the cheaper bags. She sells the bags at 1,250 FCFA/bag to farmers. In 2011, she ordered her first thirty bags, and all was sold within a week. After she turned these bags over, she ordered fifty bags, but only twenty were sold because of the late delivery of the bags. M7 reported that PICS bags are used not only for cowpea but also to other crops such as dry onion. As opposed to M6, M7 was trained on how

to use the bags. She also reported that farmers provided her good feedback about the usefulness of the bags.

Volume Buyers

PRECAD

PRECAD is a project that supports the "Boutique d'intrants" by providing loans for ag inputs/outputs. PRECAD supports the union of cooperatives led by M8 to procure PICS bags. The union of cooperatives is specialized in the storage of grains and legumes, including cowpea. The grains are sourced from members from 23 villages, totaling 286 producers (including 49 women). Cowpea is stored in ordinary bags with the use of phostoxin. In 2010, M8, through the boutique d'intrants, ordered the bags from Agri Sahel at 1,200 FCFA/bag. For the first year, M8 said that the cooperative was not confident about the effectiveness of the PICS bags. To minimize risks associated with cowpea losses, the cooperative stored part of cowpea in PICS bags with phostoxin and the second lot in PICS bags without phostoxin. After this first experience they found out that cowpea stored without phostoxin was as good as the one stored with phostoxin. In 2011, the union of cooperatives received some technical training from a PICS technician who demonstrated how to use the bags efficiently. The cowpea stored in 2010 was sold to the WFP. The WFP often purchases grains for the school feeding program in Mali. M8 shared his experience with the WFP. The WFP was glad with the results, especially for the safety issues associated the grains stored in the PICS bags. In that year, the cooperative sold 10MT of cowpea to WFP[3]. In 2011, the cooperative signed a contract with the WFP to provide 25MT of cowpea. The WFP bought 450 bags for the storage of the cowpea.

The major challenge faced was the handling issue associated with the size of the bags. It is difficult to lift bags of 100kg. The overcome this situation, the WFP ordered bags of 50 kg. M8 reported that when a phostoxin is used to store cowpea, the grain stored should not be consumed before six months whereas for PICS bags, the grain can be consumed at any time.

Evolution of the supply chain and major milestones

In February 2009, the project coordinator at Purdue initiated partners meetings to discuss the implementation of the PICS project and to plan activities for this first year. Partners include WV-Mali, the in-country coordinator; IER, the institution leading training of field technicians; and SITCO and Embalmali, the manufacturers. In this same month, the PICS coordinator selected the manufacturer Embalmali to manufacture the bags. Bagayoko was hired as the PICS business consultant to identify potential distributors of the bags and facilitate the production of the bags. In May 2009, an agreement was signed between the three distributors (Faso Kaba, Agri Sahel, and Kene-Agri) to distribute PICS bags in Koulikoro and Kayes; Segou and Mopti; and Sikasso, respectively. In June 2009, an agreement was signed with Embalmali to manufacture the bags in Mali. 25,000 bags were ordered with a down payment of 50% (20% from the wholesalers and 30% from the PICS project), with the remaining 50% paid by PICS project at delivery. At the same period, the promotional campaign was launched on radios and television to build the awareness of farmers and other potential bags users of the PICS technology, including its advantages and

[3] One cooperative from Koutiala reported that the WFP has refused to buy its grains because of the level of infestation. The grains were stored in ordinary bags.

effectiveness for cowpea storage across the country. Advertisements on twenty-one radio stations and the national television channel were paid by the PICS project to broadcast PICS messages. Later in July, a contract was signed between the PICS project at Purdue and the in-country partners (IER and WV-Mali) to lead the training of extension and to support PICS bag distribution in Mali. PICS training was launched in November 2009 and continued through December, covering a total of 2111 villages. Posters were distributed in local languages to allow widespread of the information at farmers' level.

In December 2009, Kene-Agri, the PICS bags distributor in Sikasso, dropped out from the distribution of the bags because of low sales. Kene-Agri is led by Sanogo Fousseni, an ag input dealer since 1993. He is an agronomist and has worked for years as an extension agent. He received the first order in 2009 for a total of 5,000 bags. The PICS project purchased 2,500 bags for demos. This initial bulk payment encourages the distributor to invest in the distribution of bags. From the remaining 2,500 bags, only 85 bags were sold in 2009. Because of low sales, the remaining bags were picked up and distributed to Agri Sahel and Faso Kaba. According to him, four major reasons explained the low sale in 2009. First, the poor distribution of rainfall significantly affected the level of production of cowpea; secondly, the price of the bags (1,100 FCFA/bag) is expensive for farmers since they were used to buying ordinary bags at 250 FCFA/bag. The third reason is the unavailability of cowpea in the vicinity because most of the cowpea of Sikasso comes from Mopti. Because of the presence of the Agri Sahel PICS bags semi-wholesaler at Mopti (Bankas), farmers did not sell most of the cowpea in Sikasso market in 2009. Most of the farmers, instead of sending their cowpea to Sikasso and selling at a low price, preferred storing them with the PICS bags. The fourth reason is the risk-adverse behavior of farmers for a new technology. They are, in general, less inclined to use new technologies unless the technology has been proven. Another reason Sanogo evoked is how the network for PICS bags distribution was set up. According to him, the network was not functional because the three semi-wholesalers with whom he will work with were proposed to him by the business consultant. The tie between him and the semi-wholesalers was not strong and this was also a cause of low sale because of the lack of coordination and management. Since 2009, Sanogo did not order the bags. In 2011, he said there were a lot of farmers have asked for bags. He realized that the demand of bags has been growing because the bags are actually used for other crops. Now he wants to start again with this business but as a retailer because of some capital constraint. Over time, he can become a semi-wholesaler or wholesaler if his capital allows. He is in the process of contacting Agri Sahel to order bags on cash and carry basis for the coming season.

In 2010, the PICS project continued building farmers and grain vendors' awareness on the usefulness of the PICS bag. In April 2010, an OBC was held in Seguebawili. Attendees of this ceremony encompassed the PICS team at Purdue, represented by Baributsa; WV-Mali; IER; various PICS bags distributors; the business consultant; a local radio station to broadcast the event for local communities; and farmers. In June 2010, a six-month promotional campaign was launched on 21 radio stations and on national television in eight languages by the PICS project for its efforts to build the awareness of bags users and to strengthen the distribution chain. In September 2010, the project in-country coordination initiated a two-day grain and bags vendors training at Bla (Segou) and Kolokani (Koulikoro) on the use of the bags, as well as its benefits. The objective of this training was to boost the sale of the bags in the distribution network of Agri Sahel and Faso Kaba by linking grains vendors and bags vendors. Strategies for an efficient distribution of the bags were discussed during this training. In October 2010, the distributor Agri Sahel was trained on the use and

the benefits of PICS technology. The restaurant managers in Bla were also sensitized on health hazards associated with chemicals in foodstuffs and in cowpea in particular.

In March 2011, OBCs were organized at Bla, Sinzana, and Touna with grain vendors. In June 2011, a workshop was organized by the AGRA Market Access project in Sikasso to discuss how PICS bags can be part of the post-harvest strategy in Mali. From September to November 2011, market traders were also trained in the use and benefits of PICS technology.Challenges faced by PICS project and partners in developing the supply chain

In Mali, there were many small challenges, but no major challenges faced by the project partners. This is explained by the fact that the supply chain was led directly by the distributors, with the help of the business consultant, in monitoring the order of the bags and its distribution along the supply chain. Project partners were more essentially focused on the technical part of the project (i.e., media, outreach activities at the village level, and OBCs). The down payment of 50% provided by the PICS project at Purdue to national distributors as an incentive to invest in PICS bags was entirely reimbursed by the national distributors. One challenge faced by the technical team in 2009 was the low production of cowpea. There were some villages were it was difficult to get five farmers for the demos in 2009. The major reason is the low production of cowpea.

Strategies developed to encourage actors' investments

Private actors' investments in the PICS supply chain were favored by the promotional activities (i.e., media, sensitization, OBCs) undertaken by the project to build the downstream demand of the supply chain. The promotional activities help raise the awareness of farmers of the usefulness and effectiveness of the bags, as well as show the business opportunities to distributors to encourage chain actors' investments in the sale of the bags. The use of the national television in Mali to broadcast the PICS message in local languages had a large impact on farmers' awareness of PICS technology because most of them have access to the national channel. Most importantly, the length of broadcast (three months for TV and six months for community radios) had a large impact at the demand at the downstream of the chain.

The willingness of the manufacturers to invest is the foreseen increase in demand for the bags. Currently, the manufacturers are willing to deliver the PICS bags at the same price at the doorsteps of the distributors. Additionally, they are willing to use their network to supply bags directly to farmers is necessary (i.e., where the PICS actors are not present). Another motive is the public health issue associated with the use of the bags. The use of PICS bags prevents farmers to rely on insecticides to store cowpea.

The willingness of the wholesalers to invest in PICS bags is the creation of a new line of product which will significantly add to the types of customers such as grains traders and NGOs. The fact that PICS bags are advertised through various channels of media is a way for the wholesalers to be well-known and to potentially increase the volume of sale for other ag inputs.

Challenges and opportunities to supply chain sustainability

Constraint: Delay related to delivery of plastic liners from Fasoplast in 2010/11.
Strategy: Where feasible, identify opportunities and mechanisms to increase local manufacturing capacity to avoid delays in manufacturing the polyethylene bags.

Constraint: Unreliable power supply impacting price with Emballage Miankala.
Strategy: Working thru partners to facilitate capacity building among supply chain actors to identify needs and voice concerns at local/regional level.

Constraint: Increasing prices and/or volatility of raw materials.
Strategy: Discuss strategies with the department of industry and MOFA to lessen the cross-border duties and tariffs for raw materials to partially offset the effect of the increase of raw materials on bags production cost. Considering PICS bags in the portfolio of ag inputs may be an alternative to make the bags affordable to farmers.

Constraint: High number of missing bags (about 210 missing bags from a total of 10,000)
Strategy: Supply chain actors (i.e., wholesalers, manufacturers, the business consultant to some extent) should meet and discuss options to overcome the issue of missing bags in the future to safeguard credibility among actors in the network.

Constraint: Delivery arrangement with Emballage Miankala not suitable for Faso Kaba.
Strategy: A dialogue between Emballage Miankala and the wholesaler Faso Kaba to find a suitable delivery option is necessary to strengthen the chain.

Constraint: Low margins at semi-wholesaler level in 2009 (50 FCFA/bag) when bags sold at 1,100 FCFA.
Strategy: The promotional price set in the first year of the project continues to influence farmers' decisions to procure the bags. Retailers are tied up with this ceiling price which may become a bottleneck for the development of the chain in the near future. At the current status of the distribution chain in Mali, let the market determine the price of the bags at the retailer level to create incentives at the downstream of the supply chain.

Constraint: Misuse and/or bad practices of PICS technology (i.e., separating inner liners to make two bags, non-removal of impurities from cowpea).
Strategy: More sensitization about PICS technology, including media, of farmers buying bags from Faso Kaba outlets.

Constraint: Non-payment by extension agents in the Faso Kaba network (49% in 2010).
Strategy: Good monitoring, along with creating incentives to extension agents by allowing them to sell the bags not at the predetermined price but at the price that matches with demand at a specific location.

Opportunities to expand the supply chain via increased private sector investments

There are three main opportunities to expand the supply chain through increased private sector investments. First, organize an annual meeting with actors of the supply chain at the beginning of the cropping season to plan the order of the bags. Second, strengthen the relationship between the technical team (coordination, technicians) and the supply chain

actors through frequent dialogues about cowpea production (expected yield) and commercialization, bags manufacturing, and bags distribution. Third, support the media efforts: The media effort was a key in spreading the message about PICS bags and supporting the adoption of the bags.

Lessons Learned

Manufacturers

Manufacturers in Mali are challenged in complying with and maintaining the thickness of the polyethylene bags and to produce and supply the bags on time.

The volume of PICS bags currently manufactured is still very limited and therefore renders the business financially less attractive.

Wholesalers, Semi-wholesalers, and Retailers

Distribution of PICS bags through the extension agents is not a viable strategy for the sustainability of the chain.

The existence of a bilateral relationship between the wholesaler and the semi-wholesalers (for exchange of goods) is key for the sustainability of the supply chain.

The margin at the retailer's level is not attractive and may discourage the investments at the downstream of the chain.

They are eager to distribute the bags but don't want to bear the risk of purchasing with they own resources.

Business Consultant

Well-defined Terms of Reference and strategic recruitment of business consultant (i.e., rural business experience, entrepreneurial history, broader market perspective) is key to getting results, particularly during the initial phase.

Across the supply chain

The retail price of an individual PICS bag is 1,200 FCFA to 1,300 FCFA (around $3 USD) on average, and it is affordable to farmers who are persuaded about the effectiveness of the bags (no insects in the cowpea, fresh and clean cowpea); however, the poor rainfall reduces cowpea productivity and therefore limits the demand for the bags.

The multiple applications of the bags at the end users level (i.e., rice, millet, bambara groundnuts, dried onions) may increase the demand for the bags and enhance the sale of the bags.

There is a growing demand at the downstream of the chain because many actors including farmers and volume buyers such as Farmer Based Organizations (FBO), traders, NGOs (e.g. PRECAD), and research institutions (e.g., IER) are becoming more aware of the usefulness and effectiveness of the bags.

PICS bags distributors in Mali use various marketing strategies (investment in advertisements, use of rooming vendors, and extension agents) to efficiently deliver the bags to farmers; however, given the wide scale of cowpea production areas across the country, more time is needed for bags vendors for an effective countrywide supply chain.

Recommendations

A quality control mechanism at the manufacturer's level is necessary to ensure the thickness of the bags. Such a mechanism may include unexpected inspection of the bags in the markets.

Vendors meeting should be encouraged at the beginning of each cropping season to plan the procurement and efficient distribution of the bags.

The price of the bags should be set according to the supply and demand that prevails in the market place to enhance vendors' investments in the procurement and distribution of the bags.

ANNEX

Figure 1: Supply chain of PICS bags in Mali

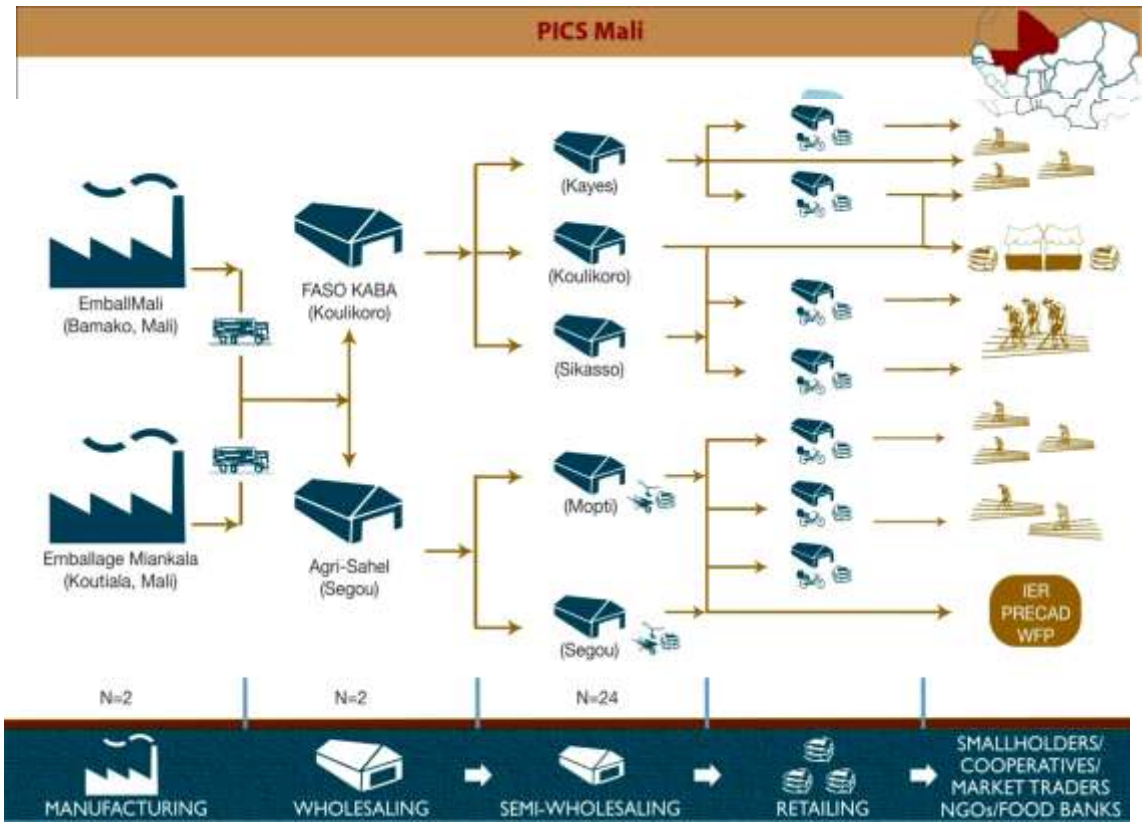


Figure 2: Cost structure of the production of PICS bags by Embalmali

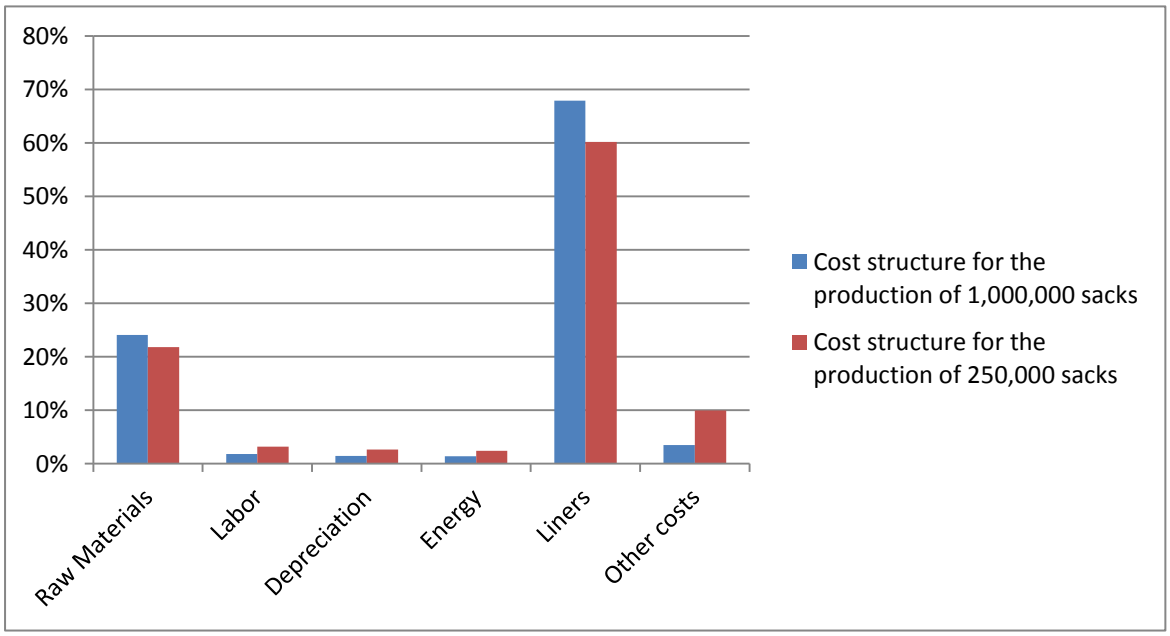


Figure 3: **Cost structure of the production of PICS bags by Emballage Miankala**

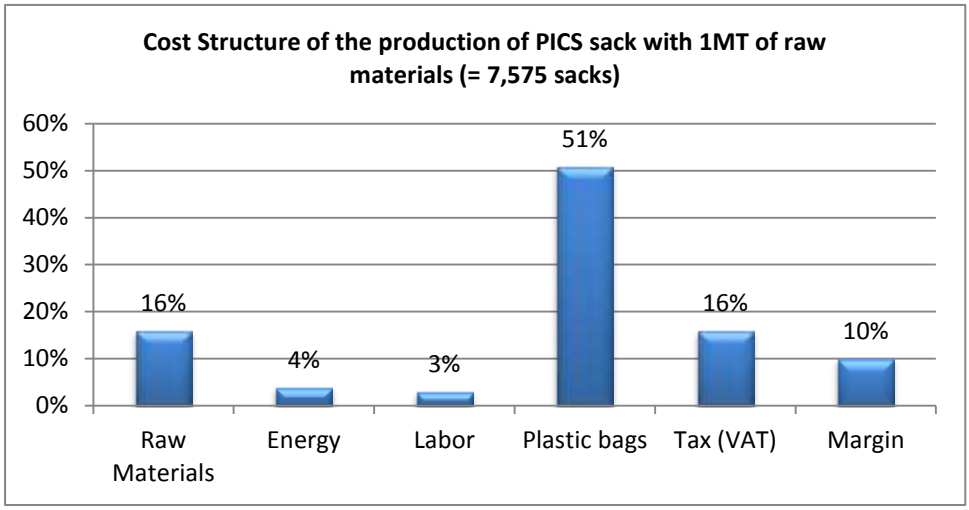


Figure 4: **Price markup across PICS supply chain actors**

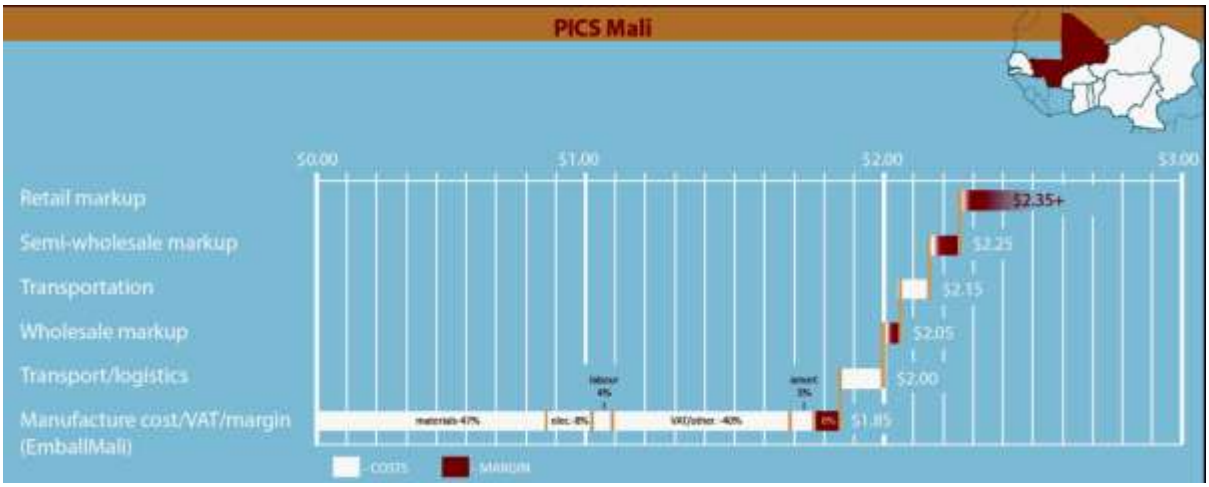


Figure 5: **Distribution network of PICS sacks for Faso Kaba**

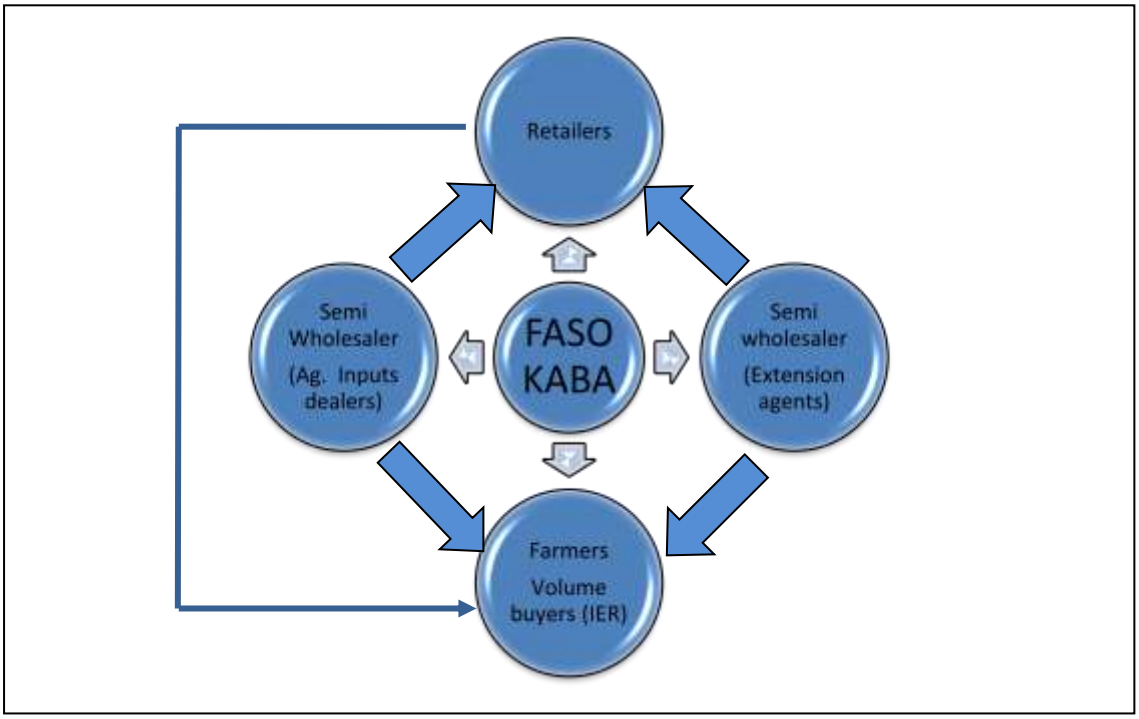


Figure 6: **Distribution network of a semi-wholesaler as an ag inputs dealer**

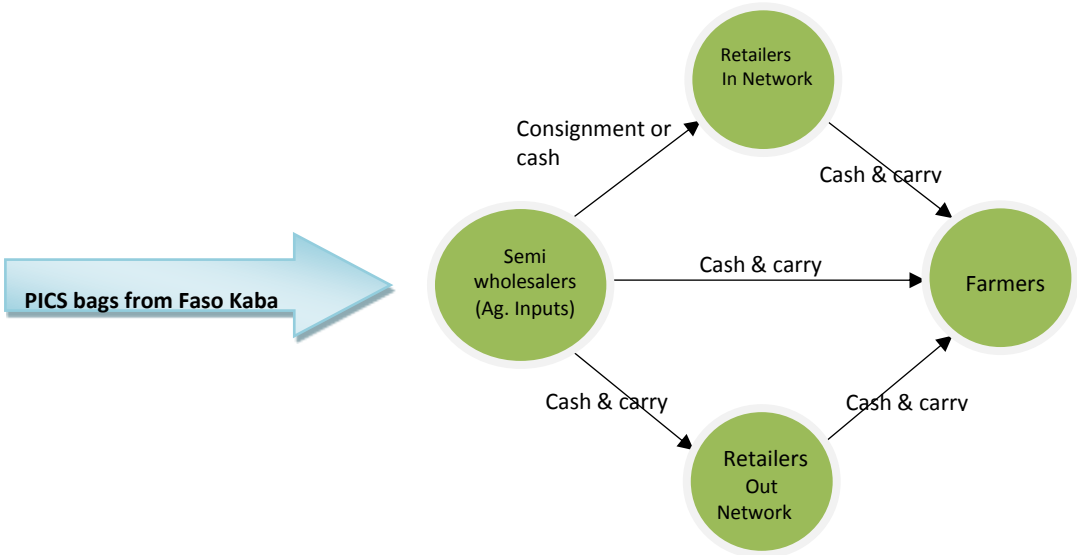
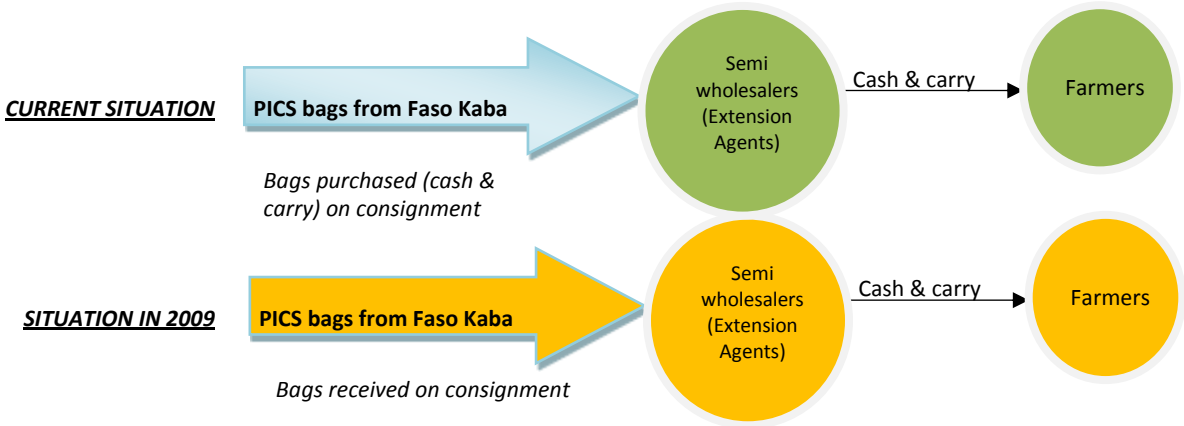


Figure 7: Distribution network of Semi wholesalers as Extension agents



<u>Figure 8</u>: Distribution network of PICS bags of AGRI SAHEL

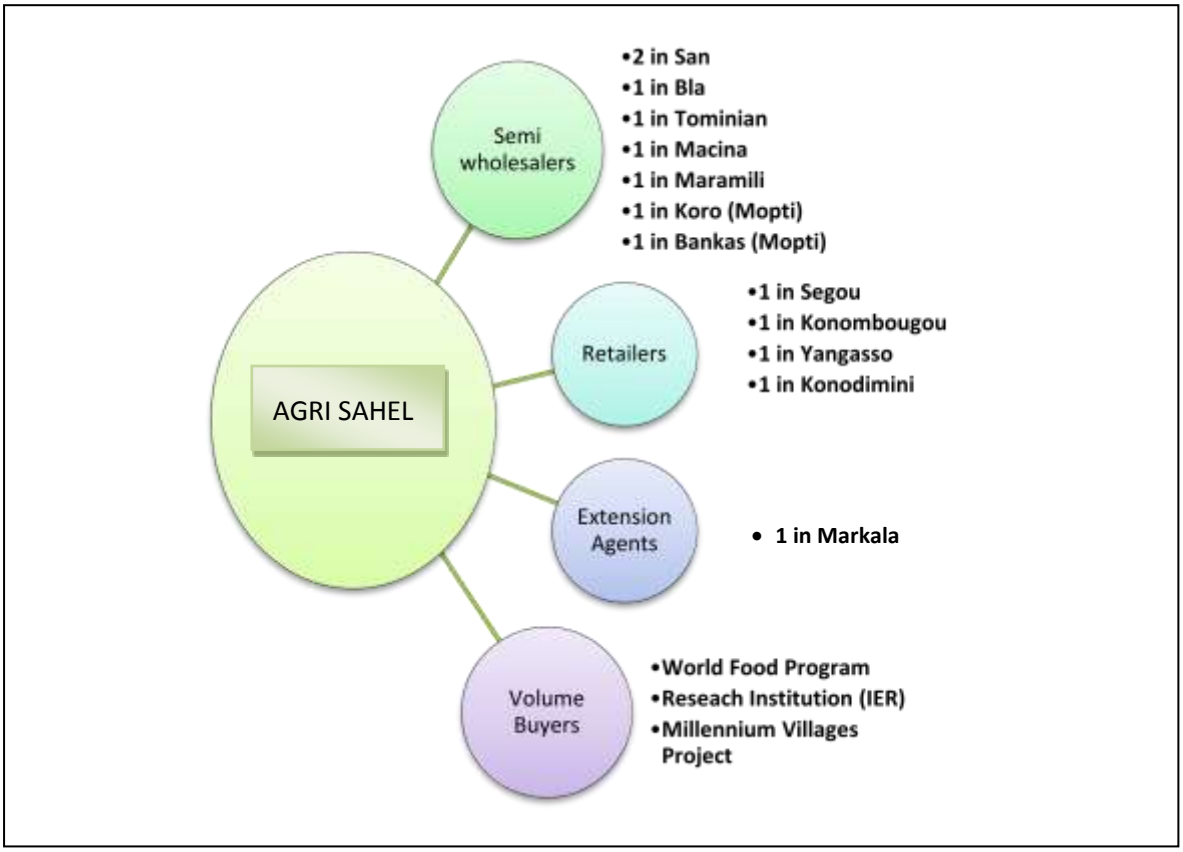


Figure 9: Distribution network of Faso Kaba and Agri Sahel for PICS bags

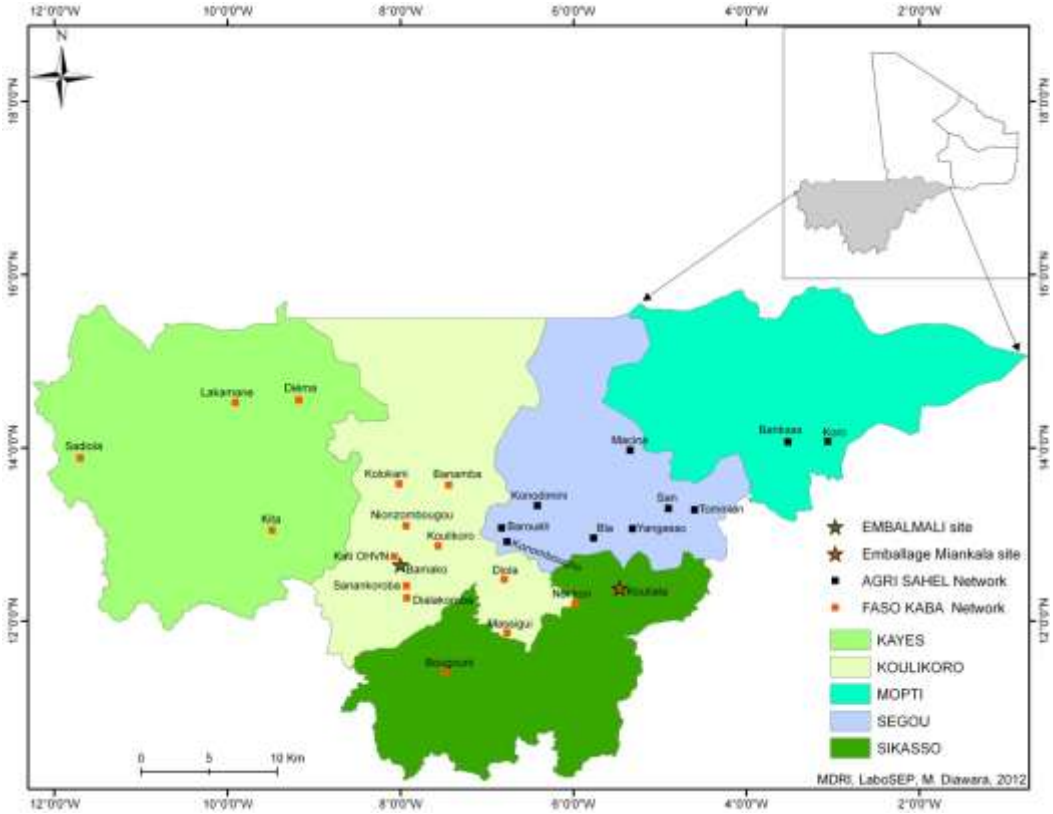


Fig 10: Evolution of the supply chain in Mali

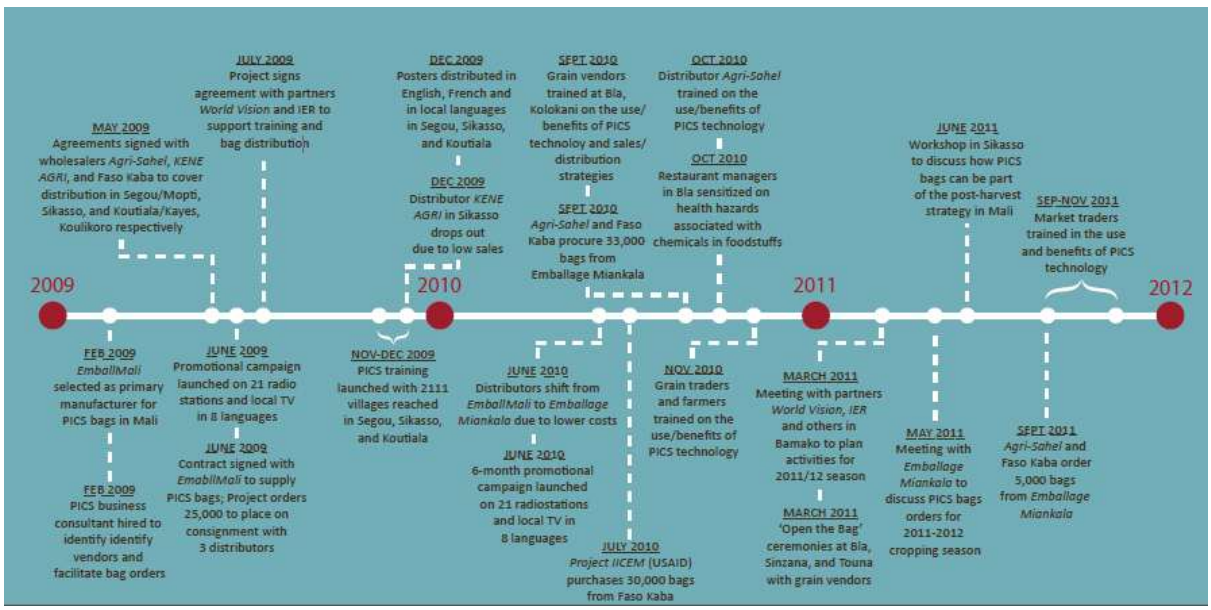


Table 1: Distribution network of PICS Wholesalers (Faso Kaba and Agri Sahel)

#	Faso Kaba	Agri Sahel
1	Nionzombougou	San
2	Kita	Bla
3	Kolokani	Tominian
4	Dialakoroba	Macina
5	Sanankoroba	Konombougou
6	Diola	Baroueli
7	Koulikoro	Koro
8	Lakamane	Bankass
9	Banamba	Yangasso
10	Nonkon	Konodimini
11	Bougouni	Maranmili
12	Diema	Segou
13	Kati OHVN	Markala
14	Sadiola	
15	Kita	
16	Diéma	
17	Massigui	
18	Kita	

Table #2: Villages selected for PICS bags demos

Regions	Cercles	Villages covered	Wholesalers
Koulikoro	Banaba, Kati Kolokani, Dioila	500 Villages	Faso Kaba
Kayes	Kita Diéma	250 Villages	Faso Kaba
Ségou	Ségou central, Bla, Macina, San, Baraouéli, Tominian	750 Villages	Agri Sahel
Mopti	Koro, Bankass	250 Villages	Agri Sahel
Sikasso	Sikasso central Koutiala, Yorosso Bougouni	500 Villages	Kene-Agri for the first year Agri Sahel for the second year
Total	**18 cercles**	**2 250 Villages**	*Three wholesalers in Year 1 *Two wholesalers in Year 2

Table 3: Situation of bags at the end of the cropping season in 2010

Wholesalers	Initial endowment	Number of bags for the Demos	Number of bags sold per wholesalers	Missing bags	Remaining bags per wholesaler
Agri Sahel	*10 000*	*5 000*	*2 305*	*150*	*2 545*
Faso Kaba	*10 000*	*3 750*	*1 570*	*0*	*4 680*
Kene-Agri	*5 000*	*2 500*	*85*	*0*	*2 415*
TOTAL	**25 000**	**11 250**	**3 960**	**150**	**9 640**

Table 4: Status of bags' dispatching sale and payment in the Faso Kaba distribution network (As of November 2011)

N°	Locality	Date of Delivery	# of bags	Unit price	Amount	Amount paid	Returned bags	Balance
1	Nionzombougou	18/10	150	1,100	165,000	165,000		0
2	Kita	16/10	335	1,100	368,600	280,000		88,600
3	Kolokani	6/1	517	1,100	568,700	100,000		468,700
4	Dialakoroba	11/11	41	1,100	45,100	45,100		0
5	Sanankoroba	21/11	150	1,100	165,000	110,000		55,000
6	Diola	16/10	208	1,100	228,800			228,800
7	Koulikoro	16/10	100	1,100	110,000		110,000	0
8	Lakamane	17/10	0	1,100	0			0
9	Banamba	19/11	0	1,100	0			0
10	Nonkon	14/11	80	1,100	88,300	41,000		47,300
11	Bougouni	3/11	121	1,100	133,100	23,100		110,000
12	Diema	4/1	410	1,100	451,000	451,000		0
13	Kati OHVN	29/10	100	1,100	110,000			110,000
14	Sadiola	4/11	0	1,100	0			0
15	Kita	5/11	100	1,100	110,000	80,000		30,000
16	Diéma	30/11	250	1,100	275,000	80,000		195,000
17	Massigui	13/12	250	1,100	275,000	46,600		228,400
18	Kita	5/1	600	1,100	660,000	385,000		275,000

NIGER

Presentation of the PICS supply chain study

The PICS case study in Niger documents the country's experience in building up a sustainable, commercially-oriented supply chain to channel the PICS bags technology to end-users. This analysis describes the current situation of the PICS supply chain in Niger and challenges faced by the stakeholders. The study then reports the milestones that impacted the development of the PICS supply chain, as well as strategies implemented by the project, partners, and actors to develop a viable distribution system of PICS bags. Next, the case study points out key challenges and opportunities that have potential to enhance the sustainability of the supply chain. Finally, major lessons are drawn based on the analyses to stimulate private sector's investment for a sustainable growth of the PICS supply chain.

Current situation

The description of the current situation of the PICS supply chain is illustrated through a supply chain map and a profile on the supply chain actors. The supply chain map identifies the key players and the marketing channels for the PICS bags in Niger, while the supply chain actors profile provides details on the role and activities of the stakeholders and challenges faced by each actor.

Mapping out the supply chain

The supply chain map (see figure 1 in Annex) gives a simplified presentation of the flow of PICS bags from the manufacturer to the end-users. There are indirect interactions among actors in the supply chain, but for the sake of clarity, direct connections among actors are only represented on the graph. The marketing of the PICS bags in Niger is currently organized by the national distributor, Ibrahim Zanguina. He imports the PICS bags from Lela Agro in Nigeria and channels the bags to his regional wholesalers, settled in the five main regions of Niger. From the regional wholesalers, the bags are sold to wholesalers and semi-wholesalers in the districts of the country. The retailers are in charge of selling the bags to end-users, mainly represented by farmers. Some NGOs facilitate the distribution of the PICS bags to farmers, particularly farmers located in villages with poor infrastructure access.

Supply chain actors

The key players of the PICS supply chain in Niger include: one importer, who is the national distributor; five regional wholesalers; 61 semi-wholesalers; numerous retailers; and numerous farmers. Besides those key players, there are other stakeholders represented by volume buyers (including NGOs), Office des Produits Vivriers du Niger (OPVN), cowpea market traders, and business consultants.

National Distributor: Ibrahim Zanguina

Zanguina is the importer of the PICS bags in Niger and the national PICS distributor since September 2009. He took over the distribution of the PICS bags in Niger after the

former national distributor, Sani Gado, took a ministerial post. Before being the national distributor of PICS bags, Zanguina was already involved in the PICS supply chain as the regional wholesaler of PICS bags in the Dosso region. He worked concomitantly in the distribution of cell phone cards in the Dosso region. As such, in the Dosso region, Zanguina relied mainly on his network of cell phone retailers to sell PICS bags. In 2010, Zanguina created an enterprise named "Enterprise Husa'a", which was in charge of marketing agricultural inputs and cereals in the region of Dosso. PICS bags have been included in the set of inputs and products sold by Enterprise Husa'a, and this enterprise acts currently as the wholesaler of the PICS bags in the region of Dosso. In other regions, Zanguina does not have a pre-established national network; instead, he works with five regional wholesalers and their network of retailers.

The relationship between Zanguina and wholesalers and retailers is informal and based on several different types of marketing agreements. Since 2010, a cash-and-carry payment system has been implemented between Zanguina and his wholesalers to remedy to the problem of default in payment encountered in the previous years with the stock on consignment or credit payment system. Thus, in every year since 2010, Zanguina has a vendor meeting in the month of July with his wholesalers and Lela Agro, the PICS bags manufacturer in Nigeria. During those vendor meetings, all wholesalers submit their demand for PICS bags for the incoming cowpea harvest. These demands are centralized by Zanguina who places the orders gradually with Lela Agro. The total demand is divided and placed in three orders with Lela Agro to minimize the risk of carrying large inventory stocks of PICS bags. The wholesalers pay a 50% down payment at the time of the order, and the remaining amount is paid when the bags are delivered. The PICS bags are imported from Lela Agro and distributed to the different regional wholesalers. The national distributor incurred the transportation costs from Lela Agro to the regional wholesalers.

Although the cash and carry system is the established mode of payment since 2010, the credit mode of payment or stock on consignment is still carried on between the national distributor and some of his vendors. This latter mode of payment is practiced when the relationship between Zanguina and the buyers is strong and characterized by a high level of trust and commitment.

There are numerous challenges that the national distributor needs to address for a greater sustainability of the supply chain of the PICS bags. The first challenge is the availability of PICS bags in due time. Availability of the PICS bags involves timely and spatial procurement of the bags. The timely availability guarantees that there are enough bags in the market at the beginning of harvest, before farmers start making their storage decision, and throughout the cowpea season to prevent any rupture in supply. PICS bags need to be available right at harvest, before farmers start making alternative storage decisions. Thus, the best time for the PICS bags to be available with the national distributor is the month of August, just before harvest. During those two past years, there was a problem with the timely availability of the PICS bags. In 2010, there was a disruption in the supply chain in the month of October because the vendors underestimated the demand in PICS bags. 2010 was a very good production year of cowpea, characterized by an increase in area planted and production by 34 % and 125 %., respectively (Ministère du Développement Agricole, 2010). The total demand of PICS bags estimated by the vendors before harvest was 100,000 bags. Thus, a first order of 50,000 bags was placed at the beginning of harvest. This first order was sold off very quickly in less than a month due to the surge in the 2010 cowpea production. Hence, a second order of the remaining 50,000 bags occurred a few

weeks after the first one. This second order was delivered very late, almost in December because of the late payment of the 50 % down payment by Zanguina. The delay in the bags procurement led to a rupture in the supply of PICS bags from October to the end of November. In 2011, the availability of the PICS bags at harvest was deferred by few weeks. This delay was explained by the fact that some wholesalers did not pay their cash advance on time to Zanguina for the bags ordering. Wholesalers pay some cash advance to Zanguina before the bags ordering as a guarantee that the bags are needed at the lower level of the supply chain.

The national distributor will have to meet the challenge of developing the network of PICS bags distribution outside the region of Dosso, particularly in the region of Maradi and Zinder. As it is portrayed in figure 2 in the annex, the distribution network of the PICS bags is quite dense in the Dosso region compared to the relative sparseness in the Maradi and Zinder regions, which produce larger quantities of cowpea than the Dosso region. In the Maradi and Zinder regions, the distribution network is mostly limited to the urban areas.

The 2010 rupture in the supply of the PICS bags and the non-availability of the bags right at harvest in led to two other challenges that the national distributor need to overcome for greater sustainability of the distribution of the PICS bags. These challenges are: (i) a reliable and timely estimation of the demand for PICS bags, and (ii) the cash mode of payment.

Having a reliable estimate of the demand in PICS bags is crucial for an adequate supply of the PICS bags in the market. The most common estimation approach currently used by vendors of PICS bags is based on past sales, vendors' subjective expectation of future demand, or on the spot during the vendors meeting organized in July of every year. Those estimations lack accuracy and are often very different than the actual orders made by vendors when harvest unfolds. Vendors are also risk-averse and do not want to take the risk of ordering bags before observing the harvest outcome.

The cash mode of payment, particularly the provision of the cash advance for the bag ordering, is a challenge for some wholesalers who are more liquidity-constrained. The cash-and-carry system of payment has been adopted since 2010 to address the problem of default in payment observed with the credit mode of payment used before 2010. Hence, the shift from credit to a cash mode of payment with a 50 % down payment was not easy during the first year of implementation. In 2011, the difficulty of raising the 50 % down-payment from the regional wholesalers has delayed the ordering of the triple bags from Lela Agro by a few weeks. Also, with the delay in raising the down payment and to be able to pay the cash advance to the manufacturer Lela Agro by the time of the bags ordering, the national distributor took a bank loan of 12.5 million FCFA.

Cowpea production, as any rain fed agricultural commodity in Niger, is very variable and depends on the climate. 2010 was a very good year for cowpea production because of good rainfall; however, 2011 has been characterized by low and poorly distributed rainfall across the agricultural season, leading to a poor harvest of cowpea. As a result, the demand for PICS bags has been very low, and there is a large inventory stock of PICS bags remaining with the national distributor.

The regional wholesalers

There are currently five regional wholesalers distributed across the five main producing regions of cowpea in Niger: Oumarou Dan Malka in Niamey region; Enterprise Husa'a in Dosso region; Assoumane Salifou in Tahoua region; Maman Na Iya in Maradi region, and Malan Manirou in Zinder region.

The wholesalers are involved in other activities, including seed production, cereal and cowpea trade, and agricultural inputs. They are supplied in PICS bags by the national distributor. The transportation costs for procurement are supported by the national distributor. The wholesale price for 2011 was fixed at 925 FCFA/bag. This price rose relative to the past, where the price was on average 850 FCFA/bag. The price change reflects the change in bag capacity, which has now increased and holds 100 kg instead of 80 kg. Zanguina has thus caught up to a change made in other countries several years ago. The number of bales purchased by the regional wholesalers is variable relative to the cowpea harvest, the existence of an extended distribution network, and strategies implemented to turn over the stock of bags very rapidly. For instance, in 2010, enterprise Husa'a, the wholesaler of the Dosso region, has sold more than 100 bales of 300 PICS bags each. The achievement of this record in the number of bags sold was explained not only by the good cowpea season but also by other factors, such as the reliance on the pre-established Airtel phone card distribution network and the aggressive marketing strategy. This marketing strategy consisted of reaching and including in the PICS distribution network people or traders of various types of goods who have strong connections that could enhance diffusion of the PICS bags in the lower stream of the supply chain. Besides, mobile vendors are often sent to weekly rural markets to sell the bags and increase the turnover rate.

The distribution network of the regional wholesalers is composed of semi-wholesalers (61); retailers; NGOs, including CRS and Cooperative League of the United States of America (CLUSA); and end buyers such as farmers working individually or in associations ("Boutique d'intrants"), government projects, and small cowpea traders. Regional wholesalers' networks of semi-wholesalers and retailers are generally drawn out of their social connections and customers to minimize the risk of default in payment. The mode of payment is very flexible between the wholesalers, semi-wholesalers, and retailers. When the relationship is a long-term relationship with multiple interactions and trust, the bags are purchased on credit basis or placed on consignment. Otherwise, they are bought on a cash basis, as it is the case with end buyers. The semi-wholesalers are located in the departments of the regions and the transportation costs incurred either to the regional wholesaler or to the semi-wholesaler depending on the payment arrangement they concluded. Long distances between the wholesaler and any vendors often impedes participation in the PICS bags business, as high transportation costs will reduce the price margins on the bags.

In 2011, the selling price to semi-wholesalers and retailers was 1,000 FCFA/bag, and 1,100 FCFA/bag to the end buyers. This leads to a price margin of 75 FCFA/bag obtained with the semi-wholesalers and 175 FCFA/bag with the end buyers. The larger price margin obtained with the end buyers increases the incentive of the regional wholesalers to develop strategies to target this market segment. Hence, some wholesalers, such as enterprise Husa'a in Dosso and Assoumane Salifou in Tahoua, use often mobile vendors to sell the PICS bags to end buyers in different markets.

Wholesalers use their own financial resources to invest in the PICS business. None of them requested a bank loan because of the uncertainty related to the business activity and the low cash flow especially during years of poor cowpea production. Also, some wholesalers are less inclined to take bank loans because of their Muslim religious beliefs that do not encourage credit requests with an interest rate. This can be perceived as a social constraint limiting access to credit.

The first challenge faced by the regional wholesalers is poor road infrastructure and high cost of shipment. Road infrastructure in some departments and villages is very poor, increasing the costs of shipping the bags to those locations and limiting their shipments. A second challenge is the unreliable supply of bags from the national distributor. Wholesalers need to respond to the demand for bags from the lower end of the supply chain. They need to have a consistent procurement of PICS bags from the upper stream and not create a rupture in supply, as was the case in 2010. Third, the cash payment system represents a constraint for large investments for some wholesalers who have a tight budget. The low cash flow of the PICS bags, particularly in years of poor cowpea production, increases the opportunity cost of wholesalers' capital and impedes their willingness to tie their money to the PICS business. Lastly, there has been poor estimation of the demand in PICS bags. Estimation of the annual demand in PICS bags before harvest is very approximate and is based on past sales and their subjective belief of the upcoming harvest. This poor estimation results in large discrepancies between expected demands in PICS bags submitted to the national distributor during the vendor meetings in July and their actual orders after harvest.

As in the case of the national distributor, variability of cowpea production threatens investment in the PICS bags business. Many wholesalers have large inventory stocks of PICS bags because of the poor cowpea production in 2011.

Departmental wholesalers and semi-wholesalers

There are five departmental wholesalers and 61 semi-wholesalers involved in the supply chain of PICS bags (see table 1 in the annex). The departmental wholesalers and semi-wholesalers source their bags from regional wholesalers or from the national distributor. The number of bags purchased depends on the cowpea season and the distribution network of the semi-wholesalers. Some departmental wholesalers with large distribution networks, such as Assoumane Chamana in Dogondoutchi, can sell up to 33 bales in a given cowpea season.

The buyers of PICS bags with the semi-wholesalers include mostly farmers (more than 50% of sales) but also retailers, NGOs, cowpea traders, and projects. It is very common for semi-wholesalers to work with some mobile vendors, generally their relatives, to reach out different markets and increase the number of bags sold.

The mode of payment of the PICS bags by the upstream vendors is flexible and depends on the relationship between the semi-wholesalers and the wholesalers. The stock on consignment method is used when the relationship between the semi-wholesalers and the wholesalers or the national distributor is characterized by strong commitment and trust. Examples of such relationship are observed between N1 of Tahoua and his wholesaler Assoumane Salifou, and also between N2 of Dogondoutchi and his wholesaler Enterprise Husa'a. PICS bags are also placed on consignment with some retailers having strong social bonds and repeated interactions with the semi-wholesalers. In 2011, the purchasing price of

the PICS bags with the wholesalers was 1000 F,CFA. Those bags were resold to retailers at 1,025 FCFA/bag and to end-users at 1,100 FCFA/bag.

The challenges faced by the semi-wholesalers in the distribution of the PICS bags are identical to those of the wholesalers.

Retailers

The supply chain of the PICS bags includes numerous retailers. Those retailers are involved in several types of activities, including farming, seed multiplication, and cereal and cowpea trades in order to meet their financial needs. Retailers who have a long-term relationship with wholesalers and semi-wholesalers work often on a stock on consignment basis with their suppliers. Those with weaker social ties or are outside the wholesalers/semi-wholesalers traditional network, purchase their bags on cash and carry basis in small quantities. They renew their stock of PICS bags when they are able to turn over the initial stock.

Bags were purchased in 2011 at 1,025 FCFA/bag and sold at 1,100 FCFA/bag. This latter retail price is quite fixed across regions and has been influenced by the first year's retail price set by wholesalers and the PICS team in order to avoid speculation and ensure the affordability of the bags in the lower stream of the supply chain during the initial stage of the project. However, this official retail price is not always implemented by the vendors. The retailing price depends more on the demand for the PICS bags and the distance travelled to sell the bags in remote rural markets. For example, in 2010, with the abundant cowpea production and the increasing demand of PICS bags, some vendors sold the bags at 1,500 FCFA/bag. It is also often reported that in distant villages, vendors sell the bags for more than 1,100 FCFA/bag. Those who buy PICS bags from the retailers are largely farmers (more than 70%). The remaining percentage includes cowpea traders, processors, and few NGOs.

Some retailers have very good entrepreneurial behavior and are able to evolve into semi-wholesalers. This is the case of N3 in the department of Boboye who works as a carpenter and a street vendor of breakfast "Aboki" as his primary activities, but was able to sell almost 1,000 bags in 2010. With this dynamism, N3 wants to be recognized as a semi-wholesaler in the department.

The retailers face the challenges of having access to a sufficient number of bags from the upstream vendors when needed. When there is a disruption of supply of the PICS bags from the wholesalers, their business is also impacted. Along with this, many downstream vendors are liquidity-constrained, and it is very challenging for them to procure the PICS bags on a cash basis. Also, given their tight budgets, many retailers who procure their bags on cash are forced to wait until their can turnover their stock increasing the risk of rupture particularly during the period of peak in demand of PICS bags.

End Buyers

Large cowpea traders

The involvement of cowpea traders as buyers of the PICS bags depends on the volume of cowpea marketed. Cowpea traders are profit-oriented, and the extent of their participation in the market of the PICS bags is dictated by the economic benefit derived relatively to the costs incurred. Before the inception of the PICS bags in the market, cowpea traders used insecticides, principally phostoxin, to preserve cowpea from the bruchids' attack. Traditionally, one tablet of phostoxin is placed in a 100 kg bag of cowpea. The cost of this tablet is 100 FCFA. Adding the labor cost, estimated at 250 FCFA/bag, and the price of one ordinary bag evaluated at 300 FCFA, the total expense for storing 100 kg of cowpea using chemical can be estimated at 650 FCFA. The chemical treatment should be renewed, on average, every three months for longer period of storage. Thus, for a storage length ranging from three months to a year, the total expenses will be between 650 FCFA and 1700 FCFA/bag.

By using the PICS technology, the expense incurred for storing 100 kg of cowpea is estimated at 1,100 FCFA, which represents the retail price of the PICS bag. A PICS bag can be used to store cowpea for three years (on average) without any replacement, with the assumption that there are no leakages or breaches in the PICS bag. This will also imply additional cost of re-bagging cowpea in ordinary bags when cowpea is sold to buyers. This additional cost includes the labor cost, estimated at 250 FCFA/bag, and the price of one ordinary bag, evaluated at 300 FCFA. So, the annual expense for storing 100 kg of cowpea can be estimated at 733 FCFA/year.

Thus, the PICS technology is cost efficient relative to the use of insecticides when cowpea is stored for more than three months and when the PICS bags can be reused over years. Hence, cowpea traders storing for a longer period of time because of market uncertainties or handling less than 1 T of cowpea have more incentive to buy the PICS bags. For those types of traders, handling costs for re-bagging cowpea in ordinary bags during market transactions can be minimal, but as the volume of cowpea handled becomes very large (more than 1 T), traders' willingness to pay for PICS bags decreases. For these traders, the turnover of cowpea is high (cowpea is usually stored for less than six months), and the handling costs for reusing PICS bags are also significant.

Two examples can be used to illustrate the point above. The first one is the small cowpea traders of Dogondoutchi who purchase their PICS bags from the departmental wholesaler N2. These cowpea traders store annually less than 1 T of cowpea and purchased between 50 to 100 PICS bags in 2011 with N2. Those cowpea traders keep the PICS bags for reuse over years and found it profitable to use PICS bags for cowpea storage. Some of their buyers, especially traders coming from the coastal countries such as Benin, are willing to pay a premium price for cowpea stored in the PICS bags. On the other hand, for the large company exporting cowpea, Compagnie Commerciale du Niger (CCNI), located in the region of Maradi, using PICS bags to store cowpea is not profitable. This company stores, on average, 3,500 T of cowpea per year and incurred much less costs by using chemicals for cowpea storage. In addition, their buyers, represented at 90 % by Nigerian traders, are not willing to price differentiate between cowpea stored in PICS bags and using insecticides. Buyers are looking often for low prices and are not quality-conscious.

Although all cowpea traders recognize that the PICS technology is very effective as opposed to the use of chemicals, some of them are reluctant to adopt this technology because of the higher upfront cost incurred. With this, very few buyers are willing to pay a premium price for cowpea stored in the PICS bags, giving less incentive to cowpea traders to adopt the PICS technology. Reusing the PICS bags implies cautious handling to avoid any leakage and additional cost of re-bagging cowpea in ordinary bags during the market transactions. These costs increase significantly as the quantities of cowpea managed becomes very large. PICS bags also represent a threat to revenues of cowpea traders; if many producers can store their cowpea in the PICS bags, less cowpea supply will be available at harvest, which will result in high cowpea prices. Therefore, traders buy cowpea at a harvest price that is already high, thereby reducing their margin even after storage.

Cowpea processors

In the growing stage of the project development in Niger, women cowpea processors have been increasingly sensitized on the PICS bags and have started to purchase the PICS bags to store cowpea for their business activities. Women processors of cowpea often work in associations and process cowpea in local products called couscous. Two cooperatives of women processors were interviewed during the field trip. These were the female cooperative of Tongone in Dogondoutchi and Union Gaalo in Zinder. These cooperatives became aware of the PICS technology through the radio messages since 2009 but were trained on the technical aspects by the business consultants in 2011. Women processors in those associations have developed a strong interest for PICS technology for several reasons. The first one is an economic reason: with the availability of the PICS bags, women buy cowpea at harvest at low prices and store it for their business activities during the off cowpea season. This helps them avoid purchasing cowpea at a higher price in the market. As a result, women can make more profit on their business activities. The second reason is that processed products made from cowpea stored in the PICS bags take less labor time for cleaning and are tastier than that stored with insecticides. The third reason is related to the likelihood of obtaining a price premium by selling cleaner processed products made with cowpea stored in PICS bags. N4, secretary of the Union Gaalo in Zinder, stated that processed products from PICS bags appeared cleaner, and they can sell their products with a price premium up to 15%. The purchase of bags occurred with local vendors at the retail price of 1,100 FCFA/bag in 2011. Quantities purchased are relatively small, mostly dependent on the size of their activities. In the cooperative of Tongone, an average purchase of two bags per woman for a total of 75 members was made in 2011. The Union Gaalo includes twenty associations of women processors and used twenty-five bags in 2011 for cowpea storage and processing.

The main challenge encountered by women processors is the lack of liquidity to purchase sufficient cowpea at harvest for storage. Women are sometimes forced to buy cowpea at higher prices during the off-season because they lack the financial resources necessary to build enough stock at harvest.

Farmers

Farmers are the end buyers for which the PICS technology had been initially designed. Farmers' awareness for PICS technology has been built with village demonstrations identified as the initial stage of the project (since 2007). They are the main target of the vendors. The quantities purchased by farmers are usually small because of the low cowpea yield (on average, 350 kg/ha for the traditional variety). The purchases are made individually by producers or in associations. Farmers use the PICS bags to store cowpea for

consumption, farming, or late sales. Since 2010, associations of producers involved in the project Intensification de l'Agriculture par les Boutiques d'Intrants Coopératives (IARBIC) have been sensitized and have been actively participating in the market for the PICS bags. In November 2010, fifty producers associations were sensitized regarding the PICS technology. The project IARBIC has been sponsored by FAO and implemented in all regions of Niger since 2009. This project aims, among other goals, at strengthening the existing cooperative farm input outlets called "Boutiques d'intrants" and building new ones. Through this project, farmers' access to quality seeds, fertilizer and other farm inputs is improved. Agricultural inputs are generally purchased at a subsidized price with the state company La Centrale d'Approvisionnement en Matériels Agricoles (CAIMA). The IARBIC project has also started to promote the development of inventory credit "warrantage" to help safeguard small loans from the banks or micro-finance institutions. PICS bags are bought by farmers in the associations either for their private needs or for the association inventory credit. The bags are purchased with local vendors available in the neighborhood of the "Boutique d'intrants" at a retail price of 1,100 FCFA/bag in 2011.

Farmers face several challenges. First, there is limited access to the PICS technology in distant villages due to limited development vendors' network impedes farmers' entry in the market for PICS bags. Second, in 2010, the rupture in the supply of the PICS bags has hampered the availability of the bags in markets and led to numerous price speculations. Third, many farmers' associations have poor technical and organizational capacity, which limits their ability to negotiate and place collective orders for the PICS bags. The purchase of PICS bags is often made by individual farmers instead of being centralized; however, as farmers get better trained in the IARBIC project, it is expected that their technical and organizational capacity will be improved. Fourth, for some small cowpea producers, using 100 kg bags is not convenient. They have a higher preference for 50 kg PICS bags that can be used to store smaller quantities of cowpea and is easier to carry and handle.

NGOs

NGOs are involved in the supply chain to enhance farmers' awareness for the PICS technology and facilitate their access to this innovative storage technology. Many NGOs have been involved in the PICS supply chain in Niger in diverse capacities, either to facilitate the distribution or channel the bags directly to farmers. NGOs involved more recently in the supply chain in the distribution of PICS bags include NCBA CLUSA, CRS, and Fonds International de Développement Agricole (FIDA). These NGOs' major goals include assistance to farmers located in unfavorable environments, marginal areas, as well as populations under emergency relief programs. In this context, NCBA CLUSA, and FIDA intervened respectively in the departments of Filingue (region of Tillabery) and Aguie (region of Maradi) and procured the PICS bags directly to farmers at a 100 % subsidized price (i.e., no cost to the farmer). The NGO CRS organized trade fairs through which vouchers for free purchase of PICS bags were distributed to farmers in the regions of Tillabery, Maradi, and Zinder. A coupon was given to every producer who attended the trade fairs; they had the choice with this coupon to purchase either a plastic drum or a PICS sack to store cowpea. In all regions but Tillabery, producers used mostly the coupons to purchase the PICS bags. In Tillabery, producers preferred the plastic drums because they can use them to transport potable water and because of low cowpea production in the department.

No major challenges were encountered by the NGOs in performing their activities in the supply chain of the PICS bags. Nevertheless, the non-availability of the PICS bags during part of the 2010 cowpea season led to some disruption in the activities of some NGOs. For instance, CRS had to delay organization of the trade fairs, and NCBA CLUSA's demand

for the PICS bags during that year was poorly satisfied. While they ordered 10,000 bags, they only received 600.

Business consultants

Business consultants are also partners of the PICS project in Niger. They play an effective role in connecting stakeholders and ensuring a good functioning of the PICS supply chain. Two business consultants, Mr. Hassan Guingarey and Mr.Haboubacar Balla, were hired in November 2009 in replacement of Abdou Souleymane who left the project for academic training in Nigeria. Guingarey was in charge of the Tillabery, Dosso, and Tahoua regions while Balla's scope of work includes the regions of Maradi and Zinder.

In line with the terms of reference of their contracts, the role of the two business consultants in the PICS project consisted of three things. First, the business consultants assist the wholesalers, semi-wholesalers and retailers to sell their PICS bags. For this aim, the two business consultants organized training activities, advertisement campaigns, monitoring and evaluation of the supply chain. The radio advertisement messages are prepared by the business consultants in collaboration with other partners of the supply chain. They selected private and public radios to air the messages. Numerous stakeholders in the cowpea industry have been sensitized and trained on the PICS technology. In November 2011, a total of fifty farmers' organizations, four NGOs, five humanitarian organizations, and two projects were trained by the business consultants. Second, they identify the demand for PICS bags from the bottom to the top level of the supply chain. Every year in the month of July, vendor meetings are organized to evaluate the PICS supply chain and collect the vendors' demands in PICS bags. These demands are then centralized by the national distributor who orders the bags from Lela Agro. Third, they assure a good flow of PICS bags by assisting vendors to identify markets with excess and deficit in PICS bags. This role of the business consultants has been often acknowledged by the vendors as being very essential especially in the peak season. Indeed, this role was particularly critical during the year 2010, characterized by a high demand in PICS bags. During that year, it was very valuable to have information on the supply markets where the PICS bags could be purchased.

The challenges identified by the business consultants were more specific to the supply chain. These challenges included: the default in payment of the credit by some vendors and departmental directions of agriculture during the first years of the project; the rupture in the supply of PICS bags in 2010; and, the necessity to ensure a good flow of PICS bags from the supply to the demand markets.

Government /OPVN

The government has been involved in the supply chain of the PICS bags through the Ministry of Agriculture and OPVN. This section will focus on the role played by OPVN, since it is likely that cowpea storage will be of major importance for the government in the context of the "3 N" (les Nigeriens Nourissent les Nigeriens – Nigeriens Feeding Nigeriens) policy. The role played by the Ministry of Agriculture will be analyzed in the next section.

OPVN is a state enterprise in charge of the management of the food security stock in Niger. This enterprise builds stock of grains for exports or the domestic markets during deficit years of production.

In 2008 and 2009, OPVN imported large quantities of triple bags from Burkina Faso and Nigeria as a governmental policy to support and encourage the development of cowpea production. OPVN was introduced to the PICS bags through Dr. Ibrahim Baoua. The bag manufacturer, Niger Plastique in Maradi, was also contacted to supply part of OPVN demand for the triple bags, but their marketing director did not show any interest for this market. A non-bidding process was used to select Fasoplast in Burkina and ETS Nassamou Abdoul in Niger as the suppliers of the OPVN triple bags. ETS Nassamou Abdoul subcontracted with Lela Agro in Kano/Nigeria to manufacture the triple bags. Thus, in September 2008, Fasoplast supplied 400,000 triple bags of 50 kg. The unit price of the triple bags was 1,095 FCFA. The same month, ETS Nassamou Abdoul supplied 250,000 bags of 100 kg at a unit cost of 1,800 FCFA. In May-June 2009, OPVN ordered 100,000 triple bags from Fasoplast at the price of 1,095 FCFA/bag. The quality specifications of the triple bags were defined by Institut National de Recherche Agronomique (INRAN). This latter institution was also in charge of controlling the quality of the bags after procurement.

These triple bags were used to store cowpea purchased with producers in every region of Niger. Cowpea was purchased at a price of 250 FCFA/kg when it was 120 FCFA/kg in the market in order to stimulate cowpea production. It was then conditioned in the triple bags and stored in the OPVN warehouses. Buyers of these stocks initially targeted were foreign government agencies, but most of these stocks were finally sold to private domestic buyers and to the WFP. The stock of cowpea has been entirely sold and nothing remains in storage. Only some unused triple bags still remain in storage. The head of the agency could not quantify the remaining stock. This policy had a sound impact among producers because it increased their revenues. It helped them to meet their food security needs because cereals were kept for home consumption and cowpea was used as their cash crop. Many producers started to grow more cowpea, so they increase the area allocated to cowpea. Thus, although the president who initiated this policy is no longer in power, there is a high likelihood that such initiative will take place in the coming years according to the head of the OPVN office in Niamey. Indeed, in the context of the new agricultural policy developed by the government, which is defined as the 3N, cowpea production and marketing will be of first importance in this program.

The challenges encountered were related to the quality of the triple bags. The first stock of bags supplied in 2008 did not have any quality problem. It met INRAN's specifications. This was not the case for the 2009 procurement. Numerous quality issues were reported in spite of INRAN's quality control (INRAN control is only tested on a small sample of bags). These include bags defects, missing bags, thinner inner layer bags, breakage of 100 kg bags due to rough handling by OPVN laborers, and use of phostoxin in the PICS bags because of ill-informed workers.

Evolution of the supply chain and major milestones

The evolution of the supply chain in Niger and the major milestones achieved is summarized in figure 3 in the annex.

The PICS project in Niger started in May 2007. The first year of the project, identified as the pilot phase, was used to build awareness for the PICS bags. This technology

was perceived as a major innovation over the traditional method of storage, including the use of insecticides with harmful effects on human health. Activities consisted of stimulating a demand for the PICS bags and included information and sensitization campaigns through radio advertisement, posters, village demonstrations, and open-the-bags ceremonies. World Vision and INRAN were the main partners in charge of the extension activities. A total of 116 villages were sensitized on the PICS technology. The size of the PICS bags diffused was 50 kg.

In June 2007, Niger Plastique was identified as a potential manufacturer of PICS bags in Niger but could not produce PICS bags because of some equipment problems. That same month, the business consultant Souleymane was hired by the PICS project to control the quality of PICS bags sold by merchants and assure that merchants are not selling at a price higher than 1,000 FCFA.

The second year of the project (June 2008-May 2009) was devoted to building a distribution network for the PICS bags. The PICS bags diffused were 100 kg bags because farmers preferred 100 kg bags; this decision was reinforced by lower cost per kilo of grain stored. Potential wholesalers/semi-wholesalers and retailers were identified in every region. Tera Salifou from Burkina Faso was identified by the PICS team at Purdue to be the distributor of the PICS bags in Niger in May 2008. He was working in collaboration with another local distributor Gado and Baoua of INRAN. In addition to its traditional role of performing extension activities, INRAN became more involved in building up the PICS supply chain. This institution worked particularly in the development of a network of vendors that could supply the PICS bags up to the village level. INRAN participated in identifying some regional wholesalers interested in the PICS bags business. The primary activities of these regional wholesalers were the trades of various types of articles (i.e., cereals, cowpea, ordinary bags, consumption goods). Official contracts were made with the regional wholesalers involved in the supply chain. These wholesalers were associated to Gado, the national distributor, and Salifou, the supplier from Burkina Faso. It appeared that these wholesalers identified did not have an organized network of vendors extended to the farm level, so in order to reach producers in villages, these wholesalers were advised to work with extension agents from the Ministry of Agriculture. Thus, retailers placed PICS bags on consignment stocks ("depot-vente") with some extension agents. After the sales, the money was expected to be remitted to the vendors. Those extension agents received a margin (up to 100 FCFA per bag). Selling prices of the PICS bags was at 1,000 FCFA/bag, as in the first year. Producers paid for the bags in cash at the time of their orders, and the Chef de District Agricole (CDAs) were in charge of bringing the bags bought to them. Extension agents were also used as relay in channeling the bags to farmers in places where no vendors were available.

The experience of using the extension agents as sales agents ended up of being a failure because many of them mismanaged the PICS bags sales and did not reimburse the payments of the PICS bags to the distributors. Some wholesalers took advantage of the project and did not reimburse the money owed to the distributor. To ensure the sustainability of the project's activities in Niger, INRAN put pressure on the credit defaulters to reimburse their due money. Those who could not reimburse were kicked out of the supply chain and replaced by new ones. A new system of bag purchased based on cash and carry was adopted in 2010. Because of this bad experience, the system of consignment stocks came to an end, and Gado became the national distributor of the PICS bags in Niger in the following year.

During this scaling-up phase of the project, PICS demonstrations were staged in 5,630 villages during the 2008/2009 season. Radio continued airing messages in French, Hausa, and Djerma during October to December 2008, as in 2007. In May 2009, OPVN ordered 750,000 triple bags to build a national stock of cowpea and stimulate production of cowpea as a cash crop. The same month, the bags of 50 kg initially diffused were replaced by 100 kg bags based on farmers' preferences according to the PICS leaders.

The third year of the project (June 2009-May 2010) was characterized by a growth of all activities. 56 radio stations were chosen to broadcast messages in seven local languages. With the departure of the first business consultant, two business consultants were hired to facilitate the distribution of the PICS bags in November 2009. Zanguina was also selected the same month as national distributor of the PICS bags in Niger in replacement of Gado. In December 2009, diffusion of cell phone videos for PICS bags advertisement took place. In January 2010, the extension agents from the Ministry of Agriculture were dropped from the distribution of the PICS bags because of the problem of non-repayment of the credits. They were replaced by private vendors. In the same vein, from March to April 2010, some private merchants who failed to reimburse their due amount were replaced by new ones in Niamey, Tahoua, Maradi, and Zinder. Some defaulted wholesalers have converted themselves into retailers, buying from new wholesalers.

In the fourth year (June 2010-May 2011), the growth of the project achieved higher dimensions. A new system of payment based on cash-and-carry was implemented between the national distributor and the regional semi-wholesalers as a remedy for the failure of the credit system. After several claims, in November 2009, the capacity of the PICS bags manufactured was able to hold exactly 100 kg of cowpea instead of 80 kg in the past. In the same month, new market segments were targeted during the sensitization campaigns. Hence, in November 2009, 49 PICS vendors, 117 cowpea traders, and four NGOs were trained by the business consultants. The 2010 cowpea season was characterized by very large production and a rupture in the supply of the bags during the peak season. From October to December 2010, the PICS messages began to be aired on TV in French, Hausa, and Djerrma. The national distributor Zanguina paid a contribution of 20 percent to air these messages.

In May 2011, Zanguina ordered 77,000 PICS bags from Lela Agro and requested a bank loan of 12.5 million FCFA to contribute in the payment for this order in addition to the cash advance provided by the wholesalers. Unfortunately, the 2011 cowpea season was very poor, and the number of PICS bags sold during that season was very low, which led to large inventory stock of bags at every node of the supply chain. In September-October 2011, there were some reports of release of unused OPVN triple bags in the markets, specifically in the Zinder region.

Challenges faced in developing the supply chain

Building an extended distribution network to reach out to farmers

One challenge was the identification of vendors with networks extending to the farm level to ensure the accessibility of the bags in villages. Most vendors identified did not have a well-established distribution network reaching villages. Moreover, the vendors identified

were not connected and committed to each other. This gave rise to distrust, a general lack of communication, and low rates of credit reimbursement in the first years of the project.

Reimbursement Issues

There were reimbursement issues with some wholesalers, and some Direction Departementale de l'Agriculture (DDAs) in Zinder during the initial stage of the project. The non-repayment of the money due by some extension agents and vendors during the first years of the project limited the growth of the supply chain.

Strategies developed to encourage private actors' investments

A number of strategies were initiated by the project in order to stimulate the private sector's investment in the supply chain. During the first year of activities (2007/2008), the PICS project financed 100 % of the bag procurement. Those bags were placed on credit to vendors, and the reimbursements were expected to take place after sales. The project invested in media advertisement to promote the PICS bags and develop awareness for this new technology. It also collaborated with local institutions including INRAN, WV, and the Ministry of Agriculture to perform training and village demonstrations to diffuse the PICS technology in a large number of villages. In 2009, the project supported expenses for greater advertisement involving the use of cell phone videos and market demonstrations. The same year, two business consultants were hired to monitor the supply chain and ensure a good flow of information and PICS bags among merchants. In 2010, the project invested in the organization of the vendors' meeting, the training of 49 PICS vendors, four NGOs, and the sensitization of 117 cowpea traders. Due to the effectiveness of the PICS project investments, the private sector is increasingly willing to invest its own resources to take control of the supply chain. Indeed, from October to December 2010, Zanguina paid 20 % of the expenses to air the advertisement messages on radios. For the 2011 cowpea season, he took a bank loan of 12.5 million FCFA to order the PICS bags with the manufacturer Lela Agro. In 2011, the NGO CRS partnered with the project in organizing trade fairs to stimulate greater demand for the PICS bags.

Challenges and opportunities to supply chain sustainability

Numerous constraints are encountered among different stakeholders of the supply chain and hamper the development of the supply chain. These constraints are discussed across specific stakeholders.

Vendors

The low reimbursement rate of credit because of the opportunistic behavior of some vendors and extension agents was a central problem that hindered the development of the PICS supply chain during the first year of the project. Related, the process of selecting vendors without much social connections and relationship among themselves led to a lack of trust and commitment between vendors.

There is a concentration of the distribution networks in urban areas and capital cities of the regions. NGOs and the FIDA representation often claimed a very limited number of vendors in rural areas compared to urban cities. The larger presence of vendors in the main

business centers restricts the availability of bags in villages and the adoption of the PICS technology by farmers, who are still the main buyers of PICS bags.

The fact that the PICS bags are so far limited to cowpea storage leads to a limited period of sales and makes the use of the PICS bags restricted mainly to only one product: cowpea. This is particularly important during years of low cowpea production.

Many vendors found the price of the PICS bags to be expensive especially for large purchases. The retail price of 1,100 FCFA/bag in 2011 and 1,000 FCFA/bag during the previous years is found to be barely affordable for buyers who are on a tight budget. For many informants, there is a possibility to reduce this price by a reduction of the manufacturer costs. These informants believe that Lela Agro's price for the PICS bags is a "project price" and is much above the price that could be set to a private businessman. According to them, Lela Agro is apparently developing an opportunistic behavior by taking advantage of the project.

The traditional approach of estimating the demand for PICS bags by vendors based on past sales and their subjective knowledge of future demand often gives rise to considerable gaps between their expected and actual orders and increases the risk of holding significant stocks.

The retail price, fixed by the project in 2007 and 2008, oriented retail prices in the subsequent years and reduced vendors' margins when there were market opportunities to charge for higher prices. This gave poor incentives to merchants to invest in the PICS bags business and potentially limited the development of the market for the PICS bags.

Goverment

The OPVN's past policy to import triple bags from manufacturers outside the country instead of purchasing the stock from the national distributor did not encourage the development of local distribution network and was a missed opportunity for the vendors to expand their business.

Poor road infrastructures in some rural areas increase the transportation costs and reduce the incentive of channeling the bags to those geographic areas.

Large Cowpea Traders

Large cowpea traders are potential volume buyers for the PICS bags and represent opportunities for market development; however, their involvement in the PICS market as buyers will depend on the cost-effectiveness of the PICS technology compared to their traditional technologies of storage, principally the use of insecticides. For large cowpea traders who are profit-maximizers, the use of insecticides to store their cowpea is more profitable than the use of PICS bags in the short run.

The issue of re-bagging cowpea stored in PICS bags before sales involves additional labor costs and hinders the adoption of the PICS bags by large cowpea traders.

Given the key constraints highlighted above, the recommendations discussed below can be considered to promote the development of the supply chain:

At the government level

Strengthen enforcement mechanism on the use of insecticide to store cowpea. Many laws already exist on the regulation of the use of insecticide to store food products. It is therefore important for the government to develop enforcement mechanisms of these legislations to preclude the use of insecticide for cowpea storage for public health purpose. Indeed, in some countries, such as Nigeria, many deaths were reported among populations that consumed cowpea stored with insecticides.

Include PICS bags in the list of agricultural inputs. The agricultural inputs are generally exempted from taxes. The PICS bags can be considered as post-harvest inputs necessary for grain storage. Although being diffused more recently compared to fertilizer and improved crop seeds, the adoption rate of the PICS bags has grown faster than those previous inputs. According to Baoua, "it is amazing to see how fast the PICS bags have been adopted by farmers. This is a very unique case of technology diffusion that never happened in the past. The adoption rate of the PICS bags is even above that of fertilizer, which has been introduced a long time ago in Niger." Hence, it is important for the local PICS partners and NGOs to lobby to the government authorities to exempt the PICS bags from the payment of taxes.

Promote awareness of health related risk in insecticide use for storage. Over the past few years, awareness for PICS technology and sensitization campaigns has been supported entirely by the PICS project. As the project ends in Niger, and for a greater sustainability of the supply chain, the government should be more involved in sensitizing consumers, cowpea traders, farmers on the harmful effects of the use of insecticides and the health benefits provided by the adoption of the PICS technology.

Provide reliable cowpea production forecast. The Ministry of Agriculture, through extension agents, can assist farmers technically in predicting their cowpea production early. Some research institutions, such as AGRHYMET, that specialize in forecasting crop harvests can provide their services to the stakeholders for a reliable estimation of the cowpea production and the resulting demand in PICS bags.

Promote research/development for improved cowpea varieties. The demand for PICS bags is highly correlated to cowpea production. The Ministry of Agriculture should continue efforts of investing in research and development in order to find improved cowpea varieties adapted to the climatic specificities of each region of cowpea production. Also, to ensure a good production of cowpea, it is important for farmers to have access to affordable crop protection products that could be used to protect their crops on the field and guarantee a good harvest.

Accelerate research effort to use PICS bags for other grains. The extension of the use of the PICS bags to other grains such as rice, maize, millet, sorghum, groundnuts, and sesame will enhance the demand and will be vital for a sustainable development of the supply chain.

At the vendor level

Use multiple selling points and mobile vendors for rural markets. The supply chain has been growing in Niger over the years, but there is still a big challenge of increasing the accessibility of the PICS bags in villages. Vendors should invest in implementing strategies, such as multiplication of the selling points and use of mobile vendors in weekly rural markets to improve farmers' access to the PICS technology.

Training in business management and accounting. Very few vendors are able to keep record of their transactions in PICS bags and develop marketing strategies to increase the sales of bags. It is therefore fundamental to strengthen their marketing and accounting skills with some training in business management and accounting

Create partnerships with farmers, NGOs, DRA, and research organizations to have reliable estimate of cowpea production and PICS bags. It is very challenging for vendors alone to have reliable estimates of the demand for PICS bags. Thus, partnership can be developed between vendors, farmers, NGOs, and Ministry of Agriculture for assisting vendors in getting reliable estimates of the demand in PICS bags.

At the NGO, Humanitarian Organizations, and Donor Level

Keep providing relief distribution of PICS bags for emergency areas and building the demand for PICS bags with subsidized PICS bags. The provision of subsidies must be limited in the short run, or a system of progressive reduction of subsidies on the PICS bags over time must be implemented to stimulate farmers' participation and to not disrupt the private sector's business. NGOs must coordinate their actions with the private sector to not disrupt their business.

Keep facilitating the distribution of the PICS bags. The NGOs should keep purchasing PICS bags from local private vendors and facilitate the distribution of the PICS bags by connecting vendors to farmers or to potential buyers. They can provide information on the number of selling points, their locations, and contact information of vendors.

Enforce the purchase of cowpea in hermetic storage technologies such as PICS bags for food security programs. This preference for hermetic storage is justified by the health problems linked to cowpea stored with insecticides. The enforcement of the purchase of cowpea traded only in PICS bags will be an effective way for the NGOs to constrain cowpea traders to give up on the use of chemical for cowpea storage and adopt the PICS bags as a more effective and safe technology to store cowpea.

Undertake sensitization efforts for the adoption of PICS bags over alternative technologies to stimulate demand. The NGOs involvement in sensitization was very essential for the development of the supply chain of the PICS bags in Niger. Sensitization efforts must continue to promote the PICS technology in new market segments.

Lessons learned

From the experience of the development of the PICS supply chain in Niger, some key lessons can be derived. Initial project investment (radios, training, posters) in building awareness for the products were capital in sensitizing buyers and building product awareness. All stakeholders agreed that messages aired on radio have been essential in stimulating demand for the PICS bags and are willing to invest their own resources in radio advertisement.

There is no best model of vendors required for the development of the supply chain of the PICS bags. For example, Zanguina, who was neither an agro-dealer nor a bag trader, was able to become a main player in the supply chain; another example would be N3 in Boboye, who was a carpenter and street vendor of breakfast "Aboki" but was able to sell large quantities of PICS bags. The most important skills for a vendor to emerge in the supply chain are to have entrepreneurial behavior, have willingness to look for markets, and reach out to buyers.

Pre-existing vendors' distribution networks facilitate the flow of the PICS bags. Examples can be found with Zanguina who used his Airtel network to channel the PICS bags and N2, who used his network of cereal traders to sell the PICS bags.

With the difficulty of enforcing informal contracts, the cash-and-carry system is most appropriate in limiting the defaults in payment. Other types of payment arrangements can prevail depending on long-term relationship and trust among stakeholders.

More efficient involvement of the Ministry of Agriculture in the supply chain is in building demand for the PICS bags, which includes assisting farmers in estimating their production and needs for the PICS bags. Officers of the Ministry might be involved for their own private business but not as an agent of the Ministry of Agriculture.

The annual vendors meetings enabled a yearly evaluation of the supply chain and addressed some inefficiency in the supply chain. Some major decisions took place during the vendors meetings. These were the shift to more efficient mode of payment and sharing of the risk in initial investment between national distributors and wholesalers/semi-wholesalers.

The development of Boutique d'Intrants and their partnership with private distributors facilitates farmers' access to the PICS bags (reduction in the unit price, reduction in the cost of screening for private dealers, negotiating for the price, transportation costs). Efforts must be done by NGOs and the Ministry of Agriculture to support these organizations. That will strengthen their technical capacity and organizational skills.

The establishment of a monitoring and evaluation system to link vendors among themselves and assess demand and surplus markets is essential for the good functioning of the supply chain. The roles of the business consultants in sensitizing, estimating the demand in PICS bags, and facilitating the distribution of the PICS bags have been much appreciated

by stakeholders. Thus, after the project, the national distributor may develop a private system to take over the roles played by the business consultant in monitoring the bags flow and sales across the supply chain. If this private system appears to be too costly for the national distributor, it will be important that at least contact information and locations of wholesalers and semi-wholesalers in the supply chain be made available to vendors and stakeholders.

To improve private distributors' incentive in the PICS bags business, limit interventions setting a reference retail price and let the market determine the retail price. Although the reference retail price was good the first year of the project to stimulate demand for the PICS bags, it had side effects in the subsequent years because retail prices were still announced on radio which reduced retailers' margins and incentives.

Good communication between INRAN, national distributor and business consultants was fundamental in ensuring the sustainability of the supply chain.

ANNEX

Figure 1: Supply Chain Map of PICS Bags in Niger

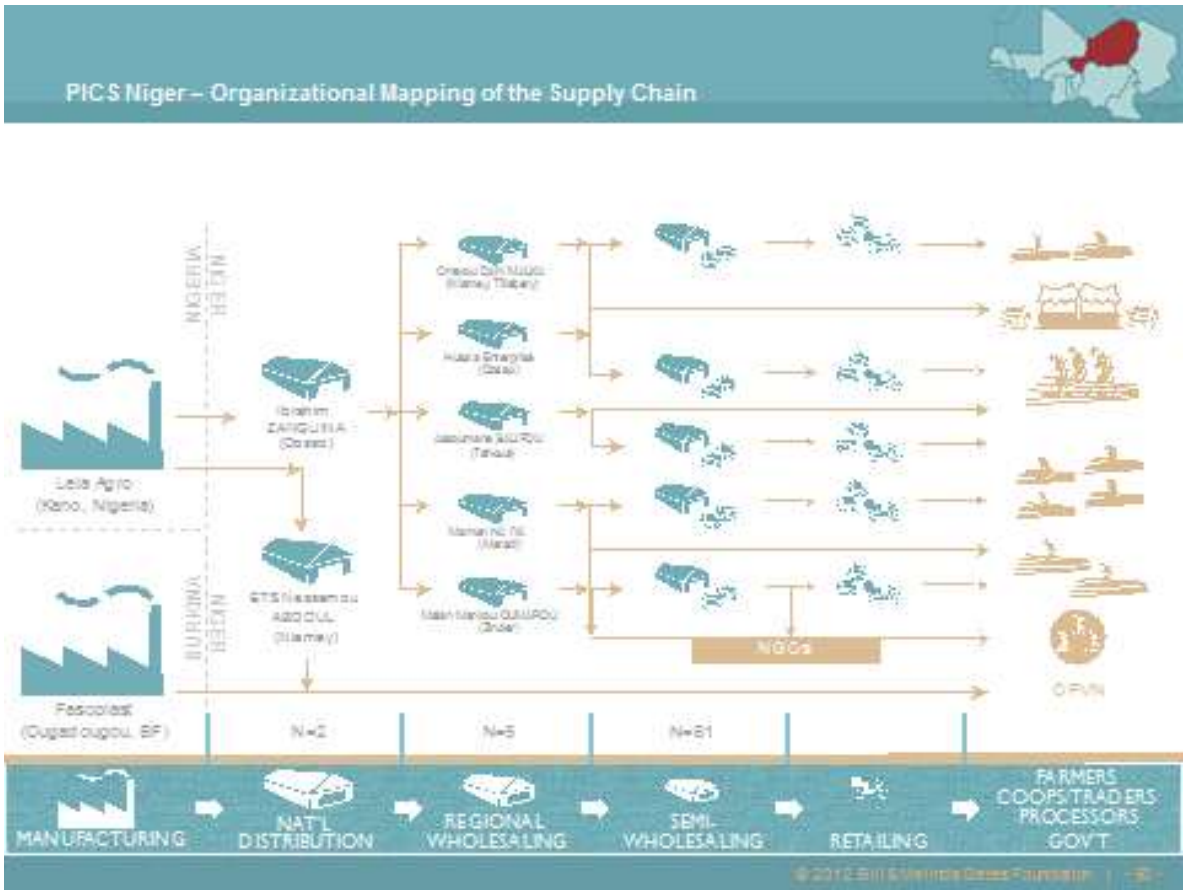


Figure 2: **Map of the Distribution Network of PICS Bags in Niger**

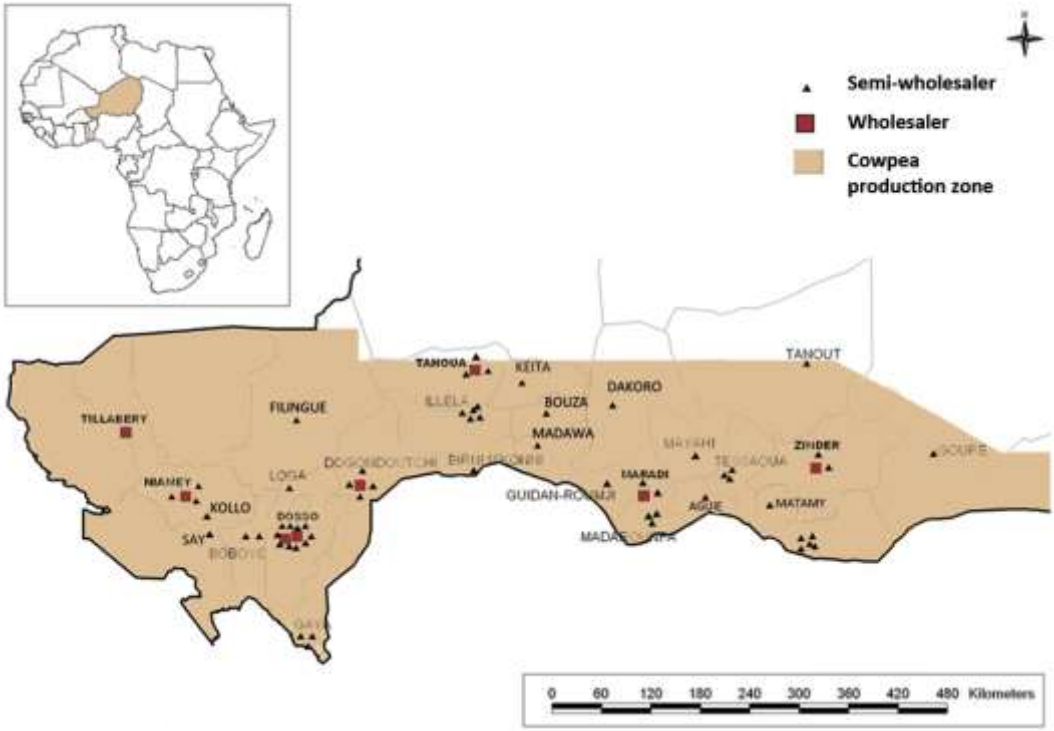


Figure 3. **Outline of the Major Milestones in the Evolution of PICS Supply Chain in Niger**

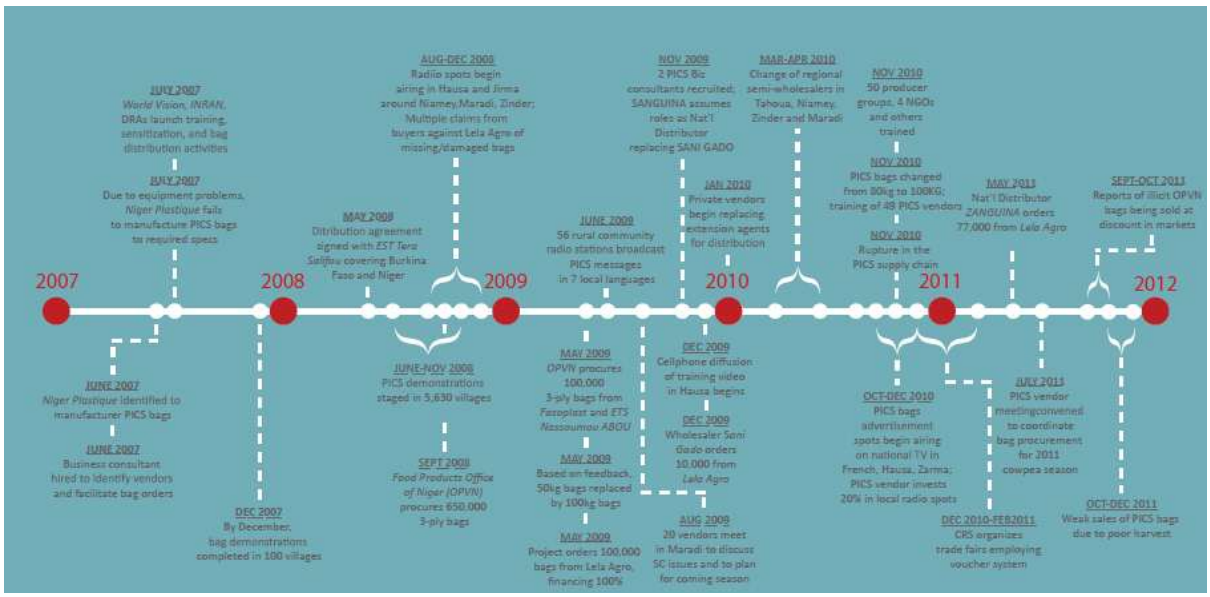


Table 1. Number of Wholesalers and Semi-wholesalers in the Regions of Niger

	Wholesalers	Semi-wholesalers
Region Niamey Total	**1**	**2**
Niamey	1	2
Region Tillabery total	**1**	**3**
Tillabery	1	0
Kollo	0	1
Filingue	0	1
Say	0	1
Region Dosso	**3**	**25**
Dosso	2	10
Doutchi	1	5
Gaya	0	5
Loga	0	1
Boboye	0	4
Region Tahoua	**3**	**9**
Tahoua	2	1
Illela	1	4
Bouza	0	1
Madaoua	0	1
Keita	0	1
N'Konnie	0	1
Region Maradi	**1**	**12**
Maradi	1	4
Tessaoua	0	2
Mayahi	0	1
Aguie	0	2
Madarounfa	0	1
Dakoro	0	1
Guidan Roumdji	0	1
Region Zinder	**1**	**10**
Zinder	1	2
Goure	0	2
Magaria	0	4
Matamey	0	1
Tanout	0	1
Total	10	61

NIGERIA

Presentation of the PICS supply chain case study

Cowpea, *Vigna unguiculata*, plays a key role in the agriculture and food supply of Nigeria. It is one of the most important grain legumes in Nigeria, where it serves as a major source of protein in human and animal diets (Okigbo, 1978; Akinkurolere, Adedire and Odeyemi, 2006). Nigeria is the largest producer and consumer of cowpea in the world. Cowpea is grown extensively in the country as an intercrop with cereals and yam and occasionally in rotation with cotton. The annual production of cowpea in the country was estimated to be more than 2 million metric tons, representing about 50% of the annual total world cowpea production (Singh, Ehlers, Sharma and Freire Filho, 2002).

There is a very promising market for the sale of cowpea grain and fodder in Nigeria. Farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to increase their annual income by 25% (Dugje et al., 2009). Most farmers, however, do not want to risk storing their cowpeas due to devastating losses they are likely to accrue in storage. They instead sell their cowpeas at harvest when the prices are lowest. The cowpea prices can more than double in the off-season.

The primary constraint inhibiting effective and efficient storage of grains in Nigeria is attributed to insect pests (Adedire 2001, Akinkurolere, Adedire and Odeyeimi, 2006). Cowpea is usually prone to attack by bruchids (*Callosobruchus maculatus*) in the country (Ofuya and Bamigbola, 1991). This insect pest is responsible for about 90% of the damage to stored cowpeas (Ayertey, 1981). Newly threshed cowpeas with initial little bruchid infestation can be rendered unpalatable and worthless in the market within two months of storage. Farmers have been used traditional methods such as ash, 'rumbu', and drums to store their cowpeas with minimal successes. In recent years, however, the cowpea farmers and merchants have been applying toxic chemicals such as phostoxin and actellic dust to kill or repel the weevils from destroying their stored cowpeas. The cowpeas become poisoned as a result of the poor handling of the chemicals, resulting in public health hazards. This has led to food poisoning and even death as a result of people eating chemically protected cowpea across the nation. In this regard, cowpea storage technologies that cause less harm are urgently needed to save not only lives but also to overcome the wastage of cowpea in storage. This led to Purdue University with its partners initiating the Purdue Improved Cowpea Storage (PICS) project, funded by the Bill and Melinda Gates Foundation. The goal of the project is to have 50% of farm-stored cowpea in hermetic storage without insecticides in West and Central Africa by 2012.

Supply chain actors

The major PICS supply chain actors in Nigeria include the PICS bag manufacturer, middlemen (vendors and sub-vendors), Agricultural Development Program (ADP), transporter, processors, and farmers. Service organisations important to the PICS supply chain include NGOs and extension agents. Other important stakeholders include Purdue University, IITA and business consultants.

Manufacturer: Lela Agro

Lela Agro sits at the apex of the supply chain tree. It is charged with the production and distribution of PICS bags in Nigeria. In January 2008, attempts were made in contacting a group of polypropylene bags manufacturers so as to make a selection on whom to mass produce the PICS bags for Nigeria. Several manufacturers indicated interest, but Lela Agro was selected because it had the lowest manufacturing cost and was most interested in developing the PICS distribution system in Nigeria. Lela Agro has been the sole manufacturer of the PICS bags in Nigeria since then. During the early stages of PICS production, Lela Agro delivered stock on consignment. This method was abused and was changed in 2009 to cash-and-carry. Nevertheless, the manufacturing company still maintains stock on consignment delivery with some of its trusted vendors.

It was not easy for Lela Agro to mass produce high density polypropylene bags of 80μ thick. It has made giant strides in producing the PICS bags, but there are challenges the company needs to overcome to remain in the PICS bags business and equally ensure the sustainability of the supply of the PICS bags. One challenge is the recorded high acceptance of the PICS bags by the market attracted competing companies producing similar bags. The springing of the competing companies in the business is viewed as a threat by Lela.

A second challenge Lela Agro faces is the supply network. Though the bags were originally promoted for cowpea storage, end users have on their own successfully tested the use of the bags in storing other crops (not just cereal, but also legumes and oil crops like groundnut and melon. Some of the end users even use the bags to store cassava and yam flour). There is the prospect for a large demand for the PICS bags in Nigeria. More promotions and sensitizations will therefore lead to more demand of the PICS bags. There is a need for Lela to improve upon the existing supply network to accommodate this demand. Cowpea is produced in Nigeria as rain fed and irrigated. There are cases of end users not getting access to the PICS bags on time. There may be a need to establish regional distribution centers for easy access of the bags to the end users in all parts of the country. The establishment of the regional centers will also resolve the complaints of some of the vendors who mention the high cost of transporting the bags.

A third challenge is the current packaging of the PICS bags. There is a need for Lela to repackage its PICS bags. Presently, the bags are arranged in bales consisting of 300 bags each. Transporting the bales (including all the handling services) is a big problem to sub-vendors who operate in the hinterland where the road transportation network is very poor. Repackaging bales to include no more than 100 bags each will attract more sub-vendors into the business. It is pertinent to note that repackaging the bale to contain 100 bags or other bag quantities fewer than 300 has its shortcoming. The 300 bag bale was adopted by Lela because of the practice of transporters to charge by the piece and not by the weight. Transporting a 100 bag bale would thus, cost the same as a 300 bag bale. The 300 bag bales therefore reduced transport costs.

Lastly, the ability to estimate cowpea production is a challenge. The demand for PICS bags is not only seasonal but also hinged on the time and volume of harvest of most crops particularly the time and volume of harvest of cowpea. Years of poor harvest will lead to poor demand for the PICS bags. Related, if the bags do not get to the end users at the time

of harvest, they may be forced to use other methods to protect the quality of the produce. Lela should therefore be able to estimate demand so as to not overproduce (and tie down capital), nor under-produce (which can lead to an increase in the prices of the PICS bags which can also drive out prospective buyers).

Major Vendors

The major vendors are next to the manufacturer in the supply chain. They are the large vendors, like Na1 in Plateau State and Na2 in Sokoto State. They have the ability to buy any amount of bales in a single purchase depending on the available demand. In 2010 and 2011 they sold a minimum of 25 bales each. In certain instances, they are given placement orders by the wholesalers. They have a chain of vendors and sub-vendors in neighbouring states. There are not many of these types of vendors in the supply chain. These vendors constitute less than 1% of all the vendors in the supply chain; as such, this channel is weak.

The major vendors buy PICS bags in large quantities and sell to the wholesalers (vendors), sub-vendors, retailers, and the end users. They already have an existing trading relationship with Lela Agro before the advent of the PICS bags. They are, therefore, involved in some other activities apart from the sale of PICS bags. For example, Na1 has been involved in the sale of polypropylene bags manufactured by Lela for over 4 years; he is also a volume cowpea merchant. Na2 is also involved in the sale of Dangote products, along with Lela polythene bags for over 20 years. Due to the existing relationship between the major distributing vendors and Lela Agro, the PICS bags purchased are placed on consignment. The mode of payment between the major vendors and vendors, sub-vendors, and retailers is pliable. The adopted policy by the major vendors is that of cash-and-carry; however, based on trust and long lasting relationship with these actors, PICS bags are purchased on credit or placed on consignment. The major vendors, however, sell to end users based on cash-and-carry only. The major vendors buy PICS bags at ₦260 and sell to multiple buyers at ₦280. Small scale users buy at ₦300. The retailers are the major buyers of PICS bags from the major vendors. They constitute more than 60% of the buyers of PICS bags from the major vendors. The end users constitute more than 35%, and the wholesalers not more than 2%.

The major vendors are faced with two main challenges. The first challenge is that the distribution network of the major vendors is not too well developed; however, these actors have the most developed network distribution of their goods in the supply chain. They have agents stationed in certain towns of the state of their residence. They have lacked distribution agents in states other than their state of residence. Na1 has five of such agents in Shandam and three in other parts of Jos South. Na2 has three agents in the three agro-ecological zones of the state. These agents serve as their distribution centers. All the agents are only allowed to sell based on the cash-and-carry method. The second challenge is the poor road infrastructure and high shipping costs. Road infrastructure, particularly to the hinterland in Nigeria, is generally in deplorable conditions, thereby increasing the costs of shipping the bags to those locations and increasing the prices of the bags.

Wholesalers

The wholesalers are next to the major vendors in the supply chain. In most cases they have the ability to buy no more than two bales in a single purchase. They buy from the major vendors and sometimes directly from the manufacturer and sell to the retailers and the end users. They, therefore, act as both wholesalers and retailers. As important as the function of the wholesaler is, the wholesalers are not many in the supply chain. They constitute not more than 2% of the total actors in the supply chain. They are mostly located in large towns and do not have distributing agents as the major vendors. They own their shops from where they conduct their sales. Most of their customers are end users who are mostly farmers and processors of mostly grains and leguminous crops. The end users constitute more than 75% of the buyers of PICS bags from the wholesalers. The retailers constitute not more than 25%.

Most of the wholesalers of polypropylene bags are also cowpea volume merchants. The reluctance of the volume merchants to participate in the sale and adoption of the PICS bags in the protection of cowpea may partly be attributed to the fact that most of them are the major dealers of chemicals applied in cowpea protection and partly be due to the uncertainty about the market demand for PICS. The demand of PICS bags is mostly seasonal and they do not want to tie down their capital. There is also the possibility that the wholesalers have not been sensitized enough.

ADPs

The initial arrangement was that the ADPs were not to be involved in the sale of the PICS bags. The PICS bags were a viable solution to prevent sickness that occurs with poor food storage in all the states of the Federation. The poor participation of the polypropylene bags volume merchants in the marketing of the PICS bags was therefore not accepted by the ADPs.

Most of the ADPs have strong ties with the rural populace (mostly farmers), and the ADPs are the extension arm of the Ministry of Agriculture; therefore, the ADPs were involved in the awareness creation and sensitization process at the onset of the PICS chain development. PICS bags demand pressures were therefore mounted on the ADPs by the farmers. The farmers were sensitized but did not have access to the PICS bags. The ADPs were therefore motivated through their Rural Infrastructural Development (RID) Departments: the commercial arm of the ADPs that is involved in the sale of farm input to the farmers. The ADPs have a wide network distribution that covers most parts of the state. More than 90% of the sales of PICS bags in the hinterland, particularly in the North Central States, are conducted by the ADPs. While the wholesalers and semi-wholesalers reside in cities and state capitals, the major users of the bags reside in the hinterland.

The extent of the participation of the ADPs in the sale of the PICS bags is state-specific. For example, Plateau State is a cooperative in the ADP (but not under the control of the ADP) that is involved in the sale of the PICS bags; however, in Nasarawa State, the ADP is fully involved in the sale of the PICS bags through its RID department. The PICS desk officers in some ADPs transformed themselves to become PICS bags distributors in their states. In Niger State for example, the PICS desk officer Na3, out of sympathy and concern for the farmers, started using her personal finance to procure the PICS bags and selling to the

farmers. Over time, she transformed into a major distributor for PICS bags in the state and mobilized trusted extension agents to serve as her retail agents. She is responsible for more than 90% PICS bags sales in Niger State. In Kano State, the transformation was a bit different. The desk officer, Na4, was also moved by compassion and integrity when farmers started accusing him of introducing to them a technology that they (the farmers) could not access. He used his resources to purchase some bales and started selling to the farmers at ₦280 to multiple buyers and ₦300 to single buyers; however, he did not include the extension agents and he did not plan to transform to a major distributor.

All the ADPs enjoy a good working relationship with Lela Agro except in Zamfara State where the desk officer (Na4) has frequent disagreements with Ahmed Kaumi. Na4 accuses Kaumi of not always delivering the bags on time, while Kaumi accuses Na4 of impatience and overbearing behavior. It always takes the intervention of the business consultant (Sanusi Yakuba) to resolve their quarrels. ADPs that have functioning RID Departments (as found in Nasarawa State) are quite efficient in the distribution of PICS bags in their state; however, there are states that need to learn from the Nasarawa experience. The RID of the Nasarawa ADP has been involved in the successful sale of farm input to the farmers through the state extension agents. There have not been reported cases of financial misappropriation because any default extension agent will have the amount deducted from the monthly salary and be demoted as well. Revenues accrued from the sale of the PICS bags are paid into the account of the RID and not to an individual; as such, though the state lacks enough wholesalers and retailers, the farmers are still able to get the bags. Retailers and wholesalers are being encouraged to be involved in the distribution of the PICS bags but on a cash-and-carry basis.

One challenge faced is the infrastructure. The roads leading to the hinterland are in deplorable state such that in certain periods of the year the extension agents find it difficult to get to some villages.

Retailers

The retailers are mainly small-scale merchants with low income levels that reside in the countryside. They buy the PICS bags from the wholesalers or the major vendors by tens or dozens for sale principally to the rural end user who cannot afford transport (or otherwise) to the town. The retail price generally ranges from ₦300 - ₦500. The retailer's position in the supply chain is next to the wholesaler and the ADP.

The retailers adopt the marketing of PICS bags as a secondary occupation. In other words, they have a separate main occupation. Most are mainly farmers and crop traders. Most of the retailers get their stock on cash-and-carry basis; however, the retailers with existing trustworthy social and business ties with the wholesalers and the major vendors work often on stock on consignment basis with their suppliers. They renew their stock of PICS bags after selling the initial stock. Most extension agents double as retailers on individual basis; getting most of their supplies from the ADPs.

The retailers are faced with lots of challenges. The first challenge is existing infrastructure. The mode of transportation is poor, making transport of the bags difficult. Most of the hinterland is accessed either on weekly market days or on motorcycles due to the

bad road network linking the hinterland with the city (the source of the PICS bags). The poor road network limits the quantity of bags a retailer could transport; when the demand is high, retailers therefore struggle to meet with the demand. Second, since the retailers mostly depend on the wholesalers and major vendors for the supply of the PICS bags, when there is a disruption of supply of the PICS bags from the wholesalers, their business is also impacted. Lastly, many of the low income retailers are credit-constrained. It is, therefore, very challenging for them to purchase the PICS bags on a cash-and-carry basis. Given their budgets schedules, many of the retailers who purchase their bags on a cash-and-carry basis are forced to wait until they turn over their stock before having the next consignment. This increases the risk of rupture, particularly during the peak period of the demand of PICS bags.

Farmers

Farmers constitute the majority (more than 90%) of PICS bags end-users. The farmers are the producers of the cowpea and other food crops. They tend to produce and sell off the produce during the on-season, when prices are cheap and later tend to buy back from the market during the off-season, when prices of the food crops are high. The merchants buy the cowpea and other food crops cheaply during the on-season and sell at a higher cost during the off-season. The merchants store their cowpea with chemicals, which has led to the death of many. The PICS technology was initially designed to target the farmers, thereby saving the rural populace from death as a result of cowpea protection with chemicals and ensuring poverty alleviation in cowpea-farming household since the bags will help the farmers to store their produce and not be in haste to sell, thus getting better prices for their produce.

Farmers' awareness for the PICS technology has been built with village demonstrations that have occurred since 2008 during the pilot stage of the project. The quantities of the PICS bags purchased by the farmers are directly related to the quantities of harvested output, and, as such, the quantities purchased of the PICS bags are usually low since most of the farmers are subsistence in practice. Farmers usually purchase the PICS bags either as individuals or collectively as farmers associations. The bags are therefore used by the farmers to either store the cowpea for food consumption or for future sale.

Lack of vendors is a challenge; there is an inadequate number of vendors involved in the sale of PICS bags in the rural areas; as such, this is limits farmers' access to PICS bags in some of the states. Anoter challenge is that initially, prior to the first use of the PICS bags, the farmers were of the belief that the price of the PICS bags is on the high side; however, after the first use, the farmers have been eager to buy despite their budgetary constraints. Another challenge is the existence of competing bags. The appearance of competing triple bags in the market could threaten the fragile adoption of the PICS bags.

Cowpea processors

The cowpea processors add value to the cowpea and transform the cowpea to different forms acceptable to the end users. Included in this category are the restaurants that deal with cowpea processed foods, as well as boarding schools and hotels that have restaurant departments. They tend to buy cowpea in large volumes due to the nature of their business and to maintain supply. The processors are not the end users of cowpea, but they are end users of PICS bags. As such, they are important in the PICS supply chain. In Kwara State, for example, according to Na5 (the director for extension services), restaurants processing

cowpea not stored in PICS bags record lower patronage than restaurants known for storing their food crops in PICS bags.

The main challenge encountered by women processors is the lack of liquidity to purchase sufficient cowpea at harvest for storage. Women are sometimes forced to buy cowpea at higher price during the off-season because they lack the financial resources necessary to build enough stock at harvest.

Volume Cowpea Merchants

Volume cowpea merchants buy cowpea in large quantities and sell it later in the off-season when supply would have dropped and prices increased. The importance of the involvement of the cowpea volume merchants in the in supply chain as intermediate users of PICS bags cannot therefore, be overemphasized. Presently, their participation is very infinitesimal in any of the states.

The volume cowpea merchants complain of the high cost of the PICS bags and the inability of the bags to tolerate handling pressures as part of the reason for not accepting the PICS bags in protecting their produce. Cowpea merchants are profit-oriented and the extent of their participation in the market of the PICS bags is dictated by the economic benefit derived relatively to the costs incurred. Prior to the inception of the PICS bags in the market, cowpea merchants used insecticides (primarily phostoxin) to preserve cowpea from insect attack. It costs, on the average, ₦200 to store a 100 kg bag of cowpea in ordinary polypropylene bags using insecticides, compared to the ₦300 price for PICS bags. It therefore implies that a merchant storing 1,000 100 kg bags of cowpea will have an additional cost of ₦100,000 if the merchant was to store in PICS bags. Since the chemicals are only effective for about six months if properly applied, the PICS bag is cost-effective relative to the traditional method of storing with insecticides when cowpea is stored for more than six months and when the PICS bags are reused over years.

The first challenge faced is the high cost. Despite the fact that all the cowpea merchants testified that the PICS technology is very effective in protecting cowpea compared to the use of chemicals (some of the merchants even going further to claim that there is no basis in comparing the two methods of storage, saying that cowpea stored with PICS technology is as good as fresh from the field), most of them are shying away from adopting the PICS technology because of the higher cost incurred.

A second challenge is the fact that it was observed from the supply chain survey that most volume cowpea merchants are also major dealers in the sale of the agrochemicals used in the cowpea storage. These same merchants are equally executives of the unions of cowpea merchants and agrochemical dealers. The union executives have the ability to use their position to influence union members to either fully participate in the supply chain of the PICS bags. As such, the reluctance in the participation of the volume merchants in the PICS supply chain may not necessarily be connected to the high cost of the bags (as has been claimed) but might be due to the opportunity cost of losing the market for chemicals as a result of the decreased demand for the chemical that might ensue from the use of the PICS bags.

Extra handling care is highly needed if the PICS bags are ever to be reused. This extra care makes the re-bagging of cowpea in ordinary bags more tedious and thus adds to the cost in the market transactions. This cost increases significantly as the volume of cowpea becomes very large. The use of poking to test for the cowpea quality during sale destroys the quality of the PICS bags and prevents future use for hermetic storage. The prevalence of this attitude might decrease when trust has been built on the quality of cowpea being stored in the PICS bags. There is still the need for more sensitization of the cowpea merchants.

NGOs

The NGOs are involved in the supply chain as service providers. They tend to create awareness for the PICS technology and facilitate their access to this innovative storage technology. A number of NGOs have been involved in the PICS supply chain in Nigeria in diverse capacities. Sasakawa Africa Association (SAA) is an international agricultural development NGO involved in the productivity of farmers. It organized trainings (through village and market demonstrations) on the use and efficiencies of PICS bags in Adamawa and Jigawa States. SAA is also sponsoring two students to for a Bachelor of Science in Extension in the Department of Agricultural Economics and Rural Sociology from Ahmadu Bello University in Zaria, with the aim of conducting research on cowpea storage methods, comparing the PICS method of cowpea storage with traditional (i.e., hermetic GP tank, jerrican, and 'rumbu') methods of storage. Another NGO involved with PICS bags supply chain is CHANGE in Sokoto, Sokoto State. CHANGE is in partnership with USAID, and concentrates on the improvement of the welfare of orphans and vulnerable children (OVC) to have access to basic education. The OVC include the 'almajiris' and the street kids. In trying to achieve the stated objective, CHANGE decided to empower the caregivers so that the caregivers would, in turn, improve the lives of the OVC. Due to workshop organized by the IITA, the NGO got to know about the importance of PICS bags. Since the OVC is into production and processing, the NGO decided to sensitize the OVC so that they can employ the PICS bags in boosting their economic status.

Both SAA and CHANGE were not directly involved in the distribution or sale of PICS bags. They only created awareness, performed technical training, and enhanced availability of the PICS bags to the farmers. The farmers were only linked to vendors and directed to where they can buy the bags.

The Women's Development Initiative (WDI) is an NGO that has been very much involved in the sale and distribution of the PICS bags in some communities in Jigawa State and, to a lesser extent, in Kano State. They tried to get volume cowpea merchants involved in the use of PICS bags in Jigawa State without success. They also tried getting polypropylene bags merchants in Jigawa State to get involved in the sale of the PICS bags without success. They tried to open shops in some villages to serve not only as distribution centers but also as educating centers. They ended up empowering two individuals to serve as mobile vendors moving from one market location to the other selling the PICS bags.

One challenge was collaboration. WDI encountered lots of challenges in helping to make the PICS bags available to the farmers. WDI tried collaborating with Kano Agricultural and Rural Development Agency (KNARDA) and Jigawa Agricultural and Rural Development Agency (JARDA)--the ADPs of Kano and Jigawa states--in their activities, particularly with respect to PICS bags sensitization and distribution in Kano and Jigawa States, but the Ministry of Agriculture in the two states failed to give a reply to the WDI

request. WDI followed up by writing the two ministries a second time stating their request and the areas it needs to collaborate. A copy of the letter was provided to Maiyaki Damisa and Yakuba to peruse. Yakuba further advised them in ways of getting the attention of the ministries.

In addition, all the NGOs were constrained by funds in executing their PICS bag projects.

Business consultants

The business consultants play crucial roles and hold strategic positions in the supply chain of the PICS bags. They source for vendors and offer business advice to the vendors involved in the PICS supply chain in each state. The business consultants worked with PICS bag distributors and vendors in Nigeria to develop a smooth distribution system for PICS bags in the cowpea zones of Nigeria. They sometimes mediate in business disputes between the manufacturer and vendors. An example was the dispute between Na4 and Kaumi, which Sanusi (the BC in charge) helped to broker. Na4 felt Ahmed Kaumi had not been fair to him: despite his payment of money into Lela's account as agreed, the PICS bags were never delivered to him on time until he raised a quarrel with Kaumi. Kaumi, on the other hand, felt Na4 was disturbing him a lot but Na4 complained that he was under pressure from those that placed their orders with him and could not get their goods. Na4's other grievances with Kaumi /Lela Agro included poor packaging of the bags, as well as general trustworthiness. Some of the bales are not complete and the inner polypropylene bags were not always properly sealed. In 2010, he recorded 29 bad bags. In 2011, there were bales that were short of 16-20 bags. There were others that were in excess of 2-3 bags. In addition, Na4 felt Kaumi was not trustworthy. When demand for bags was at its peak, Na4 would call Kaumi on phone but Kaumi would not pick the phone. Kaumi's attitude usually makes Na4 angrier. When Kaumi was asked why he refused to pick Na4's call, he replied that Na4 disturbs him a lot and that Na4 was not the only customer he needed to pay attention to.

The major challenge faced by the business consultants is in getting volume cowpea merchants and volume polypropylene bags vendors involved in the PICS bags chain. The business consultants played radio and television jingles and equally conducted market demonstrations but with little success.

Government

The government got involved in the PICS bags supply chain in Nigeria through the ADPs. The ADPs are directly under the state Ministry of Agriculture. The ADPs provided the extension agents that conducted village demonstrations and played very crucial roles in the distribution of the PICs bags. In states with poor participation of the local vendors, the extension agents assumed the roles of the vendors and continued with the distribution of the bags.

Challenges included both travel and payment of PICS bags. The extension agents (EAs) suffered to get the PICS bags to the hinterland where the rural network was very poor and the villages far from distribution centres. Sometimes the additional costs incurred by the

EAs could be so much that the incentives given them become inadequate. EAs would not sell the bags on credit, prompting disagreements with farmers.

Evolution of the supply chain and major milestones

The PICS project started as a pilot phase in Nigeria between September 2008 and April 2009. The pilot phase was used to create awareness and sensitize the cowpea rural villages on the importance of the PICS bags. The EAs from the ADPs were employed to carry out village demonstrations of the PICS bags. The quality of the stored cowpea was noted, and volunteers are sought to allow their cowpea to be stored in PICS bags for 3-6 months, when the stored bags were opened. The volunteers were not to take from the stored cowpea until the agreed date of opening the bags. On the agreed date (known as the opening-the-bags ceremony), the villagers were assembled to open the stored cowpea. Though the PICS bags do not improve on the quality of the stored cowpea, the bags maintained the initial quality of the stored cowpea. The PICS bag technology was thus perceived as a major innovation over the traditional and chemical methods of storage.

The main phase of the PICS project started in September 2009 and ended in May 2010. The extended phase of the project started between 2010 and 2011 and continued to 2012. The village demonstration approach was employed in creating awareness and sensitization of the PICS bags in the main and extended phases of the project. Other activities that took place in the main and extended phases, in addition to the village demonstrations, included radio advertisements, posters and market demonstrations.

In January 2008, Lela Agro was identified as the PICS bags manufacturer in Nigeria. In May 2008, PICS business consultant (BC) Dr. Shehu Musa was hired to identify vendors and facilitate orders of the PICS bags from Lela Agro. He was also to ensure that the quality and price of the PICS bags are maintained. In 2009, Sasakawa 2000, IFAD projectts, and local NGO (such as WDI) were identified as partners of PICS.

At the initial set up, the PICS bags were ordered on consignment stocks with the vendors; however, due the difficulty experienced by the manufacturer in loan recovery, the system of consignment stocks came to an end, and the manufacturer introduced the system of cash and carry. This system was protested by some of the vendors, who complained of poor capital investment. Some of these vendors later dropped from the PICS supply chain.

In 2011, the BC Dr. Shehu Musa was replaced with two BCs (Yakuba and Moses Elaigwu) with each taking care of ten states in the country. The PICS BCs were hired to grow distribution network and facilitate bags sales. Radio advertisements of the PICS bags were intensified in this year. In response to widespread reports of broken and missing bags among vendors, Lela Agro upgraded his machinery and quality control processes.

Challenges faced in developing the supply chain

The main challenges faced by the PICS project, partners and other actors (in developing the PICS supply chain) are putting up a distribution network that reached the rural households, loan recovery issues with some vendors during the initial stage of the project, and getting cowpea volume merchants to use the PICS bags in storing /protecting their cowpea.

Strategies developed to encourage private actors' investments

A number of strategies were put in place by the project in order to encourage the private sector investment in the supply chain. In September 2008, at the start of the project, the PICS project made a down payment advance of 30% for the 2008/2009 production season. In July, 2009, the percentage of the down payment advance increased to 50% in 2009/2010 production season. The project has been fully reimbursed for the advances. The bags were placed on credit to vendors and reimbursements were made after sales. The project invested in media advertising to stimulate the sale of the PICS bags and create awareness for this technology. The project also went into partnership with local institutions (such as the ADPs) and NGOs (SAA, SG 2000 Nigeria, and WDI) to make the PICS bags readily available in the rural areas.

Challenges and opportunities to supply chain sustainability

This section aims to discuss key challenges to the smooth functioning of the PICS bags supply chain, with suggestions of potential strategies.

There have been reported cases of hermetic triple bags (competitive to PICS bags) manufactured by the Nigeria bag manufacturing companies Nigerian Bag Manufacturing Company Plc (BAGCO) and Betheven Industrial Company Limited (BICL) in market. BAGCO is located in Kano, while BICL is in Kaduna. These two bags are being tested for their efficiency in KNARDA. The thickness of the two inner polyethylene bags has not been measured by KNARDA; however, Yakuba confirmed the thickness of two polyethylene bags inside the BAGCO bag to be 0.63 microns (this he measured himself). The bags are being sold a little less than the price market price of the PICS bags. This could have serious implication for the triple bag industry. The market for the PICS bags is still at the formative level. There are quite a number of farmers that still harbor doubts about the PICS bags. Moreover, the low household budgetary constraints might easily force the farmers to sway to cheap products, not being able to tell the implication of the difference in the grades of the bags in relation to their effectiveness in protecting cowpea. If the bags are not effective in protecting cowpea, the farmers may be forced to fall back to traditional methods of storage, scaring off other prospective buyers, which can then lead to a bad market for Lela Agro. Since this is purely the issue of competition, Lela can find ways to remain competitive--for example, by increasing promotions and sensitization, upholding quality, and reviewing the price to end users. With more choice in the marketplace, buyers will in time determine which products offer them the best value proposition for their money and the manufacturers and vendors of those products will surely be at the top.

The volume cowpea merchants and polypropylene bags merchants show a nonchalant attitude towards the PICS bags technology. They are the major merchants for chemicals used in storing cowpea. To them, promoting PICS bags might cause them to lose two major markets where they currently have nearly absolute control. The initial point of entry of the PICS bags was through farmers. The nonchalant attitude could possibly be a display of the displeasure of the volume merchants for not being the main channel of routing the PICS bags to the farmers.

There is the need for the government, through the Standards Organization of Nigeria (SON) and other relevant agencies, to ensure the 80 microns thickness of the high density polypropylene bags. This will ensure that the bags produced by all companies (that are into the manufacturing of hematic triple bags) are not substandard. This also helps maintain the quality of the bags so that all that has been achieved by PICS and other agencies involved in the development and promotion of hematic triple bagging is not watered down.

Most of the vendors are concentrated in the urban areas. This, coupled with a poor transportation network to the rural areas, restricted the availability of PICS bags in the rural areas, which also led to relatively high prices recorded in some the rural areas. The PICS bag sells between ₦300 - ₦500 in the rural areas, depending on the distance. The poor availability of the PICS bags in the market could lead to cartels taking control of the sale of the PICS bags and increasing the price; this was recorded in the Maigatari area of Jigawa State, where a PICS bag sells for about ₦1000. It is therefore important to improve on the network distribution of PICS bags.

One of the major impediments to the increased number of the vendors participating in the sale of PICS bags is market uncertainty. The demand of PICS bags is mostly seasonal, and they do not want to tie down their capital. There is still a need for increased awareness creation and sensitization (particularly through radio and television programs).

Opportunities to expand the supply chain via increased private sector investments

Despite the development of the supply chain of PICS bags being at the rudimentary stage, the innovation is highly accepted by the farmers who will increasingly be demanding the bags. The supply chain (Figure 1 in the annex) was developed to sustain the availability of the PICS bags to the end users in the country. There have been significant strides in the manner the bags were embraced by farmers and processors. The technology is chemical- and pesticide-free, simple to use, affordable, and scalable. The profit from the use of the PICS bag ranges from 80% to over 100% (Abafarin, Abdoulaye and Lowenberg-DeBoer, 2010). Initially, public EAs were employed during the pilot stage of the project in distributing the bags. The EAs were very successful in promoting the bags among the farmers, but were not so successful in the sale of the bags. This led to private sector distribution of the bags. Significant sales of the bags were made as a result. Like any other new product introduced to the market, it takes time to make consumers aware of the product and get it fully embraced by members of the supply chain.

Though the bags were originally fostered for cowpea storage, end users in the country have privately tried the use of the bags in storing other crops (not just cereal but also legumes and oil crops like groundnut and melon successfully. Some of the end users even tried the

bags for cassava and yam flour storage). There is therefore large potential for a high demand for the PICS bags in Nigeria over time. More promotions and sensitizations will stimulate more demand of the PICS bags. The cowpea volume merchants are yet to make the PICS bags a standard part of their businesses. A great number of the middle men (wholesalers, semi-wholesalers and retailers) are still required to get the bags to the end users. Moreover, a sizeable proportion of the end users are yet to be reached, particularly the end users in the hinterland. Improvement in the distribution network will greatly improve the availability of the PICS bags to the rural areas and thus enhance increase in sales of the PICS Bags. There are, therefore, greater opportunities to expand the supply chain via increased private sector participation.

Lessons learned

The following are the key lessons learned from the Nigerian experience based on field study.

The ADPs have the widest channel of communicating with the farmers since they have direct contact with most farmers in the rural areas; however, considering the volume of PICS bags sold, the ADPs are not the best channel of distributing the PICS bags. More than 70% of the total sales of the bags were done by private investors. However, the ADPs did a very good job in the initial pilot stage of promoting the PICS among the farmers.

Most volume cowpea merchants are also major dealers in the sale of the insecticides used in the cowpea storage. These same merchants are also executives of the unions of cowpea merchants and agrochemical dealers. The union executives have the ability of using their position to influence union members to either fully participate in the supply chain of the PICS bags or not. Moreover, no agrochemical dealer is ready to lose the market for cowpea for the high margin derived from it. As such the reluctance in the participation of the volume merchants in the PICS supply chain may not necessarily be connected to the high cost of the bags (as has been claimed) but might be due to the opportunity cost of losing the market for chemicals as a result of the low demand for the chemical that might ensue from the use of the PICS bags.

The North Central states (middle belt region) are mostly cowpea consumption states, despite a sizeable quantity of cowpea being produced in the states. This might possibly have accounted for the low quantity of the PICS bags sales recorded in the region. The distribution network should therefore be developed based on the cowpea production capacity for each state to optimize resource allocation. The assumption is that if cowpea production areas adopt the storage of cowpea in PICS bags, the consumption areas will follow suite.

Investments in media propagation of PICS bags have contributed substantially in enhancing product awareness and stimulating demand.

There is a need to reduce the quantity of bags in a bale. Presently, 300 sets of PICS bags form a bale. The majority of vendors are small scale and buy 1-2 bales. According to Lela Agro, 80% of PICS bag purchases are 1-2 bales; 15% are 5 bales, and 5% are 10-15 bales. The reduction in the number of bags in a bale will enhance not only the ease of transporting the bags but will enable low income prospective dealers to have the ability to invest in the PICS bags business since many low income dealers expressed high initial capital investment as a hindrance to their entrance into the business. However, given the truckers' practice of charging by the piece, smaller bales will lead to significantly higher transport cost.

One alternative is to have smaller sub-bales within the 300 bag bale. When the bale arrives at wholesaler, it could then be opened and the small sub-bales transported to the rural retailers.

Most vendors do not have a well-established network distribution system. They are mainly concentrated in state capitals and urban areas. There is a limited number of vendors in the rural areas when compared with the state capitals and urban area. The extension agents form more than 90% of the vendors that cover the rural areas. Unfortunately, they are not the best for distribution since their volume of sales in terms of the quantity of bags sold is low compared to private investors. The limited number of vendors in the urban areas therefore limits the availability of bags in the rural areas. Rural households are the main buyers of PICS bags. Improving the network distribution will make the PICS bags readily available to the rural areas will increase the volume of purchase of the PICS bags.

The NGOs might not have made significant impact in the direct sale of the PICS bags, but they made an impact in the in awareness creation and the sensitization of the farmers to imbibe the use of the bags.

The role of the business consultants, particularly in the North West and North East states, is significant and substantially helped in facilitating the distribution of the PICS bags.

The issue of high price of PICS bags is debatable; however, the price is as high as ₦300-₦500 depending on the distance of the rural to the wholesaling center. Improving the network distribution of the manufacturer will reduce transportation cost for the wholesalers and retailers. This will help in reducing the price of the bags in the rural areas and lead to improvements in the volume of sales of the PICS bags.

In developing radio jingles and live programs on PICS bags in the first year of the project, farmers and the general public were sensitized to note that the market price of a set of PICS bag is ₦300.00. Attempts by some vendors to sell above the ₦300.00 price was met with opposition from the buyers. There is a need to re-educate the public that the price of the PICS bag is no longer static at ₦300.00 but floating and determined by market forces. This will aid in improving the vendors' incentives.

The reluctance of the cowpea volume merchants in the marketing /use of PICS bags may partly be as a result of human ties to traditions and avoidance of risks associated with the adoption of new technologies. The continued creation of awareness and sensitization of the volume merchants on the cost-benefit analysis of the PICS bags may help to improve the involvement of the merchants in the PICS bags supply chain.

The purchase of cowpea in PICS bags by government and non-governmental agencies (for consumption in boarding schools as in Kwara State and for other uses) is a great stimulant for the market to store cowpea in PICS bags. In 2008, students in Gombe State were fed with food prepared from contaminated cowpea and had food poisoning as a result. This incidence became an issue for the government. The government tried to discourage the use of chemicals in protecting cowpea in the state. It had a series of meetings through the state ADP with the grains merchants operating in the state to use less chemicals but it met with no success. The introduction of PICS bags to the state was a viable solution to this problem.

Conclusion, Recommendations, and Implications

The use of the extension approach in expediting the adoption of the PICS bag technology was very effective in creating awareness and enhancing rapid and extensive promotion of the technology among farmers, traders and processors. The demand for the PICS bags skyrocketed within the three years of intervention. The sale of PICS bags increased from hundreds of purchases in 2008 to thousands of purchased in 2011. The PICS bags have thus been well-received by the cowpea farmers, traders, and processors, despite the supply chain being at the developmental stage. The technology is simple, cheap, and easy to handle. The high demand for the PICS bags could be attributed to the apparent health and economic benefits arising from the use of the PICS technology. The use of PICS bags have saved many households from death that might possibly result from poisoning by eating cowpea treated with chemicals against insect attack. An analysis of the benefit cost ratio of using PICS bags for cowpea storage revealed an increase in the profit from the use of the PICS bag ranging from 80% to over 100% per bag stored within 4 – 6 months. Many opportunities are still open for the private sector to expand the supply chain via increased private sector investments. There are several points in the PICS bag value chain that offer opportunities to increase returns to the actors, particularly poor and disadvantaged groups, including women.

One of the major impediments to the increased number of the vendors participating in the sale of PICS bags is the uncertainty in the demand for PICS bags. The demand of PICS bags is mostly seasonal, and vendors do not want to tie down their capital. Therefore, there is a need to expand research on determining the effectiveness of using PICS bags in protecting crops other than cowpea. This will help to increase the volume demand for the PICS bags and thus expand the PICS bags marketing.

Investments in media to stimulate the demand for PICS bags have made a significant impact in enhancing product awareness and boosting demand. There is, therefore, a need for the manufacturer Lela Agro to invest more in the promotional aspects of marketing the PICS bags, particularly investments in media propaganda of the bags. This will ensure the continued creation of awareness and sensitization of the target group. There are more farmers and processors who are yet to adopt the PICS bags. Continued awareness creation and sensitization will ensure increase in the demand for the PICS bags which will lead to expansion of the PICS bag market.

Vendors complain of high transportation of the PICS bags. This complaint is more rampant with vendors located in towns and cities far away from the production point. There is therefore a need to establish regional distribution centers for easy access of the bags to the end users in all parts of the country. At least two distribution centres could be established to take care of the middle belt and North East regions that are far from the production points.

There is also a need for Lela Agro to repackage its PICS bags. Presently, the bags are arranged in baled consisting of 300 bags each. Lela Agro is responsible for the cost of transporting the bales from the factory to the motor park. The wholesaler is responsible for the cost of transporting the bales from the motor park to an agreed destination point. In most cases, big trucks are used in transporting the bales from Kano to agreed destination points; therefore, arranging the bales to consist of 300 bags is more convenient economically. Cars and lighter vans are used to transport the bales from the point of delivery to the vendor's warehouse; as such, it becomes very cumbersome transporting bales consisting of 300 bags. There is a need to reduce the quantity of bags in a bale; however, since reducing the number of bags in a bale increases the transport cost charged by truckers, one alternative is to have

smaller sub-bales within the 300 bag bale. When the bale gets to the wholesaler it could then be opened and transported to the warehouse in small sub-bales. This will also facilitate low income prospective dealers to have the ability to invest in the PICS bags business.

The introduction of BAGCO and BICL hematic triple bags into the market is a cause for concern. The market for the PICS bags is very fragile and not well developed. Most farmers have not yet adopted the PICS technology and some of those that adopted might not be able to tell the implication of the difference in the grades of the bags. Farmers will go for the bag with less cost. If this bag is not effective in protecting his cowpea, he may be forced to fall back to his traditional methods of storage. In addition, others who might be willing to adopt the technology might also be scared away. In other words, the bags get a bad reputation, leading to a bad market for the manufacturers. There is therefore the need for Lela Agro and Purdue University to reach an agreement on the rights of the PICS logo when the project comes to end. With the coming into the market of the sale of hematic triple bag by BAGCO and BICL, the right to use the PICS logo will help avoid confusion.

The Ministry of Agriculture sometimes purchases grains for storage as a policy of the Federal Government (strategic grain reserve policy). If the ministry should insist only on buying cowpea that is chemical-free and stored, transported, and sold in hermetically seal containers, it will not only lend credence to the use of PICS bags but also force volume merchants to store their cowpea in PICS bags.

Other stakeholders in the system should understand the technology and know that for cowpea to store well, the thickness of the inner polyethylene bags must be maintained at 80 microns.

There should be a better synergy between the project and the policy makers. Policy intervention is very necessary. Targeting the large-scale merchants will move the sale of the bags. For this to be achieved, collaboration must be with government agencies. This can be achieved by getting closer to people that make policies. Make a national workshop comprised of the Comissioner for Health; Commissioner for Agriculture; Ministry of Information (for providing awareness); program managers and directors of ADPs; permanent Secretaries of Agriculture at the state and national levels; Chairman of Committee on Agriculture in the state and national assemblies; Standard Organization of Nigeria (SON); and the Consumer Protection Commission (CPC).

The story of death that resulted from people eating cowpea that was chemically protected will encourage them to take action.The roles of the BCs in sensitizing the PICS stakeholders and facilitating the distribution of the PICS bags should be maintained and the cost borne by the manufacturer. This will help to facilitate improvements in the PICS bag supply chain, making the bag readily available to the buyer and improving on the sales and thus income of the manufacturer.

ANNEX

Figure 1: PICS Supply Chain in Nigeria

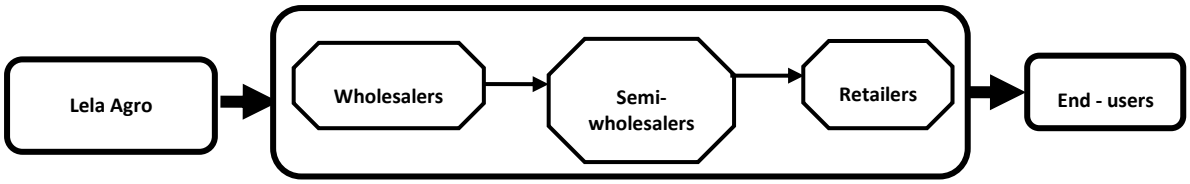


Figure 2: PICS Timeline of Events in Nigeria

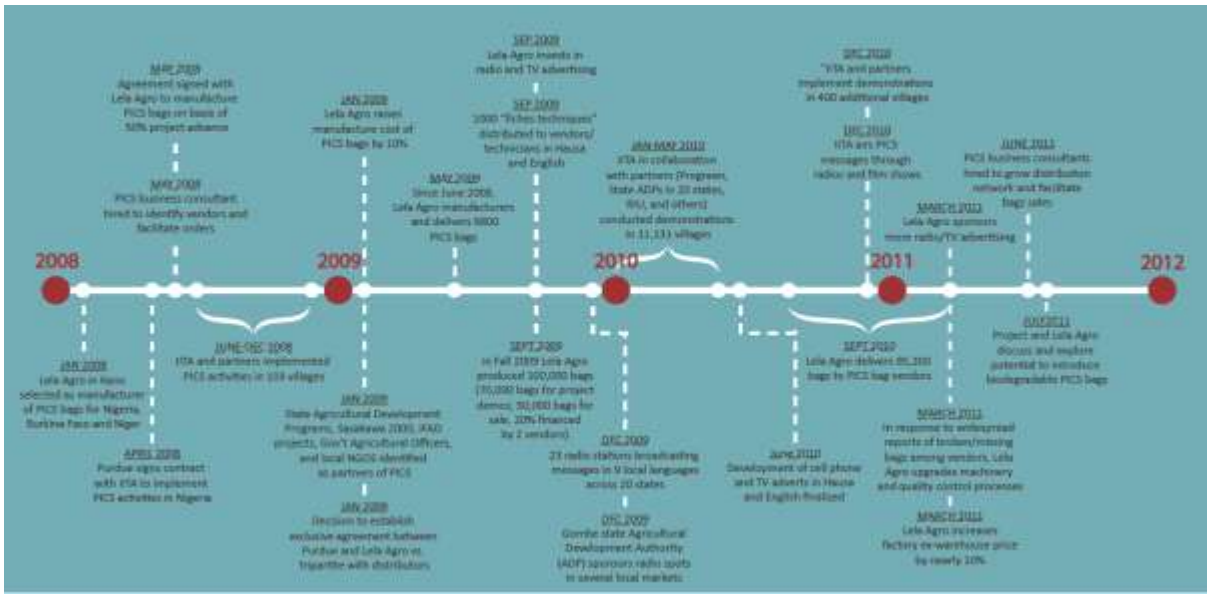


Figure 3: **PICS Vendor Map in Nigeria**

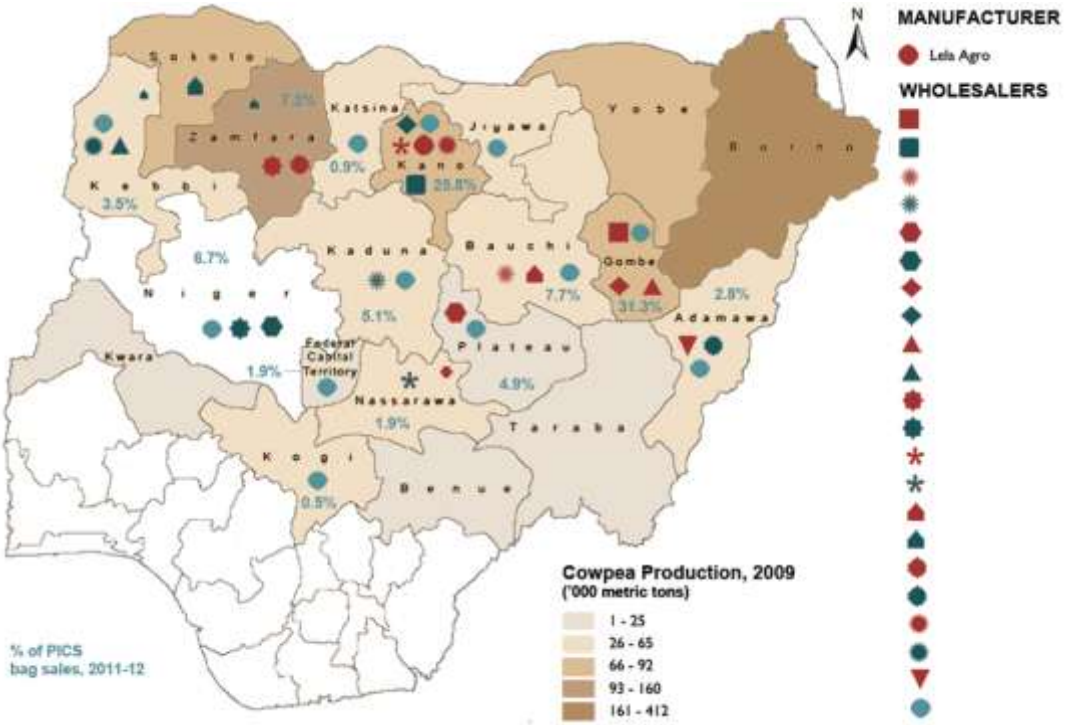
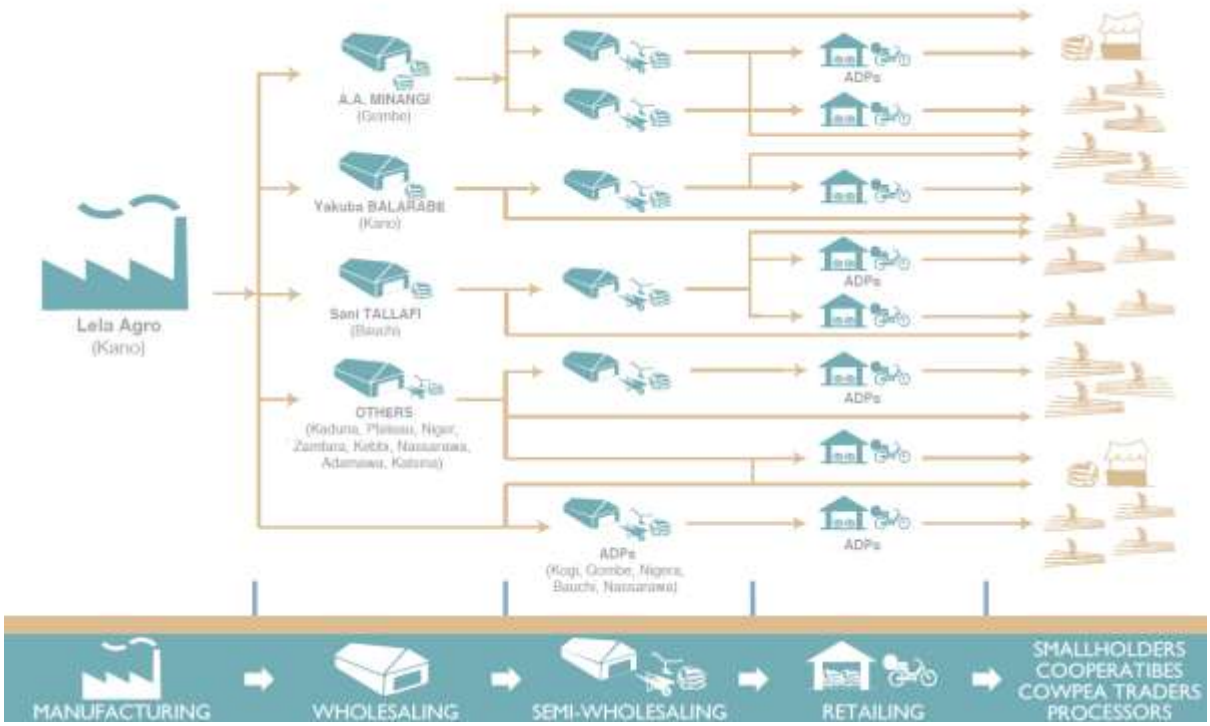


Figure 4: **PICS Supply Chain in Nigeria**



SENEGAL

Presentation of the PICS supply chain case study

PICS project implementation started in November 2009, with stakeholders meetings to identify the in-country institution to coordinate PICS activities in the country and to identify and select the supply chain actors to lead the distribution of the bags at the national, regional, and village levels. In November 2009, Baributsa contacted some potential partners, including the Citizens Network for Foreign Affairs (CNFA), World Vision-Senegal (WV-Senegal), Fédération des Associations de Développment Communautaires (FADECs), Mutuelle d'Epargne et de Crédit (MEC), and Compagnie de Filature et de Sacherie (COFISAC), the manufacturer of bags in Senegal. CNFA's goal is to strengthen the agro-dealers input network in Senegal by providing financial support for seeds system through the West Africa Seed Alliance. Because CNFA was not yet registered, it could not lead PICS activities in Senegal. Baributsa discussed the implementation of PICS activities with WV-Senegal; they suggested FADECs, a local Farmer-Based Organization (FBO) that grew out of its ADP. Some other partners were also explored, including the Austrian NGO EWA; the Wisconsin-based company AGGRAND AMSOIL Inc. that specialized in imports and exports of agricultural inputs and outputs in Senegal; ag inputs dealers like SEDAB SENCHIM; and Traore & Fils to build the PICS bag supply chain. The cowpea team of Senegalese Institute of Agricultural Research (ISRA) was also contacted. The outcome was to select and gather all partners together before the implementation of the project. Finally, the decision of working with the CADEC/FADECs was made to lead the distribution of the bags. Purdue signed the contract with the CADEC as a national distributor of PICS bags. The three FADECs (North, South and West) would lead the distribution of the bags at the community level. MEC, the microfinance institution, provided loans to CADEC to order the bags. The late Clement Faye was selected to coordinate PICS activities with the assistance of Serigne N'Dour. A bank account was opened to wire PICS outreach activities funds. The manufacturer COFISAC was selected to manufacture the bags and the training activities were led by the technicians from ISRA. The project was implemented in May 2010. The following section presents the current status of the supply chain and describes the roles of each actor as well as the challenges faced. The next section presents the evolution of activities and major milestones of the project, followed by the discussion of key challenges, strategies identified to overcome these challenges, as well as the incentives of different actors to invest in PICS activities. Closing will be the key lessons learned.

Current status of supply chain

Today, the supply chain is composed of the manufacturer COFISAC; the new wholesaler, Momar Yatou, located at Louga; and some vendors from Yatou's distribution network and from the former wholesaler's (CADEC) network. Some ISRA and Agence Nationale de Conseil Agricole et Rural (ANCAR) extension agents who led the technical component of the project (sensitization, demonstrations, and OBCs) are currently also part of the vendors of the bags. The chart below illustrates the distribution network of PICS bags as it appears today.

The Manufacturer: COFISAC

COFISAC is the most important plastics factory in Senegal. It is experienced in the production of woven polypropylene bags used for the repackaging of products such as goods for household consumption (cereals and legumes) and livestock, and for ag inputs such as fertilizers. The factory was created in 1995 and employs over 100 permanent staff. The annual capacity for woven polypropylene bags production averages 30,000,000 bags. It would take roughly two weeks for COFISAC to manufacture and deliver 100,000 PICS bags considering the fact that the polyethylene would be manufactured by Polyethylene Senegal.

With respect to the production of PICS bags, COFISAC was contacted in 2009 and manufactured 10,000 bags in 2010. COFISAC does not produce the polyethylene bags. The polyethylene bags are manufactured by Polyethylene Senegal. These bags were ordered by CADEC, a farmer-based association with the support of the microfinance institution MEC. The bags were paid for in cash. In 2011, the PICS project at Purdue asked COFISAC to identify another national distributor in its distribution network because the former one, CADEC, was not able to procure the bags. The reasons of why CADEC did not order the bags are explained in the next section. COFISAC identified one of its best and trustworthy distributors in the region of Louga (Yatou Momar Sy) where the PICS project was implemented. Yatou was proposed to the PICS project, which selected him after analyzing Yatou's ability to procure and lead the distribution of the bags. In 2011, 15,000 bags were manufactured and delivered to Yatou. At order, COFISAC asked for a down payment of 30% and the balance paid within 45 days following delivery. The bags were manufactured at 900 FCFA to the wholesaler, including the cost of the polyethylene bags (liner) produced by Polyethylene Senegal estimated at 600 FCFA for two liners.

COFISAC has a solid and functional distribution network across all regions in Senegal. The network is composed of distributors (clients) with whom COFISAC has a sale agreement. The network is built after years of working together and is based principally on trust. To maintain the network, COFISAC motivates its distributors by paying them a commission on the volume of sale each year. In addition to this network, it has about twelve additional outlets in rural areas where products are placed on consignment. Regarding PICS bags, COFISAC does not have a distribution network.

Three major challenges were encountered by COFISAC in the production of the PICS bags. The first is the thickness of the bags from Polyethylene Senegal. COFISAC often complained about the thickness of the polyethylene bags manufactured by Polyethylene Senegal. Despite several appeals, the thickness of the polyethylene bags ranges from 70 to 78 microns. Second, COFISAC faces an unreliable power supply. Electricity outages are a constraint for COFISAC. The factory uses an alternative source of energy (generator) which increases the production cost. Third, there has been an increase in the price of imported raw materials. Given the fluctuation of raw materials, COFISAC informed all the production units of the company that, from March 2011, the price of all goods manufactured will be increased by 20%. Given the specificity of PICS bags (new product designed for resources-constrained farmers to reduce the usage of chemicals during the storage), COFISAC has exempted PICS bags from this decision as its contribution to support the supply chain; however, this notice indicates the price of the bags may increase in the near future.

One strength of COFISAC is the potential upgrade of its equipment. COFISAC plans to buy new equipment in the near future to manufacture polyethylene bags which will help to control the quality of the bags and also to reduce the production cost. A second strength is the existence of potential volume buyers. Most of the authorities in Senegal are also big producers and potential volume buyers of the bags. They can also lobby for the promotion of the bags if they are aware about the usefulness of the bags.

National distributor of PICS bags (2010): CADEC

At the implementation of PICS in Senegal, the distribution of the bags was led by CADEC. At the village level, the PICS activities were led by the FADECs, which are the operating branches of CADEC in rural communities. There are three FADECs, including FADEC North, FADEC South, and FADEC West. All three FADECs are under the umbrella of CADEC. The CADEC/FADECs are well-organized farmers' associations created by WV-Senegal. The FADECs were mandated to lead PICS activities in their respective communities. In total, 662 villages were covered by the FADECS in 2010. PICS activities (demonstrations, sensitization, OBCs) were carried out in 660 villages where cowpea is mostly produced. Farmers for demonstrations were selected by the community leaders. Selected farmers were those who could store at least 50kg of cowpea for the six-month period. In addition to the technical component of the project, each FADEC selected PICS bags sellers among the membership as retailers to sell the bags to farmers. Figure 2 in the annex explains the structure of the CADEC.

In the first year of the project, CADEC acted as wholesaler of the PICS bags. The community-based microfinance institution (MEC) provided the resources to order the bags from COFISAC. In other circumstances, MEC financially supports farmers to access ag inputs through micro credits. The length of the credit barely goes beyond one year with a maximum amount of 2,000,000 FCFA. The minimum amount of credit given to farmers is 150,000 FCFA for a period of six months to one year. For PICS, an exceptional arrangement was made, and a credit of 3,000,000 FCFA, with an interest rate of 20%, was given to CADEC for a period of two years to give more time to bag distributors. Figure 3 in the annex shows the configuration of the supply chain led by CADEC in year 1 of the project

As indicated, the MEC is the funding institution which provided funding to procure the bags from COFISAC. The three FADECs acted as semi-wholesalers at the community level. Each FADEC selects retailers among its members to sell the bags to farmers. The right side of the chart shows the price at which the bags are sold along with the share of the gross margin at each level of the chain. The high selling price at the regional distributor is due to MEC's interest rate and other paper work and collateral costs.

The first challenge CADEC faces is the high interest rate by the MEC. The annual interest rate is 20% or 40% for the two years, plus 2% for administrative fees and another 1% as a collateral fee. This reduces the margin across the distribution chain and reduces the incentives of bags vendors. The second challenge is the poor rainfall. This negatively affected the demand for PICS bags in 2011 because of low cowpea production. The third challenge was the lack of marketing strategy. Bags are placed on consignment to FADECs; there is no marketing strategy to push the sale of the bags other than informing peers about the availability of the bags. Fourth, the thin margin at the retail level due to commission affects vendor's investments in the sale of the bags. Last, there is a non-full recovery of

MEC's credit. The credit is not yet fully reimbursed because all the bags were not yet sold and the term of the loan was two years. The MEC did not provide credit in 2011.

National distributor since 2011: Yatou

The second year of PICS activities in Senegal is characterized by the identification of a new regional distributor and the termination of the former one (MEC) because the loan provided in year one had not yet been completely recovered. The new regional distributor identified by COFISAC is one of the actors of COFISAC's network. The distribution of PICS bags in year two is therefore composed of the new regional distributor and vendors which belong to the FADEC network, the new distributor's network, and other new vendors. Figure 4 in the annex elucidates the map of the current supply chain in Senegal.

Yatou was the new PICS bags distributor to lead the chain in August 2011. He had been working with COFISAC for about eight years. Yatou is a seller of grains and legumes and one of COFISAC's distributors for ordinary bags. He has a big store where the products are displayed and can keep more than 100 bales of bags in addition to other products. He also has a warehouse where products are kept. He is the heir of his father's business (a great businessman well-known in Senegal and in some neighboring countries) and has over 40 years of experience buying and selling food and feed.

Yatou's distribution network comprises five major outlets located within a 30 to 80 km radius in Louga, including Sagatta, Ndiagne, Leona, and Barale, and Geoule. This network was built up by his late father, and he has maintained a strong relationship with them since he took the lead of the sale. Until now, he did not experience any major problem working with this network. The relationship in the network is based on mutual support and trust. They support each other in purchasing and selling goods. He has a good relationship with other distributors (about eight) across the country, including in Kaolack, Diourbel, Pekesse, Gossas, and Tambaccounda.

Yatou started in 2011 and ordered 15,000 bags. Among the 15,000 bags procured, 7,062 bags were purchased for demos in 1,168 villages. All the bags were purchased with his own funds. He paid 30% as a down payment to COFISAC at order and the remaining balance was paid one month after the delivery. Yatou was reluctant to take over the distribution of PICS bags because he was not involved in any preliminary activity of the project and therefore did not have a good understanding about the vision behind this project and the usefulness of the bags. He has been convinced about the opportunity of selling the bags for the near future by the manufacturer who ensured to provide support in the distribution of the bags. Noted that Yatou is one of the best customers of COFISAC and a trustworthy person who often receives appreciations from the manufacturer given the volume of goods sold each year.

COFISAC delivered the bags at 950 FCFA per unit at Yatou's store. Yatou placed the bags on consignment at 1,000 FCFA at his outlets and sells at 1100 FCFA to retailers or at 1,200 FCFA to farmers or individuals. There are about eight retailers who purchase the bags in bulk (about 100 on average) on a cash and carry basis. At the time of the interview, the unsold inventory was 21 bales (5,250 bags). The quantity of bags sold to farmers or through his outlets was 2,688 in 2011. There were 187 missing bags and seven bags with

holes (due to handling). These bags were replaced by the manufacturer. The unsold inventory in his outlets was collected immediately after the end of the harvesting time. When asked why he had such a large inventory, he argued that the cowpea production was not good in 2011; otherwise, he would have sold more than this quantity because the way the few farmers and some retailers and individuals rushed in his store to purchase the bags is a sign that the bags are well-known and appreciated by farmers.

One challenge faced by the new distributor was the delay in delivering the bags. Because of this, in 2011, some farmers went back to their traditional method of storage. A second challenge was his lack of information on PICS bags; the new wholesaler did not participate in the training organized in 2011. Third, the distribution network of the wholesaler is not well known by the technicians. Another challenge was the lack of interactions between technical and supply chain actors. The new wholesaler and the technicians (CADEC/ANCAR) do not interact; this limits access to information about the sale, the inventory, and location of bags to advice farmers accordingly. Some of the farmers have to travel to the wholesaler's shop to directly buy the bags. Last, some bags were perforated in the bale because they were sown by mistake by the manufacturer during the baling.

Semi-wholesalers (2010): FADECs

Actors involved in the supply chain led by CADEC are basically members of FADECs and extension agents selected for the technical components of the project. The FADECs acted as semi-wholesalers and operated like a management unit. Their role is to dispatch the bags to certain members selected to lead the distribution in their communities as retailers.

Mr. Garou (President of FADEC South) and Cheikh Diagne (President of MEC) led PICS bags sales in 2010. In 2010, Garou received 500 PICS bags, and 130 remained. He sold the bags during the sensitization in villages. He advised that after the first year of the project, it is good to find a new and private wholesaler to continue with the work started by the CADEC. As a leader, beneficiary, and promoter of the project, he said he should continue with the sale of the bags. He does not have any network to sell the bags but he can have some outlets based on his relatives.

Retail outlets and volume buyers for PICS bags distribution

The current retail outlets are composed of some retailers that led the distribution of PICS bags in 2010 under CADEC, the retailers of Yatou's network, and some extension agents who led the technical component of the project in 2010 and 2011. The retailers met during our investigations are categorized in three groups: the agro dealers, vendors of goods, and PICS facilitators. The following section describes the roles and challenges faced by these supply chain actors.

Case of S1

S1 is a retailer of PICS bags since 2010. Before PICS, he was a seller of other types of bags for grain storage and other products for household consumption. He received 300 bags on consignment at 1,100 FCFA from the president of FADEC North and sells them at 1,250 FCFA/bag. The bags are sold in the store. In year two (2011), he received on

consignment a bale from Yatou at 1,100 FCFA/bag. S1's clients for the bags are mainly cowpea farmers, but there are also some farmers who buy the bags to store groundnuts seeds or to keep grains for consumption.

Case of S2

S2 is another retailer of PICS bags since 2010. Before PICS business, he was an ag inputs dealer and one of the largest grains and legumes sellers in Senegal. He has two huge warehouses where he stores cowpea, millet, and rice; the groundnuts are stored in an open air area. He has also been one of the main seeds suppliers for the government of Senegal since 2006 when the government launched a program called Grande Offensive Agricole pour la Nourriture et l'Abondance (GOANA) to reduce food insecurity across the country. The quantities of cowpea supplied to the government averages 700 to 800 MT per year. He assembles this quantity by buying cowpea in weekly market directly from farmers. He also has some other grains and legumes volume buyers from different region across Senegal. The annual production of cowpea in the region can reach 50,000 MT. Seeds purchased by the government are sold back to farmers at a subsidized price during the planting season. S2 stores the grains in ordinary bags with the use of insecticides to preserve them against postharvest insects. S2 started with PICS bags business in 2010 from CADEC and had purchased five bales of bags for cash at 1,150 FCFA/bag and sold at 1,200 FCFA/bag. Some of the bags were used to store cowpea and the remaining sold to farmers. In 2011, four bales were purchased and 50 bags remained because of the uneven distribution of the rainfall, which negatively affected the level of cowpea production. Some of the cowpea in his warehouse is stored in PICS bags, but the large part is stored in ordinary 50kg bags. He said he can buy at least 20 bales of PICS bags each year if 50kg of bags could be manufactured. S2's network is composed of nine outlets where he places other ag inputs across the Coki district and outside the district. He sells the bags at his store, mainly to farmers. Some farmers buy the bags in bulk.

Case of S3

S3 is another PICS bags retailer who started in 2011. He heard about the bags through the media (radio) and he thought that this would be a good opportunity for him because cowpea is well-produced in his location. He went to the wholesaler and received one bale of bags (250 bags) on consignment at 1,100 FCFA/bag. The bags were sold at 1,200 FCFA/bag. There are some unsold bags because of low production. He wanted to use the bags to store the grains in his store but unfortunately, this year the production was not good for any crops. S3 does not know how to use the bags correctly. He did not participate in any training or demos. Outside of PICS, S3 is an agro dealer who supplies seeds such as groundnuts, cowpea, and cereals. He has stores which can contain about 1,160 MT of grains. He has a good relationship with some banks and can receive up to 300,000,000 FCFA (an equivalency of around $600,000 USD). He has about eight outlets across the country where products are placed on consignment. People in the network are also agro dealers like him, and the network was built up over years through mutual support; they exchange goods and services. His objective is to become a wholesaler because he has sufficient financial resources to order the minimum amount of bags required by the manufacturer and also capable to lead the distribution of the bags. His plan is to use roaming vendors who can go markets to markets to sell the bags. This is a potential distributor of PICS bags. COFISAC and the PICS team at Purdue should dialogue with him to check whether he meets the requirements set to be a wholesaler.

Case of S4

S4 is a PICS facilitator and a new PICS bag vendor. Her determination and vision with the PICS bags deserve to be highlighted. S4 is a 19 year old woman living in Keur Balla Seye with a secondary level of education. She dropped out from school a couple of years ago and is looking for any opportunity that could help her earn some revenue. She spends her time helping her parents in farming activities. She started with PICS in August 2011 and led sensitization and demonstrations in five villages. She is one of the best facilitators among the 25 selected to lead PICS activities in 2011. Given the increasing demand of bags for farmers who were not selected for the demonstrations, she asked her father for a loan of 110,000 FCFA and purchased 100 bags from the wholesaler. She goes from village to village and market to market with one of her younger sisters to sensitize people and to sell the bags. Additionally, she gave some bags to other facilitators for sale in their respective communities. All the bags were sold at 1,200 FCFA per unit to farmers. During the sensitization, she sold the 100 bags she bought despite the fact that farmers were still waiting for the OBCs in May 2012. Some farmers continued to ask for the bags but she feared to order again since the season was almost over. Because of her determination, about 2.7 MT of cowpea were stored in her community. According to the chief of village, S4 was such a brave and well committed young woman for PICS activities. She has received some moral support from the chief of the village who also helped her spread information about PICS. The chief of the village has bought fifteen bags for himself to store his cowpea and referred the bags to other farmers who also bought the bags. S4 plans to buy more bags for the 2012 season if she has more resources but she suggested it would be good if she could receive some bags on consignment.

Other cases

PICS facilitators such as S5, S6, and S7 who led PICS activities in 2011 also retailed the bags. These facilitators are resource persons selected by the local authorities to lead PICS activities. Before PICS, they were vendors of goods and grains at the market place. They still have some inventory because of the low level of production. They have access to credit facilities and have received loans from the local cooperative to purchase the bags. They do not have outlets and instead sell the bags at the market or from their houses. Bags are also given to their fellow vendors for sale. As opposed to other facilitators, S7, together with six other facilitators in his community, formed a group called Groupement d'Intérêt Economique (GIE) to lead the sale of PICS bags in their communities. In this GIE, each member provides resources to buy the bags. For the first order in 2011, the GIE did not have enough funds to order the bags in cash. They contacted the wholesaler who gave the bags with a 50% down payment. The balance was paid after the sale. All the bags were sold to store groundnuts.

Other bags vendors include S8, who sold about 500 bags in 2011; and S9 and S10, both technicians of PICS who had overseen PICS activities in 2010 and 2011. These technicians sourced the bags from CADEC, generally on consignment, and sold more than 2,000 bags in 2010.

Some volume buyers: case of ANCAR

ANCAR, through the World Bank program Programme Sectoriel d'Appui au Organisations Paysannes pour la production des semences (PSAOP), bought the bags to support seed producers (GIEs) to store cowpea and groundnuts seeds for the government seeds program. Seven GIEs benefited from the PICS bags. The objective of ANCAR is to

show farmers that the bags are effective in controlling storage insects for cowpea. Farmers' associations would be normally willing to buy the bags by themselves for the following years. Before PICS bags, the GIEs stored the cowpea seeds in metallic tanks with the use of Phostoxin. The decision of using the bags to store the seeds came from the quality of cowpea observed during the OBCs in year 1 of the project. In total, 1,150 bags were bought by ANCAR in cash and distributed to the seven GIEs. Bags were purchased at 1,150 FCFA/bag. For the coming cropping season, other GIEs are planning to buy more bags with their own funds.

Challenges faced by the retailers of the bags include the low margin downstream of the chain. A good portion of the profit is kept by Yatou, leaving the downstream of the chain with thin margin. In addition, retailers have to bear the transportation cost. Another challenge is the size of the bags; some grain vendors prefer the 50kg bags because they are easier to lift during the handling. Some farmers generally do not have enough cowpea to store in the 100kg PICS bags and were not willing to buy the bags. The volume of production at farmers' level is determinant in the sale of the bags. A third challenge is the availability of the bags. In 2011, bags were delivered late, and some farmers went back to their former method of conservation. In addition, there was an inappropriate distribution because the bags were available in some places where there are less needed and absent in places where there are more needed. This was a cause of a rupture observed in 2010. A fourth challenge is the financial constraints at harvest. Farmers are willing to buy the bags but are constrained by the capital at harvest. Cowpea is generally sold to overcome financial constraints faced at the beginning of the harvest period. As mentioned earlier, another challenge is the non-full recovery of MEC's credit. The credit is not yet fully reimbursed because all the bags were not yet sold thouth there was a two-year term on the loan. This is why the MEC was not willing to provide funds in 2011. One last challenge is the fluctuations of the bag price; this is observed in some locations where the bags were sold beyond the predetermined price.

Evolution of the supply chain and major milestones

The PICS project started in 2010 in Senegal. Prior to the implementation, a sample of bags manufactured by Lela Agro in Nigeria was sent to COFISAC in December 2009. In May 2010, the PICS project signed two agreements with in-country partners. The first agreement was signed with CADEC, a local NGO founded by World Vision-Senegal, to become the national wholesaler of the bags and to lead the distribution of the bags in Senegal. The second agreement was signed with Institut Senegalais de Recherche Agricole (ISRA) to lead the technical component of the project, such as the training of the facilitators, the awareness building of farmers about PICS technology, the demos of how to use the bags at the village level, and the monitoring of farmers selected to hold cowpea in PICS bags for OBCs. In August 2010, CADEC, with the financial support of MEC, ordered 10,000 bags from COFISAC. In October, the major activity carried out by the PICS project includes the contract signed with community radios to broadcast PICS messages in Louga. Meanwhile, the in-country partners, with the support of the PICS team at Purdue, implemented the training in 660 villages. In December, PICS messages were broadcast for the second time in local radios in the regions of Louga, Kebemer, and Niakhene to build community awareness about the use of bags and also to support the sale of the bags in these locations. 2011 is characterized by three major milestones. The first is the organization of the OBCs by in-country partners in April. The organization of these events consisted of selecting both the

location where the events will take place and the partners to invite for these events. These events occurred in May in Kandala, a village near Kebemer in the rural community of Sagata; and another in Khandane. About 200 participants attended in each location. The second event is the selection of Yatou to lead the distribution of PICS bags because CADEC was not able to procure the bags that year. Yatou was selected conjointly by the PICS team at Purdue and the manufacturer COFISAC. Yatou order 15,000 PICS bags that year to cover PICS villages of 2010 and also to the new villages selected in 2011. The third most important milestone is the training of 29 vendors in the benefits of using PICS bags and in the proper use of the bags. In June 2011, new partners such as Solidarite International, Millennium Village, and others staged bag demonstrations in FADEC North and East. In August 2011, the PICS project launched another training of facilitators to lead PICS activities in new locations. A total of 96 facilitators were trained to oversee activities in 1,168 villages in the rural communities of Nguer Malal, Ngueune, Sarr, Koki, Kebemer, and Meckhe. These facilitators were monitoring the demo farmers of these locations until the OBC scheduled in May 2012.

Challenges faced by PICS project and partners in developing the supply chain

One challenge faced was the low participation of farmers during the OBCs. During the sensitization, the number of attendees is higher compared to those who attended the demos or the ceremonies. The opening-the-bags often occurred in April-May, a period over which most of the farmers are busy preparing their land for the next cropping season. In addition, some were organized during weekly market days where farmers, and especially the women, are busy.

A second challenge was the lack of an appropriate store to keep the bags. In general, farmers in Senegal do not have a granary to keep cowpea compared to other grains. Cowpea is stored in tanks and kept in the yard. Inversely, cowpea stored in PICS bags should be kept in a protected place and away from rodents.

The third challenge was logistical constraints. PICS sensitization and demos are performed during the rainy season, and access to some villages is limited because of the bad road conditions. Using motorbikes to reach farmers is not always practical.

The fourth challenge was the difficulty in monitoring demo farrmers. Some farmers keep cowpea in their bedroom, which makes the monitoring difficult. It would be good if demonstration cowpea could be stored in a community store to facilitate the monitoring. It is not always easy to verify whether the farmers have opened the bags to take out some cowpea.

Other technical constraints during the promotion

One constraint was the risk of rodent attack. Famers usually store cowpea in metallic tanks, and the tanks are left in the yard. With PICS bags, farmers kept the bags filled with cowpea in their living room and are subject to rodent attacks.

It was occasionally difficult having cowpea for the demos. Some farmers do not harvest the cowpea at the same time because of the type of varieties they grow (early vs. late maturing varieties). Along with this, because of the bad season, it is challenging for farmers to have the 50kg of cowpea required for the demos.

The selection of the five farmers for demos was sometimes a source of conflict in some villages; this affects the participation during the demos and the OBCs. In addition, some demo farmers are reluctant to participate in the demos in public because they did not want people to know that they have a lot of cowpea. The demos are done in their compound with their family members.

Strategies developed to encourage actors' investments

To encourage private investment, the PICS project had undertaken some promotional activities at the downstream of the supply chain to show farmers and actors in the chain the effectiveness of the bags and the business opportunity associated with the sale of the bags. The vendors have seen a new revenue stream and a diversification into a new product. This strategy used by the project created the demand-driven supply chain. For example, in year one, the project led promotional activities (sensitization, demonstrations, OBCs) in 660 villages, and, in each village, six farmers were selected to participate. The ceremonies were done in public to show other farmers the effectiveness and the usefulness of the technology. Through the promotional activities, the PICS project guaranteed the market for the bags by purchasing about 50% of the total amount of bags ordered by the wholesaler. As an example, in 2010, from a total of 10,000 bags bought by CADEC, about 40% (3,960 bags) were purchased by the PICS project for the demonstrations. In 2011, from the 15,000 bags ordered by Yatou, 7,062 (almost 50%) were purchased by the project for the promotional activities in 1,168 villages. These bulk purchases incentivized the bag vendors to engage in the procurement and in the distribution of the bags. The second most important action performed by the project is the media effort. The use of community radio and television to broadcast PICS messages in local languages had a large impact on farmers' awareness of PICS technology because most of them have access to the national channel. Another action taken by the PICS project to incentivize supply chain actors is the moral guarantee by identifying and discussing with COFISAC and working closely with the extension agents and the in-country coordination to create the demand for the bags.

COFISAC was willing to invest because it was well-sensitized to the importance of the project and also because of the new line of product in its portfolio. It foresees a good business opportunity in the near future.

Yatou invested in PICS bags procurement because of the new revenue stream and diversification into a new product. In addition, the guaranteed market offered by the project by purchasing about 50% of the volume of bags procured from the manufacturer incentivized Yatou in investing in PICS activities.

Challenges and opportunities to supply chain sustainability

For the manufacturer:

Constraint: Low density of the inner bags from Polyethylene Senegal.
Strategy: Dialogue between COFISAC and Polyethylene Senegal on the importance of the thickness on the effectiveness of the technology and on the supply chain.

Constraint: Unreliable power supply impacting price.
Strategy: Working through partners, facilitate capacity building among supply chain actors to identify needs and voice concerns at a local and regional level.

Constraint: Increase in price of imported raw materials.
Strategy: Lessen the cross-border duties for raw materials to partially offset the effect of the increase of raw materials on bag production cost

For the wholesaler:

Constraint: Delay in delivering the bags in 2011.
Strategy: Announce the intention of the volume of order on time and develop a follow up strategy to ensure on time delivery.

Constraint: Unknown distribution network; missing bags and a lack of information on PICS.
Strategy: Supply chain actors (Wholesalers, semi-wholesalers, retailers, FADEC/CADEC/ADEC) should meet and discuss options to overcome these issues. Options may include sensitization about PICS technology, provide a list of the distributors as well as their location and contact information, and supply additional bags to wholesalers at delivery on top of the quantity demanded.

For downstream in the supply chain:

Constraint: Low margin at the downstream of the chain.
Strategy: One way to overcome this constraint is to let the market determines the price of the bags at the retailers' level to create incentives at the downstream of the SC.

Constraint: Size of the bags and bags with holes.
Strategy: Give the wholesalers options to order the size of the bags demanded in the market to the manufacturer as long as the quantity demanded meets the minimum required by the manufacturer. Also, the project partners (in-country coordination team) should inform the manufacturer about the hermetic issue of the bags by explaining the impact of the holes on the effectiveness of the technology.

Constraint: Cash constraint of the farmers at harvest.
Strategy: Encourage the MEC to initiate an inventory credit policy for cowpea/grains farmers with the use of PICS bags as storage facilities.

Constraint: Risk of rodent attacks and lack of storage facilities.
Strategy: Encourage farmers to store their cowpea in the community storage centers to avoid rodent attacks.

Constraint: Low participation of farmers in PICS activities
Strategy: Schedule the OBCs in a participative way with local leaders, farmers' associations to allow larger participation.

Constraint: Logistics related constraints
Strategy: Project partners may discuss about the logistics arrangements suitable for each country given the locations selected for the work and the resources available to that country.

Discussion of opportunities to expand the supply chain

One of the major opportunities for the sustainability of the supply chain is the existence of the high potential demand for the bags. Currently, bags are used for other crops other than cowpea, such as groundnuts and cereals (millets). Because of the large promotional activities over the two years, the presidents of the FADECs estimated the potential demand for bags in good cropping season at 30 bales (7,500 bags) for each FADEC given the multiple applications of the bags. With respect to the germination issue, cowpea stored in PICS bags present a higher germination rate compared to the one stored in metallic tanks. In addition, the freshness of the cowpea after more than six months of storage offers a tremendous advantage over cowpea stored with other storage techniques. Farmers or cowpea traders may sell cowpea stored in PICS bags at a higher price. The existence of processing units in Senegal, which processes the cowpea into various products, may drive the production of cowpea because processors can buy more cowpea and keep them in the PICS bags for as long as they can without losing its freshness. The quality of the processed products may certainly improve because of the freshness of the cowpea. During our investigation, MEC plans to support farmers in the procurement and distribution of the bags in the near future. MEC also plans to sensitize restaurants and hotels on the health hazard associated with the use/misuse of insecticides to store cowpea and to inform them to purchase cowpea stored in PICS bags. There are some seeds cooperatives which receive financial support from the MEC. The MEC plans to visit these cooperatives and sensitize them about the use of PICS bags to store cowpea seeds. In addition to the MEC efforts to expand the chain, some bag vendors currently continue to sensitize farmers who still have problem to store the cowpea on the use of PICS bags. Some of the vendors suggested that demos and OBCs could be organized in market to increase the awareness of grains vendors of the effectiveness of the bags.

Lessons Learned

Farmers based organizations (such as CADEC) can be an effective channel to deliver PICS bags to farmers, but the social orientation may hinder the expansion of the supply chain.

The access to rural credit facilities could be an advantage, but it is not essential for the development of the supply chain, given the relatively higher interest rate which reduces the margin.

Given the cash constraint experienced by the farmers at harvest, an inventory credit could be an option to enhance the storage of cowpea with PICS bags.

Investments of actors in the expansion of the supply chain is favored by the promotional activities carried out by the PICS project, which consist of building awareness of bags users to stimulate the demand and guaranteeing the market through bags purchased for the demos.

The involvement of the manufacturer in the selection of the national distributor can be an asset for the efficient functioning, growth, and sustainability of the supply chain.

A good flow of information between the supply chain actors and the creation of a platform where chain's actors can meet and discuss major issues that hinder the expansion of the chain is necessary for the sustainability of the supply chain.

The business opportunity offered by PICS project through the sale of the bags might be a source of employment for youth, especially those who are looking for profitable activities.

ANNEX

Figure 1: PICS Supply Chain in Senegal

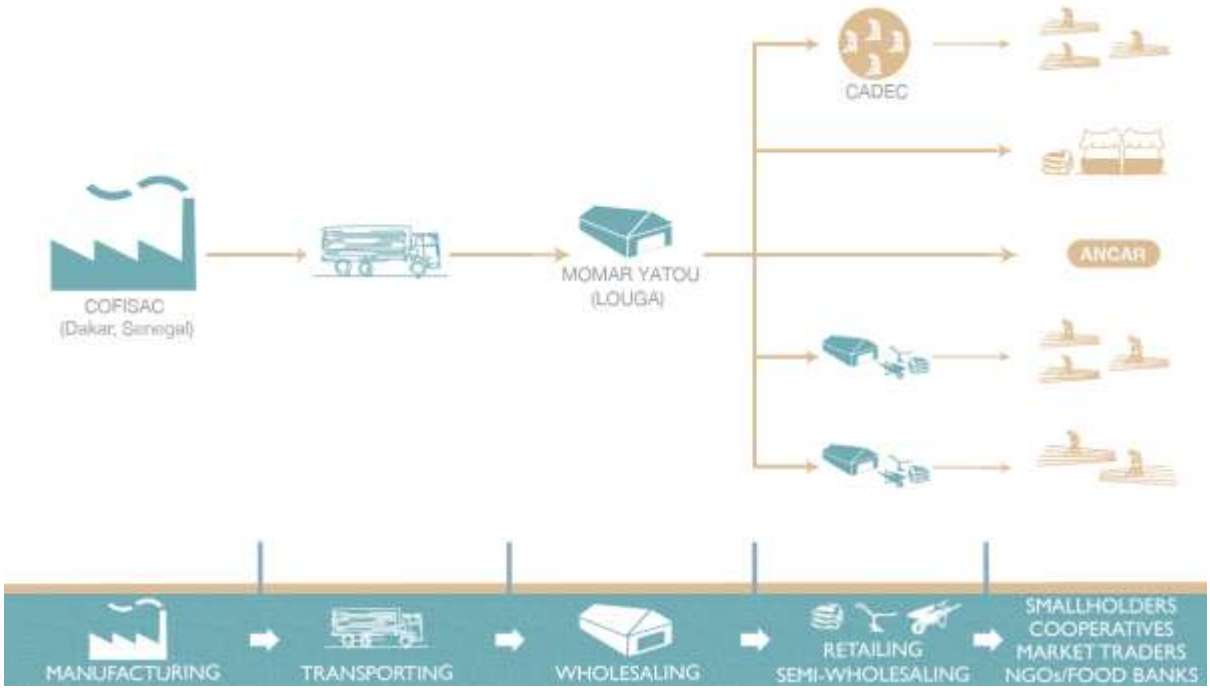
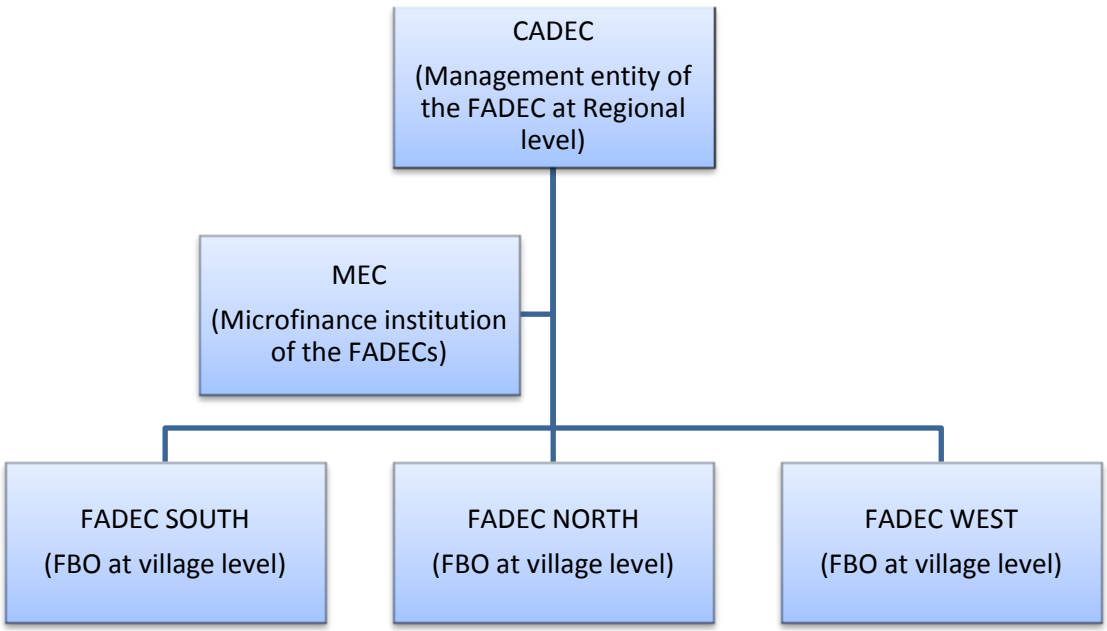


Figure 2: Organization chart of the CADEC



<u>Figure 3</u>: Supply chain led by CADEC in year 1 of the project

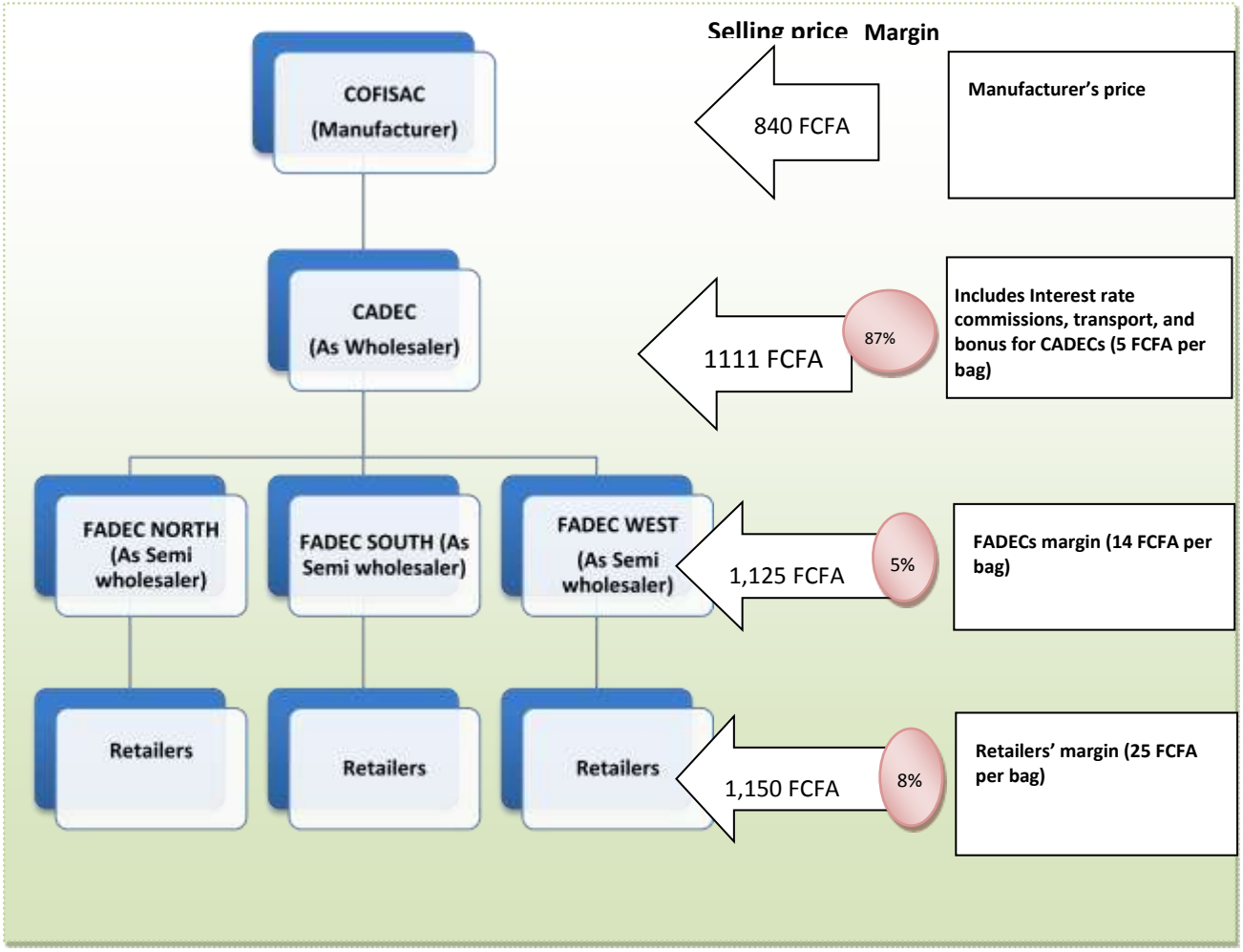


Figure 4: Supply chain led by the new regional distributor in year 2 of the project

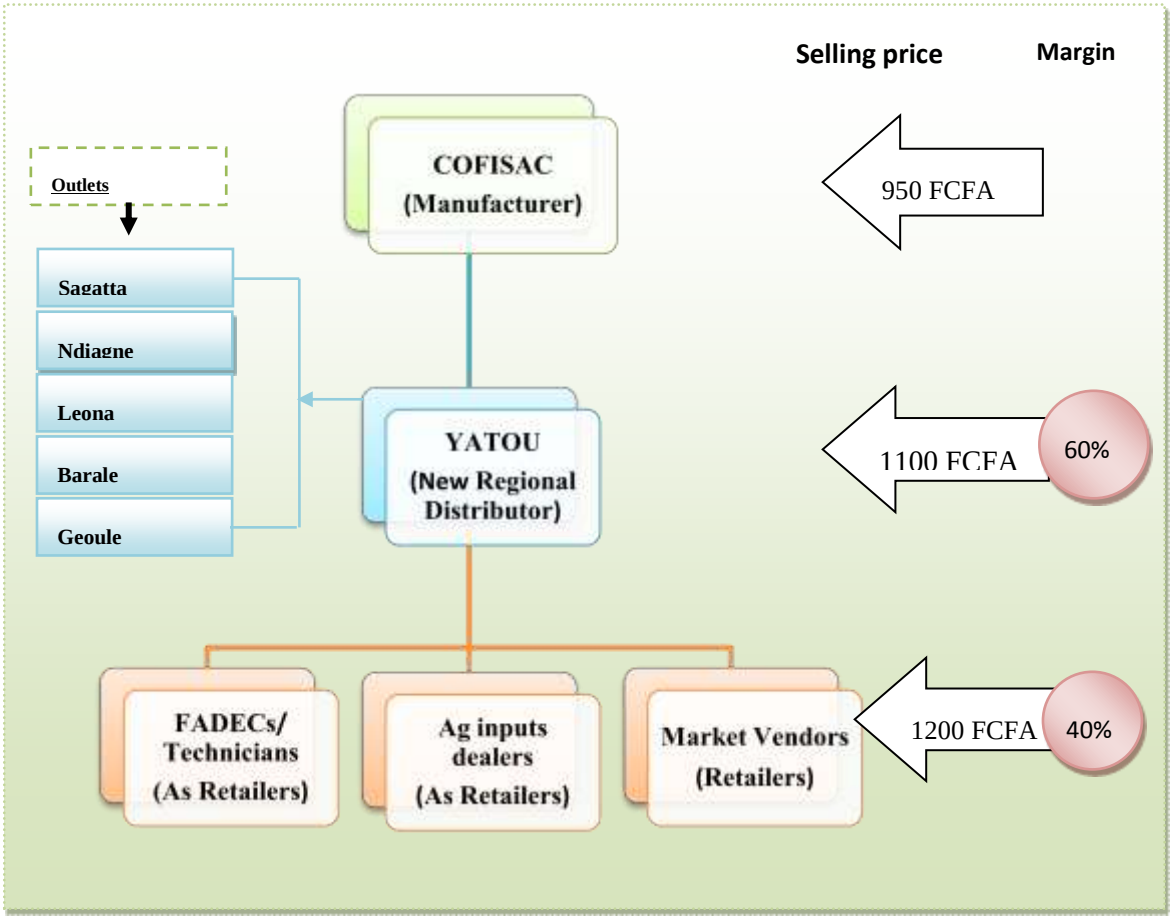
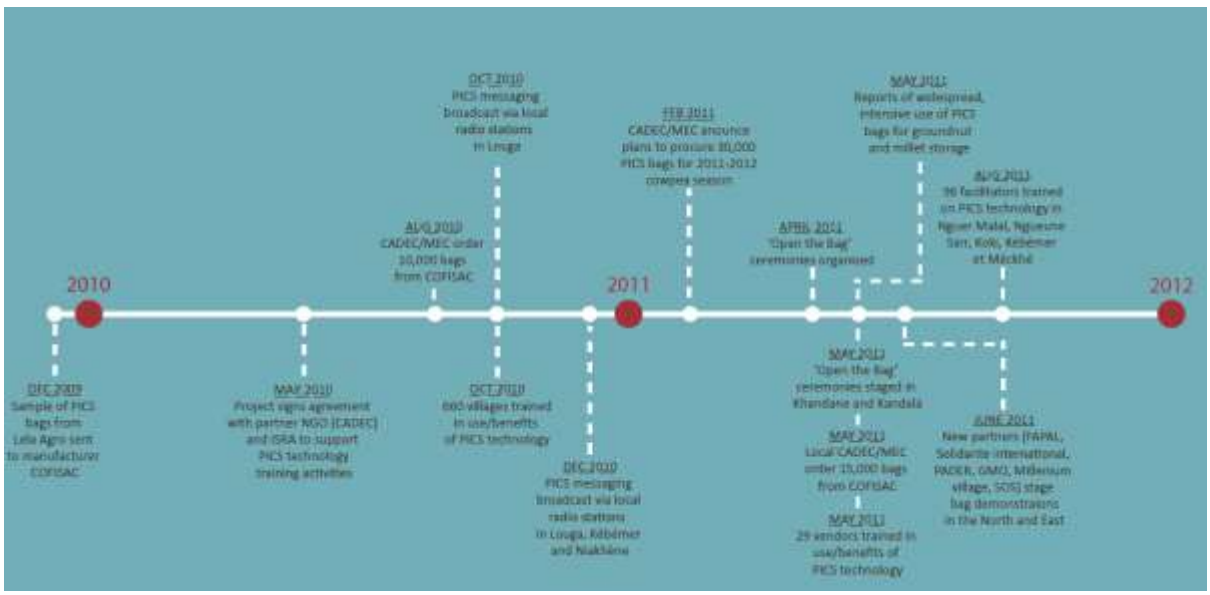


Figure 5: **Mapping of the PICS bags outlets in Senegal**

Figure 6: **PICS Timeline of Activities in Senegal**



TCHAD

Presentation of the PICS supply chain case study

Tchad is a cowpea-producing country, with an annual production representing one percent of the total production of West and Central Africa. Tchad also represents an important share of cowpea market in Africa and exports the cowpea to Nigeria, Central African Republic, and Gabon. Cowpea is mostly grown in the southern part of the country. To strengthen the cowpea market in Tchad in particular, and for Africa in general, Purdue University has selected Tchad as one of the 10 countries to implement the PICS project.

The PICS project was first implemented in Tchad during the 2010-2011 cropping season. The project is comprised of three major components. The first component is the technical component, which consisted of building actors' awareness, conducting public demonstrations, monitoring farmers who stored cowpea in PICS bags, and organizing the public opening-the-bags ceremonies. The second component is the marketing and communication component, led by the business consultant. The third component is led by two national distributors with the support of the business consultant and is related to the distribution and sale of the bags. The outreach activities were implemented by L'Association d'Appui aux Initiatives Locales de Développement (ASSAILD) and Centre Chretien D'Appui au Developpement Communautaire (CECADEC) during the 2010-2011 and 2011-2012 cropping seasons.

Current situation

During the identification of PICS partners in Tchad, World Vision (WV-Tchad) was identified to conduct the technical activities, but withdrew. The officially stated reason for their reluctance to implement PICS was security. The Purdue team, composed of Baributsa and Lowenberg-DeBoer, went to Tchad to identify local NGO partners and potential distributors of PICS bags. CECADEC and ASSAILD were identified to conduct the technical activities of the PICS project in Tchad. These NGOs were directly contracted by Purdue University. To carry out technical activities, ASSIALD subcontracted other local NGOs located in other areas. Two distributors (wholesalers) were selected to supply and distribute PICS bags in Tchad. These are Mr. Martin Kongobé, trader and entrepreneur at Moundou, Tchad; and Mr. Joseph Gandar (and Mr. Adoum Mahamat), nurse and business man at Moundou.

The first source of supply for PICS bags in Tchad was Lela Agro from Nigeria. The second source of supply (and the most recent one) is the national distributor of Cameroon: GIC-DEMRI. GIC-DEMRI constituted the most cost-effective option for Tchadian distributors.

In Tchad, the distribution network of PICS bags is composed of two complementary sub-networks, including the sub-network of Gandar (and Adoum) and the sub-network of Konkonbé. The sub-network of Gandar is composed of food traders, NGOs, and shopkeepers. The sub-network of Kongobé is composed also of food traders, NGOs,

shopkeepers, and some relatives (sisters and aunts). Gandar's network covers Tangilé, Mayo Kebbi, and Chari Baguirmi, while Kongobé's includes Logone occidental, Logone Oriental, Moyen-Chari, and Mandoul. GIC-DEMRI supplies the distributors and the semi-wholesalers in Tchad. Kongobé ordered PICS bags twice and delivered them at the Touboro border at 875 FCFA/bag. In total, 3,500 bags were ordered, including 2,000 for the first order and 1,500 for the second order. CECADEC procured 1,000 bags at 1000 FCFA/bag delivered at Guider, 30km away from the Tchad border. A trader based at Léré, bought 100 bags at 1,000 FCFA/bag delivered at Guider.

Supply chain actors profile

International coordination of PICS project: Purdue University

Purdue University is the institution that initiated the PICS project; they also created and supported, both technically and financially, the distribution chain of PICS bags in Tchad in 2010 and 2011. In an effort to increase the private sector's interest in PICS activities in Tchad, Purdue University provided some incentive efforts during the implementation of the project. First, it acted as a moral guarantee for the wholesaler vis-à-vis the manufacturer Lela Agro by linking the two national distributors with the manufacturer in a business relationship. Additionally, the PICS project itself is a volume buyer of PICS bags. To incentivize supply chain actors and to strengthen the development of the chain, the PICS project, through ASSIALD, purchased about 4,000 PICS bags at 1,100 FCFA/bag from the national distributors for public demonstrations, created and stimulated the downstream demand of PICS bags through ASSAILD and CECADEC by supporting the technical components of the project, including outreach, demos in villages and markets, open-the-bags events, and training of NGOs and journalists. Similarly, several media activities were initiated and financed by the PICS project, such as radio spots, media coverage of OBCs, and caravans (mobile adversizing through loud speakers). Finally, Purdue University has overseen the overall coordination of the project as well as the monitoring, evaluation, and development of the supply chain. Numerous visits undertaken by Baributsa to Tchad helped Purdue play this role efficiently.

National Coordinator: ASSAILD

ASSAILD is a Tchadian NGO founded in 1985, after the wars of 1979 in Tchad. Initially, ASSAILD focused on supporting farmers by providing credit for agricultural inputs and equipment. Over years, ASSAILD added other goals to its initial mission, such as the improvement of people's behavior through psychological empowerment in the field on entrepreneurship. Activities undertaken to support farmers are the creation of agro-pastoral farms, fishery, land conservation, and promotion of family farming. ASSAILD also works with farmers' organizations, supporting farmers' cooperatives and unions to develop income-generating activities. It also strengthens individual production and trains farmers on marketing and group sales to control the price in the marketplace. At the community level, ASSAILD empowers communities to have a vision for the village through the initiation and implementation of long-term projects or activities and assists them in the conception of development plans at the township and village level. Since 1997, ASSAILD's actions were focused on family, groups, and communities. Their sole current partner is the Swiss

Cooperation. Many partners have left because of the insecurity issues associated with Tchadian petroleum production.

Initially, the PICS project team at Purdue contacted WV-Tchad to conduct PICS activities, but WV-Tchad has declined this offer for security reasons. ASSAILD was therefore suggested to the Purdue team and, after some technical discussions, a cooperation contract was signed between both parties in 2010. Later on, the PICS team at Purdue and Lela Agro went to Tchad to meet with PICS partners and discuss the supply and distribution of PICS bags. This offer was a challenge for ASSAILD. PICS technology was appreciated by the populations, and also by ASSAILD because the objectives of the project matched perfectly with the vision and mission of ASSAILD. During the first year of the implementation of the project, a contract was signed with five community radios and, in the second year, with nine community radios. Moreover, ASSAILD has signed contracts with some NGOs to implement activities in their areas. These NGOs are Bureau d'Etude et de Liaison pour l'Action Caritative de développement (BELACD), based in SARH and in Koumra for the implementation of PICS activities; Tchadian Association for Rural Development (ATADER), based in Doba (oil region) for the implementation of PICS activities and for PICS bags sale; Farmers' Associations of Kabbia (AOPK), based at Gounou-Gaya for activities implementation and PICS bags sale; and Association for Rural Promotion (APR), based at GUELENDENG region.

The demonstrations were organized in 200 villages during the 2010-2011 cropping season and 700 villages in 2011-2012. In each village, six bags were distributed to farmers for a total 1,080 bags in 2010-2011, and 3,000 bags 2011-2012. The bags were procured through the national partner ASSAILD by Purdue in equal amount from the two distributors (Adoum and Kongobé) at 1,100 FCFA/bag.

The NGOs contracted by ASSAILD submit regular reports for activities performed. In 2010-2011, nine facilitators were hired by ASSAILD to cover activities in Tangile, Western Logone, and part of Eastern Logone. In 2011-2012, activities were carried out in Eastern Logone, in particular by ATADER, by four facilitators, BELACD by six facilitators, APR by four facilitators, AOPK by seven facilitators and N'Djamena by one ASSAILD facilitator.

The marketing strategy for PICS bags included caravans. Caravans were organized in weekly markets over the two years of project implementation. It consisted of sensitizing traders about PICS technology and demonstrating how to use the bags efficiently. The caravans were financially supported by ASSAILD for 70% and by the two national distributors for 30%. In N'Djamena, some demonstrations were performed in the markets by an ASSAILD facilitator. The radio ads were entirely financed by the PICS project. PICS messages were also published in newspapers such as N'Djamena Hebdo and in Tchad et Culture in 2012. Institutions that attended the open-the-bag ceremonies were FAO, WFP, Ministry of Agriculture, local NGOs, farmers' organizations, media, and the regional authorities. This event was chaired by the Governor.

CECADEC

CECADEC is a Lutheran church sponsored NGO created in 1988 and headquartered in Pala, Tchad. Its vision is to spread the Gospel and improve social welfare. Its mission is to promote holistic and sustainable development through poverty reduction in rural areas, particularly in West Mayo-KEBRRI, Mayo-Pala, Lake LERE, and Kabbia (Gounou-gaya). The main activities include the organizational development of farmers' associations, rural financing, sustainable agriculture, food safety, livestock, and training.

In February 2010, CECADEC was contacted by the PICS team at Purdue. A contract was signed in March 2010. Twenty villages were targeted, with twenty facilitators and ten field technicians hired. Major tasks performed include demos, monitoring, open-the-bags events, and reporting.

Other Partners of CECADEC include: the Evangelical Alliance Relief Fund of the United Kingdom (Tearfund), which main objectives are training in environment management, standards and quality defined by humanitarian organizations, and technical advocacy; International Peacebuilding, Relief and Development Organization (CORDAID), which partners with Tearfund and is responsible for refugees from Tchad and Sudan and bought PICS bags to store cowpea and groundnuts to feed the refugees; and Mennonite Central Committee, which provides financial support to vegetable farmers to buy and seeds and production equipment.

Business consultant

Mr. Christophe Lontchi was recruited in April 2010 during the visit of Lowenberg-DeBoer, Baritbusa, and Sobda. Several reasons explain why Lontchi was selected as a business consultant. Lontchi has known Lowenberg-DeBoer since the 1990s within the framework of cowpea research in Cameroon. Lontchi is aware of the problems associated with cowpea storage. Lowenberg-DeBoer was also aware of the work performed by Lontchi on post-harvest research on cowpea. He had conducted some trials on triple-bagging with the use of ordinary plastic bags to store cowpea, but this experiment had some limitations. He also worked with Hammond (FAO Consultant) on the cowpea-FAO project. As a business consultant for PICS, Lontchi introduced PICS bags to institutions and projects such as FAO and WFP, and he explained how the bags must be used for an efficient result through the information in the PICS posters. Moreover, Lontchi was involved in the training of the technicians, semi-wholesalers, and journalists. He kept track of the volume of bags sold by the wholesalers and semi-wholesalers. He also helped the wholesalers to expand the distribution network. He provided strong support to ASSAILD, particularly in the organization of training, the identification of trainees, and providing technical advice.

Wholesalers

Case of Joseph Gandar and Mahamat Adoum

Gandar and Mahamat are the national distributors of PICS bags in Tchad. Gandar is a nurse, retired since January 2003. He had worked at the LAI Hospital in N'Djamena. ASSAILD also chose his cousin, Adoum, to help him in the distribution because he is a businessman. Gandar provided funds to Adoum to lead the supply and the distribution of

PICS bags, and they both were to share the profits. There was a lack of confidence between the two men in 2010; therefore, Gandar decided to lead the distribution of the bags by himself. He approached ASSAILD, which gave its approval. Before PICS, Adoum sold building materials and oil containers with Coton-Tchad.

In 2010-2011, PICS bags were ordered directly from Lela Agro in Nigeria. The two national distributors each provided 3,500,000 FCFA to order the bags (7,000,000 FCFA total). The transportation cost from Kano, Nigeria to Tchad is estimated at 200,000 FCFA. In 2011-2012, 3,500,000 FCFA of capital was invested for PICS bags procurement. The transportation cost was estimated at 100,000 FCFA. Because of lack of confidence, Gandar asked his nephew Jean-Marc Bayouyeux (an economist) to monitor the sale of PICS bags with Adoum.

The second order from Lela was challenging for several reasons. First, the money was not paid on time to Lela. Secondly, the bales of bags did not reach the doorstep of the distributor at Moundou because of a lack of money to pay for the transport. They were blocked at Maiduguri, Nigeria for months. Thirdly, the size of the bales (300 bags) is too big to be handled by public transportation. To bring the bales to Moundou, they had to repackage the bags in bales of 150 bags. This repackaging cost 300,000 FCFA. The transportation cost to ship the bales to Moundou was about 20,000 FCFA/bale or 1,620,000 FCFA total for the 56 bales. The remaining bags (seven bales of 300 bags) were not shipped to Moundou, they were instead held at Maiduguri. The hold was removed when Gandar met with Lela Agro in Kano to resolve the situation. According to Gandar, the second order was a loss because of the high transaction costs (transports, freight, repackaging, high travel expenses, and communication fees).

With respect to the sale, the per unit price of the bag is 1,250 FCFA on credit, 1,200 FCFA on cash-and-carry basis for quantities of less than 300 bags, 1,150 FCFA for quantities of 300-500 bags, and 1,100 FCFA for quantities greater than 500 bags.

Case of Mr. Martin Kongobé, wholesaler of PICS sack in Tchad

Kongobé is one of the larger traders of Moundou in Occidental Logone since 1998. He sells various articles, including cosmetics, books, motorcycles, electrical appliances, car rental, and real estate. He supplies corporations, and he is a shareholder in an insurance company in Tchad. Mr. Martin also has a photo studio, a construction company, a bookstore, and a hostel at Toumaï. He was selected by the Purdue team with the assistance of ASSAILD. Kongobé and Adoum received the four bales of 300 bags in September 2010. In June 2011, he received 35 bales of 300 bags each from Lela Agro. In September 2011, he ordered 2000 bags from GIC-DEMRI in Garoua, and 900 bags from Gandar in N'Djamena. During the cropping season of 2010-2011, 1,175 bags were sold at 1,300 FCFA each in Moundou and at 1,325 FCFA each in Deli. In 2011-2012, 7,736 bags were sold. Bags were delivered to semi-wholesaler on a consignment basis or with a 50% of down payment, with the balance paid when 50% of the quantity the semi-wholesaler received is sold.

The retail price varies according to the location the bags are shipped to. Bags delivered at Koumra are sold at 1,300 FCFA because of the transportation cost estimated at 3,000 FCFA per bale of 150 bags. ATADER purchased 2,000 bags on credit at 1,250

FCFA/bag because of bulk purchasing and because it bore the transportation cost to distribute the bags in the villages.

During the caravans, PICS bags were sold at 1,500 FCFA per bag for quantities of less than 20 bags, 1,400 FCFA for quantities of 30-50 bags, 1,375 FCFA for quantities between 50-100 bags, and 1,350 FCFA for quantities greater than 100 bags.

Semi-wholesalers

CECADEC

In 2010-2011, CECADEC bought 100 bags for demos and 450 bags for sale from Adoum. In 2011-2012, 1,100 bags were purchased for demonstrations and 1,340 bags for sale. The purchasing price was 1500 FCFA/bag, and the selling price was 1,750 FCFA/bag. Some bags were placed on consignment to retailers in some villages, including Fama, Torrock, Lere, Poudoué, Mabadjin, Guendeu, Lagoon, Poutchili, Bissi Mafon, Zambreo, Keuni, Kourayadjé, Small Salama, Mar, and Pala at CECADEC's store.

Among the 550 bags ordered in 2010, 94 remained. In 2011, there were 77 bags with defects among the 1,350 ordered, and 12 bags remained. Moreover, CECADEC ordered 1,000 bags from GIC-DEMRI at 1,100 FCFA per bag delivered to Guider. CECADEC shipped 400 bags from Guider to Lere. The transportation cost was 70,000 FCFA. Some of the bags were left at Lere, and the rest were distributed gradually to various outlets. Other expenses incurred were the travel expenses to Garoua (280,000 FCFA) and 148,000 FCFA for travel costs for the distribution of bags. Gandar purchased 1,340 bags delivered to Pont-Carol (75 km away from Pala) at 1,100 FCFA per bag. The bags were sold at 1,350 FCFA. The margin for retailer is 100 FCFA per bag and 150 FCFA for semi-wholesalers.

ATADER

ATADER sells PICS bags in the weekly markets, which include the following:

1. BODO market (Every Saturday): Tc2 is the retailer in this market. He is a member of ATADER and have received 400 bags
2. Béboto market (Saturday): Tc3 is the retailer in this market and a member of the ATADER. He also received 400 bags
3. MABOMBAYE market (Tuesday): Tc4 is the retailer and a responsible of the youth training center. He received 600 bags.
4. MONGO market (Daily market): Tc5 is the retailer in this market and a member of ATADER. He received 100 bags.
5. BENDOH market (Wednesday): Tc6 is the retailer and a member of ATADER. He received 200 bags.
6. Bébédja (daily market): Tc7 is the retailer and a member of ATADER. He received 40 bags.
7. NORTH GORE (Friday): Tc8 is the retailer and a facilitator of ATADER. He received 150 bags.
8. Becada market (Sunday): The retailer is a businessman. He received 300bags.
9. DONIA (daily market): the retailer is Tc9.

10. DOBA (daily market): Doba is the headquarters of ATADER where PICS bags are kept.

This association has made three orders of 3,000 bags, 500 bags, and 400 bags. The wholesaler for ATADER is Kongobé. ATADER receives the bags on consignment. For the first order of 3,000 bags, 1,000 bags were picked up by Kongobé to take to Bédjondo awy, 45 km away from DOBA. Bags were delivered to DOBA at 1,250 FCFA/bag and retailed at 1,500 FCFA/bag. The wholesale price was 1,425 FCFA. Kongobé opened a bank account at the Société Générale Tchadienne where PICS bags funds were wired. At each market day, retailers come to ATADER's headquarters to deposit PICS bags sales money. Money was also picked up during field visits by the technicians against receipt. Retailers were loyal and honest and fulfilled their commitments.

For the demos, ASSAILD provided the bags to ATADER. The amount of bags given for demos is 360 bags. The main customers of ATADER are cowpea producers, collectors, cowpea sellers and big producers. Partners of ATADER included the European Union, Intermón Oxfam, FAO, Association for International Development (AFDI), Bureau d'Etude de Lliaison Caritative de Développement (BELACD), Organization of Civil Society Network (ROSOC), and ASSAILD.

AOPK

AOPK is a farmer organization created on November 7, 1992 and officially registered on December 7, 1999. The association has 47 groups and 1,500 farmers' associations composed of both men and women. AOPK was involved in PICS activities during a workshop in Eirene organized jointly by ASSAILD and AOPK. It was at this workshop that ASSAILD had presented PICS bags and to the director of AOPK. When the director of AOPK went back, he briefed AOPK members who accepted the opportunity during a general assembly. He presented the samples of PICS bags given to him by ASSAILD. Before the involvement of AOPK, some farmers of AOPK had bought the bags from CECADEC or from retailers of Pont-Karole. They liked the bags and testified during the awareness building activities in the villages.

Details of AOPK's contract with ASSAILD include coverage, with two departments including Kabbia and Mount ILLI; seven facilitators, with three at Kabbia and Mont-ILLI, who were trained by ASSAILD; and a one-year contract from 2011-2012. Activities included awareness raising, demonstration, and monitoring.

Villages selected included Kabbia (45 villages, 5 farmers/villages, 6 bags/village) and Mont-Illi (59 villages, 5 farmers/villages, 6 bags/village), for a total of 104 villages and 624 PICS bags demonstrations.

Of the seven facilitators, two are members of an ONDR (Office National de Dévelopment Rural) in Kabbia); four ONDR were chosen on individual basis with individual contracts (Mont-IIIi), and the different agents were chosen because they have means of travel.

In 2011, AOPK ordered 500 bags from Gandar. The bags were delivered in Pont Karol at 1,200 FCFA/bag. AOKP received logistics support from the district head to deliver

the bags at Pont-Karol to Gounou 33 km away. The bags were delivered on a cash-and-carry basis. To sell the bags, AOPK displayed the posters in public venues to inform people about the technology. During the demos, facilitators held some additional bags for sale. AOPK sold the bags at 1,400 FCFA per unit to retailers. The facilitators sold the bags at 1,500 FCFA and earned 100 FCFA/bag. If a producer buys the sack at the AOPK store, the price is 1,500 FCFA/bag, leaving the retailer with a margin of 100 FCFA per bag sold. Moreover, AOPK undertook some market demos, including in Pont-Karol market, Berem market, Djodogassa, Nghette, Gang, and Gounou-Gaya markets. Bags were delivered on credit to the facilitators. AOPK placed 150 bags in a store at Fianca, 72 km away from Gounou-Gaya. Facilitators could take bags from Fianca instead of coming to the center AOPK. The current inventory is 42 PICS bags. The distribution network of AOPK is composed of seven animators, a sentinel, and a merchant. Clients are members of AOPK, cowpea producers, traders, and families.

Traders

Case of Tc10

Tc10 is a semi-wholesaler of PICS bags at SARH region. He travels extensively for his business in West and Central Africa. He is a general trader, selling a bunch of house and office materials. He also has a travel agency and a bar-restaurant. He is in contact with BELACD people, who proposed him as a distributor of bags. He has organized a team to inform and build community awareness through radio ads. He has retail outlets in nine townships to sell PICS bags to retailer. The nine townships include the following:

1. Baliba: Tc11 is a retailer at this place. He sells ordinary bags for millet in the weekly markets. He has received 50 bags
2. Joli: Tc12 is the retailer and has received 38 bags.
3. Koumogo: Tc13 is a retailer. He is seller of sugar. He received 84 bags from Tc10.
4. Danamadji: The retailer at this location is Tc14, a relative of Tc10. He is the best seller and has sold 120 PICS bags.
5. MOUSSA Foyo: Tc15 is the retailer. He is a cousin of Tc10. He received 60 bags
6. SARH: This is the main shop in the market, opened on a daily basis.
7. BANDA: PICS bags are distributed at this location by Tc16. He received 50 PICS bags.
8. KOKAGA: PICS bags are distributed by Tc17, a trader of millet. He has received 25 bags.

Tc10 ordered 500 bags from Kongobé. The bags were delivered to Moundou at 1,300 FCFA per bag and sold at 1,500 FCFA at Sarh. The means of transportation of the bags from Moundou to Sarh was done by Tc10's vehicle. At order, 50% of the total amount is provided as a down payment, and the balance is paid one month after delivery. The money is paid into the bank account (Eco-bank) of Kongobé. The retailers or roaming vendors have a special payment policy. They receive the bags on consignment from the semi-wholesaler at 1,350 FCFA per unit and are paid back one week after. The bags are sold at 1,500 FCFA per unit. The gross margin is estimated at 150 FCFA.

Retailers

Case of Tc1

Tc1 is a dealer and has one warehouse and a shop. He is a retailer of PICS bags in the Lere market. He was involved in PICS through CECADEC. He received 100 bags from GIC-DEMRI. He sent ten bags to a friend at 1,250 FCFA/bag, who sells it at 1,00 FCFA/bag. He sent to his little brother nine bags at 1,250 FCFA/bag and sold six bags himself. The rest of the bags were burned (75 bags) in the fire that occurred in his shop on January 19, 2012.

Farmers usually store cowpea in cans and containers. They are used to their traditional storage methods. It will take time for them to be well informed about PICS technology and the advantages associated with it before using it. This year, cowpea production was not good due to lack of rain. The sale of PICS bags was affected. He suggested assisting farmers improving their production through quality seeds access, as well as appropriate pests and diseases control in the field to increase the volume of cowpea stored.

Case of Tc18

CECADEC hired facilitators according to activities planned. Activities included making contacts with communities, awareness building about PICS technology, the importance of storing cowpea, and demos of how to use the bags. The demos were scheduled for twelve villages; five farmers were selected per village and one bag was given to each farmer. Facilitators recruited also monitor farmers selected for the demos till the open-the-bags event. Unfortunately, cowpea production in 2011 was not good despite the three production periods. In general, cowpea is produced three times a year: July-September, October-November, and January-February where water has receded.

CECADEC store at Lere

PICS bags are sold in the CECADEC store located in Lere. This store represents a place where facilitators can get the bags from. In total, 104 bags were stored in this center, and 60 were sold. The selling price to farmers is 1350 FCFA/bag. The margin is estimated at 100 FCFA per bag.

Producers' center

The producers' center is founded in 2000. This center is a pilot project of the government which encompasses a former fishermen association. After the public demonstrations, facilitators were engaged in the sale of bags to producers and other users. Facilitators assisted farmers' associations that have warehouses to store grains during the lean period to use PICS bags. In total, 104 farmers' associations and 30 women associations were sensitized for the use of PICS technology. These associations constitute a veritable potential for PICS bags. Facilitators want to use this potential to boost and increase the sale of PICS bags.

Case of Tc19

Tc19 is a retailer of PICS bags in the Pont-Karol market. He has a shop and was involved in PICS business since November 19, 2011. Initially, PICS bags were sold by Tc20 who retailed them at 2,000 FCFA/bag. This price is perceived to be very high for Gandar, who decided to take back the bags because of the low sales. Tc19 was selected to distribute the bags. He received 135 bags on consignment from Gandar at a price of 1,200 FCFA/bag. Bags were sold at 1,500 FCFA/bag. He received a second batch of 62 bags which were almost all sold; only four bags remained. A sales representative of Gandar collects the money as long as the bags are sold. Both Gandar and Tc19 communicated via phone calls to monitor and track the sale of the bags. Customers are generally cowpea producers and some producers of bambara nuts (Voandzou).

Case of Tc21

Tc21 is a retailer of PICS bags in Kelo market and at her house since 2010. She sources the bags from Adoum. In 2011, she received the bags from Gandar. In 2010, 300 bags were received on consignment at 1,600 FCFA per bag and sold at 1,750 FCFA per bag, but sometimes at just at 1,600 FCFA to attract customers. In 2011, 300 bags were also received on consignment at 1,250 FCFA per bag and sold at 1,500 FCFA per bag. Bags were sold on a cash and carry basis. The majority of customers are cowpea farmers and traders.

Case of Tc22

Tc22 is a grains trader in the millet market at Moundou and a retailer of PICS bags since the cropping season of 2010-2011. He was selected by Kongobé because he knew him as a merchant of grains in the market. He has a store which can keep 2,000 PICS bags. He received 300 bags from Kongobé at 1300 FCFA and sold at 1,500 FCFA. Tc22 experienced a rupture problem in December 2011. In January 2012, he had a new stock of 1,00 bags to overcome the rupture issue. His customers are producers but also some merchants from neighboring villages who buy in bulk. He rented his store at 25,000 FCFA per month. He pays 10,000 FCFA each month to the caretaker and 1,500 FCFA per month as municipal tax. He also sublets the store to merchants and producers to store their product at 100 FCFA per 100kg bag filled with grains each month.

Case of Tc23

Tc23 is a merchant and retailer of PICS bags. She is a niece of Kongobé and has a bar and a restaurant. She was involved in the sales of PICS bags through Kongobé. She received the bags on consignment and retails them or sells in bulk. She lives in Doba, but she has outlets in Bangui, Central African Republic. Traders from Bangui have heard his name on the radio. Traders from Bangui procured the bags through their peers who go to Tc23's store in Doba to buy commodities. Bags are received at 1,350 FCFA/bag and sold at the same price without any profit at Doba. She has a street vendor who goes from village to village to sell the bags at 1,500 FCFA/bag. Other locations covered by Tc23 include Koumonvo, Mangaka, Maigobaye, Bangui, and Gore. She had received 1,800 bags and the

inventory is about 30 bags. Her customers include producers, retailers and semi-wholesalers. She experienced a rupture in January 2011.

Case of Tc24

Tc24 is a retailer of PICS bags at Sahr and an older sister of Kongobé. She has been involved in PICS bags in 2011 and had received 220 bags. She sold 184 bags and wired the money to her brother's bank account. The bags are received on consignment at 1,500 FCFA/bag and sold at the same price. For her, she is helping her brother because this is a family issue. Customers of the bags are cowpea traders and cowpea producers. To boost PICS bags production, local radios ads were broadcast with her name and her location.

Case of Tc25

Tc25 is a trader at Bongor market and belongs to Gandar's distribution network. He sells PICS bags in his shop of shoes and bags. The shop is in the market and is always busy with customers. He complained about the caravan organized in his market place, an event at which PICS bags were sold at 1,000 FCFA/bag. Since then, the market got spoiled because people were not willing to buy the sack at 1,500 FCFA/bag again. They wanted it at 1,000 FCFA. He was frustrated by the promotional sale of the caravan. Tc25 procured the bags at 1,200 FCFA per unit from Gandar and sold them at 1,300 or 1,350 FCFA for bulk buyers and at 1,400 or 1,500 FCFA for those who purchased few quantities (1-3 bags). With respect to the order, he received 300 bags in November 2011 and had sold 85 bags. Buyers came generally from Boulkou village. He paid someone to move from market to market to advertise the bag. He says that people are becoming more familiar with the bags and expects an increase in sales the following cropping season.

Case of Tc26 in the Guelendeng market

Both members of this married couple are traders and producers of peanut, cowpea, and millet. They are roaming vendors and sell PICS bags in weekly markets or at home at 1,500 FCFA/bag. At Ba-illi, Tc26 has an outlet where he leaves PICS bags for sale. PICS bags are sold in other markets such as Ba-Illi on Saturday, Sanang on Sunday, Moulkou on Tuesday, Gounaida on Friday, and Guelendeng on Monday. The main customers are traders and producers from Guelendeng and surrounding villages like Onoko located near the Chari River.

PICS project partners

Case of ATADER

ATADER is the Tchadian Association for Rural Development with actions oriented towards to rural areas. This NGO derived from an Association for International Development (AFDI) project, a French NGO whose mission is to promote farmers' organizations and group them in a federation. After the withdrawal of the French in 1999, ATADER was born and became operational in 2001. ATADER is composed of five federations of farmers and manufacturers of agricultural equipment. Farmers are trained on how to manufacture agricultural equipment. ATADER is composed of ATECOR, a group of

women whose principal activities is marketing, processing, and training; AR, a group of people that use agricultural equipment in common; a maintenance service which manufactured and fixes equipment; and, ATEQAR.

The federations are composed of 15,000 members and have an antenna in Donia since 2001. The federations were invited by ASSAILD to participate in the PICS training of technicians in Koumra in August 2011. ATADER signed a contract with ASSAILD to perform project activities in 60 villages. Four facilitators and one assistant-facilitator were assigned for fifteen villages. Five producer volunteers per village were chosen to hold the demos. Activities performed were awareness building campaigns, demonstrations, and monitoring.

Case of BELACD in Koumra

BELACD is a Catholic NGO which led the technical activities of PICS with no direct involvement in the sales of the bags. There is no semi-wholesaler in the region of Koumra. Kongobé organized caravans at the weekly markets in the region of Koumra for sale. T here are three private retailers who buy and sell during the caravans. The retailers are a woman from Koumra city, a young man from Koumra Tchad Cotton, and a man from Koko Village located 18 km from Koumra city. The markets were the caravans were organized at Peni, Bedgoudo, and Koumoura.

BELACD focuses on agriculture, livestock, education, health, microfinance, and processing of agricultural products. Their main partners are Mesercor (for financial support) and Caritas Switzerland. With respect to PICS, BELACD partners with ASSAILD for a wide dissemination of PICS information. BELACD is convinced of the effectiveness and importance of PICS bags for cowpea storage. They have a contract with ASSAILD to build public awareness about PICS technology for fifteen days, lead public demos for fifteen days, and organize the open the bag events for approximately fifteen days in May 2012. They have twelve facilitators, each of them perform works in fifteen villages, except one facilitator who works in fourteen villages. The total number of villages covered is 179. Facilitators deliver the bags to producers who live in remote villages.

Case of BELACD in Sarh

The BELACD at Sarh is the PICS project partner in the location of Sahr. They are members of Caritas International. This NGO is also called BELACD-CARITAS and was created more than 30 years ago. Its mission is to promote agriculture, livestock, improve water and sanitation, support education, and improve the health of the people in rural areas. BELACD-CARITAS has a contract with ASSAILD to perform project activities in the Sarh region. Two years ago, under a donors' proposal, BELACD was restructured into administrative and operating components. The Administrative team is composed of a director, an administrative assistant, a manager, and an accountant. The operating component was organized into six departments, including the health department, the socio-economics department, the agriculture department, the livestock department, and the environment, water and sanitation department.

Regarding PICS activities, the area covered by this NGO was the Middle-chari. PICS activities covered six out of the 33 cantons: Balimba, (fifteen villages supervised by one animator); Djoli (fifteen villages); Banda (fifteen villages); Danamadji (fifteen villages); Foyo-Moussa (fifteen villages); and Koumogo (fifteen villages). The NGO has six extension agents of facilitators and trainers and one civil engineer per canton.

Case of AOPK in Gounou-Gaya

As described earlier, AOPK is a farmer organization composed of unions and groups. The mission of AOPK is to reduce food insecurity by storing food products and sell during the lean period at an affordable price to ensure food self-sufficiency. The food is generally bought at harvest time when the price is low price. Another activity performed is to facilitate communication and cooperation between farmers on farming techniques, the dissemination of improved varieties, training of seed farmers, capacity building of farmers in crop management and support farmers' associations to get registered. Other activities include assistance in funding seeking through proposal submission, support income generating activities, promote small processing units and techniques, and grains storage and sale.

Case of APR

The APR is the rural self-promotion association created in 1993, but officially registered in 1994. The main target groups of APR are women groups in rural communities. Major activities are agricultural production support, rural water, food security, the environment, violence against women, and assisting in both developing and implementing development projects.

APR also works with women's groups: Nanguigoto, Guelendeng, and other associations from various locations in the country. APR was contacted by ASSAILD to lead activities such as awareness building, demonstration, monitoring, and open-the-bags events. For the village demos, 306 bags were sent by ASSAILD, but all were not used because the demos were not carried out in four villages due to low cowpea production.

<u>Challenges faced in developing the supply chain</u>

For wholesalers and semi-wholesalers living at Moundou, the transaction fees (transportation cost, repackaging, incidentals, taxes, etc.) is higher, leaving chain actors with low margin.

The unavailability of bags in certain places created ruptures. Sometimes to overcome the rupture problem, buyers went to the semi-wholesaler instead of relying to retailers only.

The late delivery of bags negatively affected the number of bags sold because some farmers sold their cowpea.

The low production of cowpea during the 2011-2012 campaign due to low rainfall (the rain stopped earlier than planned) also reduced the quantity of bags sold. There was also a general unavailability of early maturing cowpea seeds to cope with the short duration of rainfall.

The unique application of the bags (bags designed only for cowpea) limited the sale.

The lack of means of transport and the difficulty to find reliable and committed people to sell the bags affected the expansion of the network.

The size of the bale (bales of 300 bags) was difficult to handle and to ship using public transportation because of the weight.

Lack of information on PICS technology and its use, especially at the vicinity of the Cameroon-Tchad border, has led to misuse of PICS bags.

The manufacturing defects and the missing bags in bales impacted the demand for the bags

The inappropriate baling at the factory favored the theft of bags during the transport.

The organizations of the caravans were challenging due to lack of motivations (low incentives) and also difficulties in convincing people who are already accustomed to traditional methods to store cowpea.

There were negative effects of promotional price during the caravans on retailers' sales in localities where the caravans took place.

Risks

One risk is the influence of the vicinity of Nigeria cowpea market; this renders the forecast of the volume of cowpea to store difficult. A second risk is the production of counterfeit cheaper bags in border markets because it dampens the demand for PICS bags in the market. Third, the decline in rainfall weakens the production of cowpea and thus the availability of volume of cowpea stored. Last, the decline in research experiments on certified seeds of cowpea may be a threat for cowpea production over time.

Strategies developed to encourage private actors' investments

The main strategies developed by PICS project to encourage private investments are numerous and include: bulk purchase of bags for demos from the wholesaler by the PICS project (680 villages and five demos' farmers per village) to boost the sale of the bags; the hiring of a business consultant by the project to help the wholesaler develop the distribution chain; the signing of contracts with radio stations to organize and handle the communication component of the project: the awareness building (through poster, media, public

demonstration, monitoring, marketing and OBCs); the organization of training for wholesalers and semi-wholesalers in 2010 and 2011; the training of NGOs and journalists in 2010, 2011 and 2012; the organization of caravans in the weekly markets by wholesaler and ASSAILD; and the Assistance of the PICS team at Purdue in negotiations with Lela Agro, Wholesalers, GIC-DEMRI, and some big potential buyers.

Solutions to expand the supply chain via increased private sector investments

Support the production of cowpea through improved seeds, and encourage the use of non-chemical method to control pests and diseases in the field. CECADEC suggested to IITA to help obtain appropriate varieties such as short-season varieties.

Strengthen women's groups on the processing techniques of cowpea. They are not aware of most of the cowpea processed products.

Expand the distribution network by encouraging wholesalers to go a little further than their current network, in particular in major cowpea production niches.

Strengthen the promotion of the bags by asking the cooperation of all chain actors (wholesalers, manufacturers and retailers) to find the best and appropriate strategies. Lela Agro must find incentives to strengthen the promotion of PICS bags. Incentives may include messages on t-shirts, price promotions, rewards of the best sellers, among other things.

Increase public awareness to improve understanding of the usefulness of the bags as well as the economic benefit.

Radio messages should focus on where to buy the bags and the full names of the sellers, as well as their contact information.

Continue training of technicians/facilitators for a widespread use of the bags. Chain actors can get a financial support from small projects from the food security component.

Allow early distribution of bags (by September 15) to semi-wholesalers to avoid delays in the downstream of the chain.

Repackage the bales of 300 bags into bales of 150 bags before shipping them.

Review strategies for organizing caravans in markets by involving semi-wholesalers and retailers operating in the targeted market.

The government can get involved in PICS business by exempting the bags from taxes.

Increase involvement of civil society in promoting the technology through the food security initiative.

Support research work on improved varieties of cowpea adapted to Tchad. Funding may come from partners including IITA, Institut Tchadien de Recherche Agronomique pour le Developpement (ITRAD), Purdue University, and other research centers.

Strengthen the dialogue with potential cowpea volume buyers about the effectiveness of PICS bags.

Continue media efforts to support the distribution of PICS bags. Chain actors Lela Agro in particular, and, to some extent, GIC-DEMRI, must find incentives to strengthen the promotion of PICS bags. Incentives may include rewards to the best sellers, promotional price, among other things.

Lessons Learned

A new network developed by the wholesaler himself for PICS bags distribution is an asset for the development and sustainability of the distribution chain.

Bulk purchases through volume buyers (i.e., NGOs, projects) contribute significantly to the evolution of the chain and incentivize chain actor through volume sales.

The involvement in the chain of roaming vendors, shopkeepers (i.e., commercial agents) contributes significantly to increase sales and the turnover rate.

The successful coordination mechanism, monitoring and evaluation, and planning between project partners (Purdue, ASSAILD, CECADEC, ASSAILD NGOs, technical partners, media coverage, and the business consultant) is an important factor for the success of the supply chain.

Personal motivation, good perceptions of PICS bags, and a good understanding of inputs markets by wholesalers and actors in the network are key determinants of success and sustainability: the cases of Gandar and Kongobé are illustrative of this.

The experience of the wholesaler in regional trade (import-export) is a determining factor in the success (profitability) and sustainability of the PICS bags distribution chain.

The moral guarantee offered by the project (Purdue University) is important for the wholesaler vis-à-vis the manufacturer.

Technical support of the in-country partners is essential for further training and diffusion of PICS bags, particularly when the project phases out.

Border markets are real channels of PICS technology diffusion, but the risk of misapplication of technology by uninformed and untrained users may hinder the sustainability of the supply chain.

Volume buyers (i.e., NGOs and various projects) contribute significantly to the evolution of the chain and a source of incentive for chain actors.

Roaming vendors' involvement contributes significantly to increase sales and the turnover rate of the bags.

The strong dependence of the wholesaler on the project is a weakness to be overcome to ensure the sustainability of the distribution chain.

ANNEX

Figure 1: Map presenting the distribution network of PICS bags in Tchad

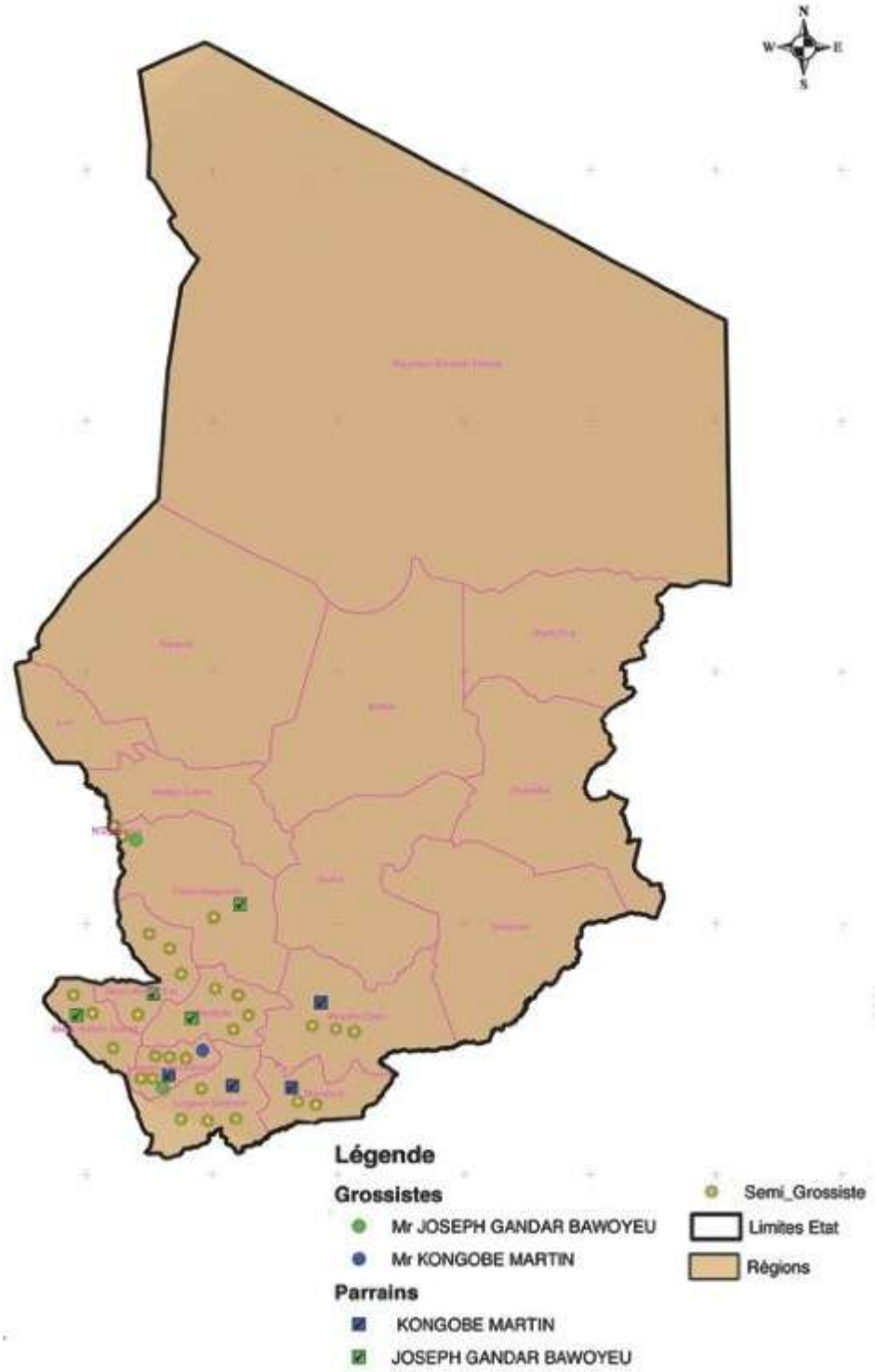


Figure 2: **Supply chain of PICS bags in Tchad**

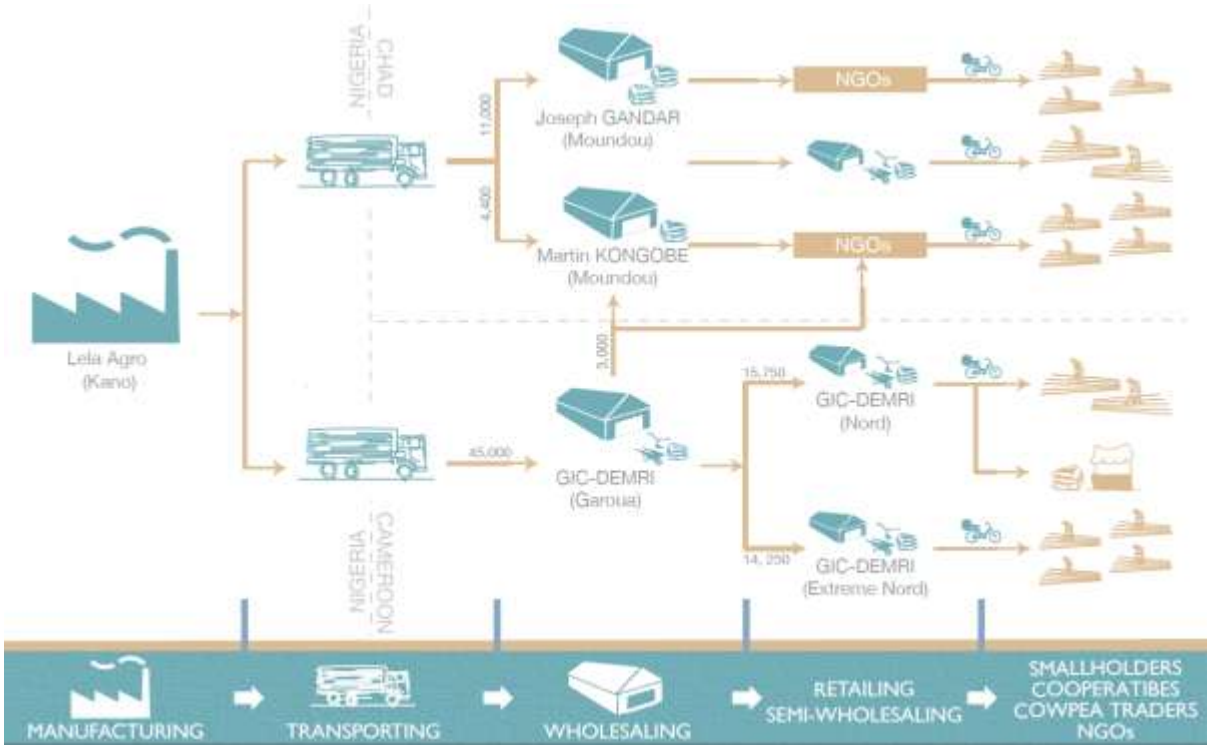
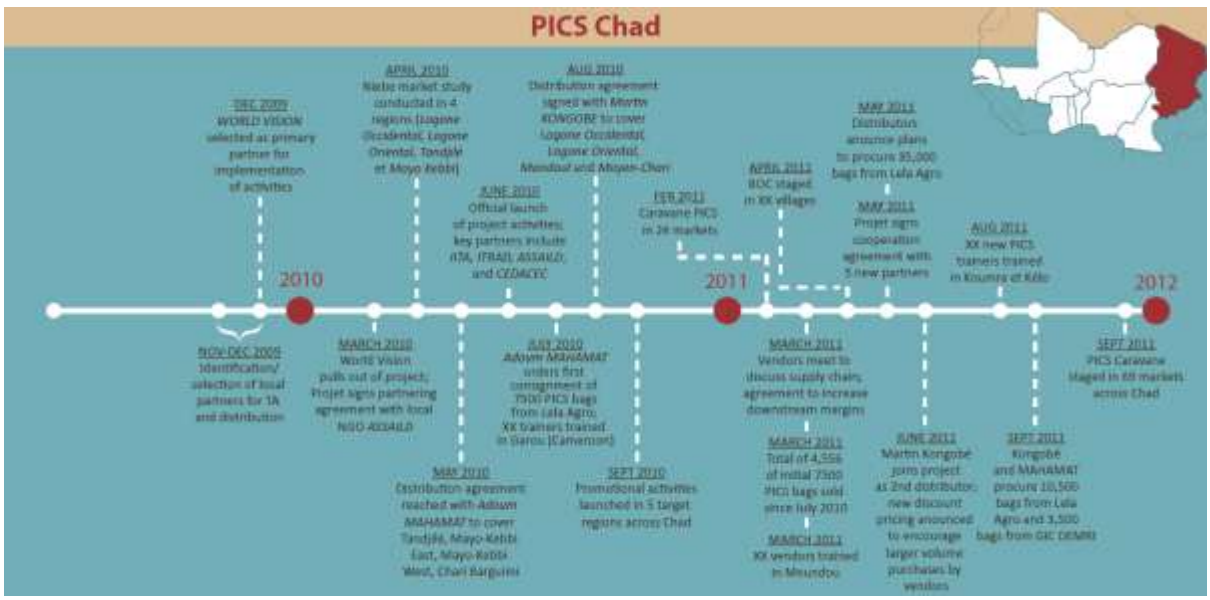


Figure 3: **Timeline of PICS projet in Tchad: 2010-2012**



TOGO

Presentation of the PICS supply chain case study

Cowpea production in Togo represents about three percent of the total annual cowpea production of West and Central Africa. Togo exports its cowpea to Benin but also to Nigeria, Ghana and other countries in Central Africa. To boost the production and to strengthen cowpea market in Togo, Purdue University has implemented the PICS project in Togo, along with nine other countries in West and Central Africa.

PICS started with its activities during the 2009-2010 cropping season in Togo. The major components of the project include: the technical component, which consisted of building actors' awareness, conducting public demonstrations, monitoring farmers who stored cowpea in PICS bags, and organizing the public OBCs by CERPA with assistance of IITA; the marketing and communication component led by the business consultant/journalist; and, the sale and distribution of the bags led by the national distributor (Mr. Leopold Gansou) with the support of the business consultant (Prosper Batana). The outreach activities were conducted by Institut de Conseil et d'Appui Technique (ICAT), with the technical support of IITA during the 2009-2010, 2010-2011, and 2011-2012 cropping seasons.

Current situation

Gansou has been the national distributor of PICS bags in Togo since 2009. He sources the bags from Lela Agro. Since 2009, only one order was made: 25,000 bags, of which 12,700 bags were destined for Togo and delivered to the Benin-Togo border at 850 FCFA/bag. From the border, the bales of bags were received by IITA-Cotonou. The bales were exempted from taxes because of the use of IITA agreement with Benin as a non-profit organization. The bales were then conveyed to Togo by the wholesaler with the institutional support of ICAT. For the first order, Gansou directly invested 20% of the cost (or 4,250,000 FCFA) and Purdue University invested the remaining 80% (or 17,000,000 FCFA) in 2009, according to the terms of contract signed by the two parties. Funds paid by Purdue University were to be reimbursed by Mr. Gansou gradually as long as the sales evolved. Note that Gansou still owes Purdue a total amount of 1,229,000FCFA based on information received from him.

The development of the distribution chain in Togo is based on a new network set up by Akoutou Akoutou (Resident Representative of the wholesaler in Togo). He created this network by selecting friends, colleagues and parents who are collectors and traders of food products in the villages. The current status of the network is characterized by an absence of PICS bags in the distribution network.

Supply chain actors

PICS activities started in July 2009 in Togo. Batana, the business consultant of PICS bags in Togo, began to develop a distribution network of PICS bags. Meanwhile, he attended a training organized for PICS facilitators by the project at IITA-Cotonou on August 17, 2009. To develop the distribution network, Batana proposed a list of semi-wholesalers, and Akoutou (wholesaler and Gansou's representative in Togo) also proposed a list of semi-wholesalers. The choice was given to Akoutou to select his own distributors. A comprehensive list of semi-wholesalers was made by combining the lists of Batana and Akoutou. The semi-wholesalers proposed by Akoutou were located in the following regions: Maritime, Plateau, Central, and Kara; Batana proposed semi-wholesalers for the Savannah area. Batana said he had proposed a long list of semi-wholesalers, but the wholesaler preferred to work mostly with his own knowledge for confidence and credibility reasons. After the opening-the-bags ceremonies, there was a huge demand for PICS bags. Batana proposed to semi-wholesalers to have retailers at the village level to meet the demand of producers and traders.

Localization of actors of the distribution network

1- Region of Plateau: 5 semi-wholesalers ←----→ 9 retailers
2- Region of Maritime: 2 semi-wholesalers ←----→ 3 retailers
3- Central region: 3 semi-wholesalers ←----→ 9 retailers
4- Region of Kara: 2 semi-wholesalers ←----→ 5 retailers
5- Savannah region: 6 semi-wholesalers ←----→ 6 retailers

PICS bags sold in Togo are manufactured by Lela Agro in Nigeria. PICS bags were imported and sold in Togo by Gansou, wholesaler, based in Benin. Gansou is represented in Togo by Akouto, who acts as a wholesaler. Baributsa has discussed the possibility of sourcing the bags from another company based in Accra, Ghana, which manufactures the bags at a lower price than Lela Agro. Until now, no bags have been procured from Ghana.

The bags were sent from Benin to Togo by IITA, received by Gansou and ICAT at the Togo border and then shipped to Lome. The bags were received by Akoutou in October 2012. The bales of bags arrived in Togo late compared to the cowpea cropping season. Batana, Moise Djadé, and Akoutou (the Togo team) distributed the bags to semi-wholesalers by taxi at their own expense. For the case of Dapaon, they took advantage of a mission of IITA, led by Djadé, to deliver the bags to the semi-wholesaler assigned for this location. The sales of the bags for demos amounted 6,250 bags in 2009-2010. 3,847 non-demo bags were sold over 2010-2012. During the 2009-2010 cropping season, few sales were recorded in Togo for the following reasons: (1) PICS bags were received late in Togo (the end of October 2009); (2) it took time to distribute the bags to semi-wholesalers and retailers; and, (3) PICS bags were a new product; since the demonstrations were not made, the product was unknown.

There was rupture in some areas. To overcome this problem, Batana said he made a request to the PICS coordinator of IITA-Benin to pre-finance the order of 2,000 bags, but this request was not accepted. There have been many attempts to deal with the rupture without

success. Facing this situation, Gansou was not willing to invest. Akoutou wanted to order but could not because this order has to be made through Gansou.

The prices for PICS bags were as follows: (1) semi-wholesalers: 925 FCFA/bag; (2) retailers: 1,000 FCFA/bag; and (3) producer: 1,100 FCFA/bag. Given the situation on the ground, the selling price of bags should reflect the following: Selling price = [(Purchase Price + Shipping costs + other intermediaries (communication, handling, incidentals)] + Margin.

Purdue University: International Coordination of PICS

Purdue University is the promoter of the PICS project and the key actor in implementing the distribution chain of PICS bags in Togo in 2009. With the support of IITA, Purdue, represented by Lowenberg-DeBoer, identified Gansou as the national wholesaler of PICS bags in Benin and Togo. A contract was signed in 2009 to make this collaboration official.

In an effort to interest the private sector in the distribution of the bags in Togo, Purdue initiated an incentive program at the beginning of the project. It provided significant direct financial support to the distribution chain by providing 80% of the initial investment to the national distributor to procure the bags from Lela Agro. The financial assistance to Gansou was about 17,000,000 FCFA for bag procurement for both Benin and Togo. This debt vis-à-vis Purdue University is in the process of being cleared gradually as long sales are evolving in Benin and Togo. Purdue served as a moral guarantee for the wholesaler vis-à-vis Lela Agro. Purdue linked up Gansou and Lela Agro in a business relationship. It was within this framework that the sales representative of the Lela Agro, Kaumi, visited the Gansou in 2009 to discuss the technical and logistical arrangements associated with the contract.

The PICS project itself was a volume buyer of PICS bags in 2009-2010, 2010-2011 and 2011-2012. To motivate and strengthen the development of the chain, the project purchased about 5,839 PICS bags (or 47% of the first order of bags) at a retail price of 1,000 FCFA from the wholesaler, semi-wholesalers, and retailers for public demonstrations. Purdue, in collaboration with IITA, hired Batana to help all stakeholders involved in the sale and distribution of the bags to establish and expand the distribution network.

Purdue provided funding (through IITA and ICAT) for technical activities to create and stimulate the demand for PICS bags. These activities include the sensitization, public demonstrations in villages and markets, open-the-bags ceremonies, and training of NGOs and journalists. Similarly, several media activities were initiated and financed by the project. These activities include television spots, radio ads, newspaper messages, and media coverage of the open-the-bags ceremonies. All these activities strengthened the diffusion of information about PICS technology across the country in 2009-2010 and in 2011-2012.

To strengthen the supply chain actors, and to increase the odds of sustainability of the distribution network of PICS bags, the project also financed the training of semi-wholesalers on

PICS technology. Finally, Purdue has overseen the overall project activities including the tracking of bags sales and the development of the chain. To ensure a good coordination, Baributsa travelled intensively to Togo from 2010 to 2011 to monitor activities that had been implemented.

IITA: Regional and national coordination

IITA is the regional partner of PICS in West and Central Africa (Benin, Togo, Nigeria, and Cameroon). This coordination is overseen by Abdoulaye based at IITA- Ibadan, Nigeria. O.Coulibaly coordinated specific activities in Benin and Togo. A team was set up to conduct the training of facilitators and technicians and to monitor the outreach activities, including sensitization, demonstrations, and OBCs. A journalist consultant, Mr. Emmanuel Tachin, was recruited by IITA to organize the media component of the project. IITA had also assisted Gansou in getting tax exemptions for the bags at Benin and Togo border using its agreement with the Government of Benin as a nonprofit organization.

ICAT: National technical partner for extension

ICAT is the national technical partner of PICS project in Togo. It signed a contract with IITA to perform the technical component of the project in 1,000 villages in 2009-2010 and 2010-2011. Activities performed include awareness building campaigns, demonstrations, and open-the-bag ceremonies. Technical support of ICAT was essential for the training of chain actors and therefore for the sustainability of the distribution network.

Lela Agro (Kano, Nigeria): Manufacturer

The PICS bags sold in Benin were imported from Kano, Nigeria by Gansou with the collaboration of IITA-Benin. The bags were delivered by Lela Agro to the Sèmè border under the supervision of Kaumi.

Mr. Léopold Gansou: Wholesaler

Gansou is a businessman and has an enterprise. He is involved in many businesses including: commerce of cereals (maize, soybean, cowpea, and groundnut); national and international transportation; and PICS distribution, among other services.

For the distribution of PICS bags, he works closely with two collaborators, including Mrs. Odette Akoutou and Mr. Gerome Oniyi. He signed an agreement with Purdue as the main distributor of PICS bags in Benin and Togo in 2009. He was suggested by O. Coulibaly from IITA-Benin. Before PICS, he had developed his own network to buy grains across the country. This network is composed of parents, friends, grains traders, and producers in villages and towns close to big food crop markets. As a volume seller, he buys, stores, and sells grains and legumes such as maize, cowpea, and groundnut across Benin and Togo. His major customers are the WFP, as well as the national food security department of some countries in West Africa.

Patient Akoutou: Resident representative of the wholesaler in Togo

Patient Akoutou is the representative of Gansou in Togo. He is a businessman and a seller of office supplies to Catholic churches. He is also a food products seller as a member of Gansou's team. He is the brother of Gansou's assistant. He has been in business relationship with Gansou for several years. In 2009, he became involved in PICS business in Togo.

Akoutou has established a network of semi-wholesalers based in major cities in Togo. The main criterion for selection of semi-wholesalers by Akoutou is confidence. He chooses people he trusts, people with whom he has always worked with in the field of business or church. He testified that the distribution chain now operates normally up to a certain level, but much remains to be done for further development. With respect to PICS bags, the margin is very low and does not encourage chain actors to invest their money. This is one of the weaknesses of the project. Another weakness of the project is the fact that the sale of PICS is a seasonal activity (three months: October, November and December). A delay in receiving PICS bags significantly affects the sale of the bags. According to the information received during the interview, the semi-wholesalers would want the bags to be considered an ag input to benefit from tax exemptions, and that the price of the bags would not fluctuate indefinitely.

Akoutou said that he proposed to ICAT authority the possibility to include the bags in the category of agricultural inputs, but his proposal remained unanswered. He has also asked IITA to assist approaching the authorities. He says to have taking a step toward the WFP for procuring the sack but without success.

Since the project began, there was only one order of PICS bags. It is up to Gansou to decide about a new order. For a new order, it should be made not later than July. According to Akoutou, the main problem about PICS business is Gansou's margin. If the margin is low, he will not invest. Akoutou is interested as a wholesaler but not without the approval of Gansou. In some places, there were problems of rupture, while, in other places, bags were available. So he moved bags from places where there was an excess supply to places where there was an excess demand to overcome the rupture problem. The regions that experienced frequent rupture problem were Central region, Sokoto, and Dapaon.

For Akoutou, if the project withdraws, he will struggle to work with all the semi-wholesalers because of lack of resources. He plans to use the following strategy: to provide technicians PICS bags directly to the distribution in the form of consignment shop. He added that he works extensively with ICAT technicians today in the supply chain. He plans to work with ICAT agencies to make the sale larger and less risky.

Akoutou's intention is to continue with the distribution of the bags in Togo. He says for now he earns nothing on the sale of the bags because of transport costs, telephone costs, handling costs, store costs, and other costs. The current situation does not encourage him but he says he

believes that over time it will work. He did a quick calculation, which, according to him, can motivate the chain's actors. Here's an example of the case of PICS imports from Ghana:

1. Manufacturing price: 700 FCFA/bag
2. Transport and other fees: 100 FCFA/bag
3. Price at doorstep of the wholesaler: 800 FCFA/bag
4. Margin for wholesaler: 100 FCFA/bag
5. Margin for semi-wholesaler: 100 FCFA/bag
6. Margin for retailer: 100 FCFA/bag
7. Selling price for producers and other end users: 11,00 FCFA/bag

For the 2012-2013 cropping season, Akoutou estimated the bag quantity at 3,000 which should be received no later than September 2012. If the season is good and the demand is high, 1,000 more bags may be ordered to meet the demand. For the 2011-2012 season, cowpea was very expensive to harvest: 800-1,200 FCFA /bowl of 3 kg. Currently, the price of cowpea varies between 1,800 and 2,000 FCFA/bowl of 3 kg.

Akoutou opened a special savings account for the sale of PICS bags at the Union Bank of Togo (UTB). This bank is present throughout Togo. He gave the account number to all semi-wholesalers who pay the price of the bags at the UTB and then inform Akoutou through phone calls. In turn, Akoutou groups the funds and sends them to Gansou.

Semi-wholesalers

There are around sixteen people, composed of men and women, who are semi-wholesalers. This group consists of: traders of cereals and other food products; high school teachers; and Institut Togolais de Recherche Agronomique (ITRA) agents.

Case of T1

T1 is a food products merchant. She also works in her husband's construction company. She is a semi-wholesaler in the Kara region. She has a family in Kara where she has her outlet. She started selling PICS bags during the 2009-2010 campaign, but she has actually sold most during the 2010-2011 campaign. She received 300 bags and has sold 180 bags. Akoutou took back 50 bags. She has three retailers: a merchant in Gnamtougou (Kara region); an electrician in Tongue (Kara region); and a director in the secondary school Kytaou (Kara region). These people are her relatives. She presented the business opportunity to them and they were interested. She placed some bags on consignment at their stores. She says she did some promotion and advertising to sell the bags. She spoke to her parents and relatives. Currently, she says the demand is growing but she has been out of stock since June 2011. In 2009-2010, the bags arrived late so she had to distribute as soon as they arrived. The wholesale price was 1,000 FCFA/bag, and the retailer's price was 1,200 FCFA/bag. Her margin is 75 FCFA/bag.

Case of T2

T2 is the semi-wholesaler in the city of Atakpamè. He was selected by Akoutou. They are friends. He agreed to invest in PICS business after Akoutou explained the advantages of the bags. The bags were stored in his store at Anié (located at 29 km from Atakpamè). He went to Anié to pick two bales of 300 bags. He looked for retailers and had developed a network of 10 retailers composed of: four Extension agents from ICAT; three ag inputs dealers; and three farmers. The geographical distribution of retailers is presented as follows: Atakpamé, Amu Oblo, Akparè, Nontshé, Temedja, Pagala-station Kougnoun, and Tchela. He received 600 bags from Akoutou and 50 bags from Batana. With the rupture problem, Batana removed 200 bags with the semi-wholesaler at Dapaon, and he dispatched 100 bags for Atakpamé (semi-wholesaler and retailer), 50 bags for Adalamé, and 50 bags for Nontshé. Sales can be summarized as follows: 200 bags at a price of 1,100 FCFA/bag directly to producers; 462 bags delivered to retailers at a price of 925 FCFA / bag; and twelve bags with manufacturing defects (torn at the bottom). 20 bags remained with retailers: ten bags at Kougnoun and ten other bags at Tchela.

Case of T3

He was involved in the distribution chain by Akoutou. He received and redistributed PICS bags for a small dealer network, chosen from his parents and friends. He has retailers in localities including Waragni (a woman merchant of food products); Pagala-gare (a woman merchant of food products); Djifama (a man, ICAT agent); Tcharèbaou (a man, ICAT agent); and Blitta-gare (a woman merchant of food products and radio animator). T3 reported that the seller for Waragni is the best seller in his distribution network. She was followed by Blitta (a radio animator). He received 649 bags; three bags worn torn (manufacturing defects), and 646 bags were sold.

Case of T4

T4 is a semi-wholesaler in Sokodé. He was selected by Akoutou in 2009. He participated in the training of semi-wholesalers in Atakpamé. He received support from ICAT agents through demonstration sales. The retailers of T4 are located in Alibi (1 retailer), Tchamba (1 retailer), Kousountou (1 retailer), Kabofi (1 retailer), Sokodé, a store of Dieudonne (1 retailer), and Sokodé, a store of T4's wife (1 retailer). The retailer of Koussountou has some sub-dealers in the villages of Balanka and Goubi; these are his parents. He placed PICS bags with them to sell. He received the bags from the wholesaler at 925 FCFA/bag and sells to retailers at 1,050 FCFA/bag. Sometimes he gives them the communication fees of 1,000 FCFA, especially for the one of Kounssoutou. He directly sells to producers at 1,100 FCFA/bag. He received 501 bags and sold 494 bags. Seven bags were defective. There is an important demand for the bags on the producers' side.

Case of T5

He is an agricultural engineer at ITRA- Kara and a semi-wholesaler of bags at Kara. His colleague was PICS-trained in Benin and, upon returning from the training, debriefed his ITRA peers. It is from this moment that T5 was informed and was immediately interested in the sale of bags as he has a store of agricultural inputs. But he has not been proposed as a semi-wholesaler. In 2010, he attended an open-the-bags ceremony in which he again expressed his desire to sell

the bags with a colleague of ITRA. Later on, he was contacted by Batana to attend a training organized for semi-wholesalers in Atakpamé in 2010. After this training he received a bale of 300 bags. His stock was sold out but continued to receive requests for PICS bags. He was able to obtain bags from other semi-wholesalers: 40 bags from the semi-wholesaler of Dapaon (2011-2012) and ten bags in December 2011. Outlets included some shops and some roaming vendors including: Kara (shop of T5), 71 bags; Atchamgbadè (1 agricultural advisor of ICAT), 50 bags; Namon (1 agricultural advisor of ICAT), 26 bags; Kouka (1 woman merchant of food products and other products), 100 bags; and Kouka (1 agricultural advisor of ICAT), 50 bags. His customers are producers, merchants, and consumers. Certain retailers have not yet reimbursed the money. These persons are located at the following areas: Namon (two bags not yet reimbursed), Tchamgbadè (two bags not yet reimbursed), and Kouka (48 bags not yet reimbursed). T5 received the bags from Patient at 925 FCFA/sack and sold at 1,000 FCFA for bulk purchase and 1,100 FCFA at retail price.

Case of T6

She was a retailer and now semi-wholesaler at Notshe since 2009-2010. During the first cropping season (2009-2010), she sold no bags. In 2010-2011, she sold 135 and in 2011-2012 she sold 32 bags. She became semi-wholesaler in 2011-2012 because of her sales efforts and credibility. Her customers are mostly cowpea traders, but there are also some producers. She received the bags at 925 FCFA/bag and sold at 1,000 FCFA/bag to ICAT agents and at 1,100 FCFA/bag to producers and to cowpea traders. In the radio spots, her name and phone number are listed. Many customers know her and contact her to buy the bags.n She has sold some bags to her neighbors to store maize.

Case of T7

T7 is an elementary school teacher and a development officer. He is the president of a local NGO called Association of Dedicated Volunteers for Development in Togo (AVDD-TOGO). His NGO works with Plan-Togo. He is the semi-wholesaler of PICS bags in the town of Sotouboua. With multiple skills, T7 is very busy working for other projects. With respect to PICS activities, he was informed by the department of monitoring and evaluation of Plan-Togo, Sotouboua Agency, who gave him some bags to sell. Akoutou has previously contacted this department about PICS business. Since he was very busy, he decided to talk to T7. T7 attended the first training of semi-wholesalers in October 2009 in Atakpamé. At the end of this training, he received the first batch of 2 600 bales. T7 has several categories of retailers:

1. First category: ICAT agents (Agricultural consultants). They are in direct contact with producers and constitute the largest group in his network. He placed the bags on consignment at the shops of these retailers. There were delays in payment and some of them have not yet paid back.
2. Second category: family members in villages.
3. Third Category: This category is composed of three street vendors. They buy small quantities (10 bags or less) at 1000 FCFA/bag and sell at 1100 FCFA/bag. They go from market to market. They also sell farm inputs. The main difficulty with the street vendors is that they pay back after several days instead of reporting on daily basis.

4. T7's shop: The semi-wholesaler has a shop at home in Sotouboua where he sells directly to customers. This shop is also the headquarters of the AVDD. The sale is carried out by himself, his wife, his children, and agents of AVDD.

His customers include:

1. An individual who bought 35 bags at 1,000 FCFA/bag. This person is a math professor who produces harvests and stores cowpea and other crops.
2. Producers of cowpea who bought one, two, or three bags.
3. Retailers of cowpea, maize, and sorghum.
4. Sellers of fresh water bought to conserve iced water for sale. The bag keeps well the iced water.

T7 showed much personal initiative. He advertised for the bags to large producers, traders, NGOs, but they have not responded yet. A member of parliament (Mr. Cornelius A. Tchassé) organized training on the storage, marketing, and processing in March 2011 in Sotouboua. Participants in this training were around 700 people, mostly women. The training was led by the RADA, a regional federation of groups of farmers. T7 attended this training. He took the opportunity to demonstrate PICS technology to participants using the PICS bags and posters. He has received some support from the audience. Some traders complained about the small size of the bags and proposed bags of 60 bowls or 200 Kg. Others criticized the price of the bags saying it is too expensive. He has personally initiated radio messages in 2009-2010 based on the first training attended in Atakpamé. He has also broadcasted messages on the local radio station COSMOS. He spent a total of 13,400 FCFA for the broadcast of the messages. He photocopied the message and posted at many points in the town of Sotouboua. According to him, the messages broadcasted explained the advantages of the bags and mostly the benefits in terms of increase of income. With his friend from Plan-Togo, they took advantage of various opportunities to present and show PICS bags using posters and sample bags such as during ceremony with development actors, Plan-Togo activities, and general meetings of farmers' groups. He also assisted farmers and producers to use the technology accordingly by helping them store their products.

Retailers

Retailers are the largest group in the distribution network. They were proposed mostly by the semi-wholesalers and the business consultant. There were several categories of retailers including: ICAT agents, shops, and shops for agricultural inputs.

Case of T8

He is an agricultural adviser at Tsevié station. He is a PICS technician and retailer. He participated in the training of technicians in Kpalimé in 2009. His coverage area includes Gapé-center in 2009-2010 and Antenna Lilicopé, Agbelouvé, Ayacopé, Kpodji in 2010-2011. He buys from T9, the semi-wholesaler of Tsevié, at 1000 FCFA/bag and sells at 1100 FCFA/sac. Stocks received are:

1. Bags received from T9: > 100bags
2. Bags received from Djadé: 60 bags

3. Bags received from Batana: 30 bags

The main buyers are the retailers and producers of cowpea. T10, a field agent, always circulates with the bags tied behind his motorbike. He is a merchant. He hosted a radio show on radio "Nonvissi" of Notché. He confirms that the spots went very well on radio. He says he met a couple in February 2012 who wants to sell the bags. They want to be a retailer at Gapé Centre. Since 2009, he put a stock of bags at a friend's house who is a nurse for sale. He delivers the bags at 1,000 FCFA/bag for him and the nurse sells them at 1,100 FCFA/bag. He gains nothing on it. Djadé gave posters to him to display everywhere in the markets, clinics, and public places. He is satisfied with this trade and he intends to continue. He says it is passionate because the diffusion of agricultural technologies is part of his mission. He says he knows the value of PICS bags and testifies that there are women who have bought the bags to store maize and they liked them: "It works!"

Case of T11

He is the head of ICAT agency of Amou-Oblo, and a retailer of PICS bags. He supervises ICAT technicians for activities in the villages of Amou. It is through ICAT that extension agents were trained on PICS bags. They conducted the following activities: raising awareness, demonstrations, monitoring, and OBCs.

With respect to PICS bags, the extension agents assess the needs of producers for PICS bags, gather together money from producers and, when the agents come to the agency for monthly meetings, they take the opportunity to supply bags for producers. T11 has some PICS bags at the agency level, but was quickly sold. The quantity received was 50 bags (for the 2010-2011 cropping season) and quantity sold was about 43 bags. The main customers are producers and cowpea traders. The bags were delivered by the semi-wholesaler at 1,000 FCFA, and T11 sold them at 1,100 FCFA/bag with the help of farm advisors who are under his responsibility. Agricultural advisors gain nothing because they considered the job as part of their field activities and the sale of bags as part of their duties. There are a total of ten agricultural advisors, and each advisor covers ten to twelve villages. The region covered is Amou. Their approach is to work with farmers' associations.

Case of ICAT agents working with Mr. T7 of Soutouboua

ICAT agents (agricultural advisors) are in direct contact with producers. He gave them the bags on consignment, but the constraint is the delay in paying back. His network of ICAT agents are in the following villages or townships: Adjengré (2), Tetero, Sotouboua (4), Kaza, Pouda, Waragni, Aouda, and Tchébébé. The semi-wholesalers place the bags on consignment: minimum =10 bags; maximum =50 bags.

Women facilitators of the PICS project

Case of T12

She is a facilitator trained in Kpalimé on PICS technology in 2009. She is also the general secretary of a women's group network. She was selected by the farm advisor for ICAT to participate in the training of women facilitators for the PICS project. She was an active

member of the women's organizations for over five years. She is also a retailer of PICS bags. She received her bags from the semi-wholesaler of Agbandi. She received 225 bags and sold 215, with ten bags remaining. In 2009-2010, she sold very few bags; in 2010-2011, she sold a lot of bags; and in 2011-2012 she did not sell bags because the crop was not good. She bought the bags at 1,000 FCFA/bag and sold to producers, traders and producers of cowpea at 1,100 FCFA/bag. She earns 100 FCFA per bag. Major customers were farmers and cowpea traders. Customers stopped by at her house to buy the bags. She took also the bags to markets, incluing Blitta markets, Waragni and Yaloumbè. She used the motorbike as means of transportation to bring the bags to the markets. To reach Blitta market, a round trip costs 80 FCFA. To reach Waragni market, she travels on foot. To reach Yaloumbè market, a round trip costs 600 FCFA.

Case of T13, retailer of PICS bags at Amlamè

She is the secretary of the women's group "AMENOUVEVE", and a member of a group of women in the village of Amlamé. T13 is also a facilitator of the PICS project and a retailer of PICS bags. She was selected to participate in the project by the branch manager of ICAT-Amou. She has participated in the training of facilitators in Kpalimé, Togo in 2010. It is during this training that she was proposed to be a distributor of PICS bags. After the training, she contacted the semi-wholesaler at Atakpamé, T2 in 2010. For the 2010-2011 cropping season, she received a stock of 30 bags at 1,000 FCFA each and sold them at 1,100 FCFA each. Her customers are producers, traders, and some officials to keep the cowpea for home consumption.

Shops

Case of T14

T14 is a retailer of PICS bags at Sokodé. She was connected to the semi-wholesaler of Sokodé, T4. She has a shop of various goods located in the city. In 2010-2011, T4 proposed to T14 to sell the bags and she agreed. She received the bags on consignment at 1,050 FCFA each and sold them at 1100 FCFA/bag. Her margin is 50 FCFA/bag. She was out of stock since the beginning of the 2011-2012 cropping season. She confirmed that there was a strong demand for bags. The producers were asking for the bags and she had already received an order of more than 50 bags from producers for the 2011-2012 cropping season. She noted that even though the bags are out of stock, the radio ads continue. This is a discouraging situation because many farmers come to buy the bags and can't get them.

Case of the store of T5, Ing Agronomist, ITRA-Kara

T5 is an agricultural engineer at ITRA, Kara, and a semi-wholesaler of PICS bags in Kara. He is also a retailer at the "Boutique d'intrants". He became interested in the sale of PICS bags because he was already involved in ag inputs sale in his store in Kara city. He received 71 PICS bags. The customers are farmers, traders, and consumers. Other products sold in the shop are insecticides, herbicides, fertilizers, vegetable seeds, maize seed, rice, soybean and small equipment.

Family members

Case of T15, retailer of PICS bags in Kara (connected to T1)

T15 is a relative of T1 (semi-wholesaler, Kara). T1 has placed the bags on consignment in T15's shop. He received sixty bags, but only sold ten bags. The rest of the stock remained until it was removed and given to an ICAT agent on the request of Djadé for demonstrations in the villages. He said people (producers and traders) found that the price of the bags was very high. They were interested but they are discouraged by the price. He sells a price of 1100 FCFA/bag.

Case of T7's family members

Certain family members living in other villages:

Villages/Township	**Member of the family**
Tchébébé	Brother of the semi-wholesaler, motorbike taxi driver
Bago	Brother of the semi-wholesaler, teacher
Aouda(town)	Brother of the semi-wholesaler
Aouda (Farm)	Family in-law of the semi-wholesaler (has a store for PIBS bags)

NB: The semi-wholesaler place on consignment a minimum of 10 bags and a maximum of 50 bags.

Roaming vendors:

There are three vendors for T7. They take small quantities (ten bags or less) at 1000 FCFA/bag, and they sell at 1100 FCFA/bag. They move from market to market. They also sell ag inputs. The main difficulty with the vendors is that they wait several days before reporting to T7.

Markets	Observations
Sotouboua ; Tchébébé, Titigbé, Tchila, Aouda	1 Roaming vendor
(Sotouboua ; Tchébébé, Titigbé, Tchila, Aouda)	1 Roaming vendor
(Sotouboua ; Tchébébé, Titigbé, Tchila, Aouda)	1 roaming vendor (he took three time the stock of bags)

NB: Roaming vendors take up to 10 bags

ONGs and OP

These NGOs and farmers' organizations are directly or indirectly involved in the sale of bags. Here are few cases reported in the field.

Case of NGOs Borne Fonden, Ezomé, Togo, led by Mr. Ferdinand Lare (Head of the Development unit of Borne Fonden Ezimé, Togo)

During the interview with T11, his collaborator from Borne Fonden came into his office. The PICS team took the opportunity to share PICS technology with him. Mr. Ferdinand Lare is the head of the development unit of Borne Fonden-Ezimé. He is also in charge of the children's development component. Borne Fonden is a development NGO based on sponsorship and focuses on four areas: education, health, income-generating activities, and children and development. This branch of Borne Fonden covers eleven villages, with over 600 families, and supports the whole community.

Partnership Borne Fonden – ICAT in Amou

Borne Fonden partners with ICAT-Amou. The NGO is based in Ezimé (4km from the agency). The partnership focuses on technical support in farming and livestock. This is a win-win partnership. Borne Fonden addresses requests for an action or activity to ICAT. ICAT responds to the request by submitting a training document and an operational plan. Borne Fonden, upon reception of the proposal, investigates and finance the activities for implementation. ICAT runs activities and reports to Borne Fonden. ICAT has worked with twenty families in 2011, and will also work with twenty families in 2012. Borne Fonden covers Amou community with over 600 families. ICAT offers activities to support producers and Borne Fonden finance activities. Some activities funded by Borne Fonden and carried out ICAT are (1) Corn-SOS, including improving maize yields and how to use fertilizers made available to families by Borne Fonden; (2) storage of food products; and (3) breeding of small ruminants.

The NGO Borne Fonden is interested by PICS bags but has not yet bought the bags. T11 has already spoken about PICS bags and the possibility of technical support in their areas of intervention. Indeed, ICAT is already working with Borne Fonden on agriculture by supporting access to inputs (seeds, fertilizers, and insecticides), as well as storage with families in rural areas. T11 proposed including the use of PICS bags in the portfolio of activities. Activities proposed include awareness building (demonstrations and open-the-bags ceremonies) and partial or total subsidy of PICS bags to allow poor families and rural households to adopt PICS bags in the intervention area of Borne Fonden.

Case of women's group "AMENOUVEVE" of T13

The group AMENOUVEVE" is specializing in the collection, storage, and marketing of agricultural products like maize, cowpea, soybean, palm oil, honey, and gari. Currently the group uses PICS bags (one bag of cowpea). This women's group is one of the groups selected for pilot demonstrations for PICS bags. In 2009, the group has received storage material such as sealed metal drums (barrels) and cans for preserving chemical-free food products and palm oil from the Ministry of Development. They rely on these barrels to store the products. The group is seeking funds to purchase the PICS bags because the bags are more convenient and easier to handle than the barrels, especially for women. They are about to consider seeking support from the Ministry of Development to get the PICS bags. The Ministry will study the possibility to buy the bags and distribute to them, as was the case in 2009. Here are the groups of women who participated in trials on PICS bags:

1. Group of women: AMENOUVEVE (Amlamé, 5 members)
2. Group of women: PANAPASSA (Amlamé, 11 members)
3. Group of women: ECHIGBOKELE (Héhéatro, 13 women)
4. Group of women for mutual supports (Agbogboli, 20 women)
5. Group of women for mutual supports (Kpatégan, 16 women)

Case of NGOs: Project for Self-Agricultural Promotion (APA-Togo)

Since 2009, this NGO supports women's groups in training on processing, funds management, livestock, the creation of income-generating activities, and microcredit to women's groups (with an interest rate of 6%). But some groups have not repaid the loans, and the NGO has stopped giving the credit. It was in 2012 that the NGO has taken up with the groups again. The group Amenouveve submitted a small project, and the NGO agreed to fund up to 480,000 FCFA. This is a project on the marketing of honey. T13 said that the APA-Togo knows PICS bags. During a training of APA-Togo for women's groups in Kpalime, (during which the theme of PICS technology was addressed), the participants went to visit the PICS bags with cowpea in a village near Kpalime. T13 said she also led demonstrations training on how to use of PICS bags.

Case of the local NGO AVDD-TOGO with T7

AVDD-TOGO is a development association, a local NGO with four areas: acro-ecology, health, education, and income generating activities (IGAs) /processing. The staff is composed of than 50 members with seven active members in the office. In processing, the NGO produces the following by-products: gari, sesame, tapioca, cowpea, jam, baobab fruit, soaps, lotion (for body and hair), syrups, and fruit juices (including tamarind, lemon, orange, mint). His team has been trained by the Peace Corps on technology changes and the creation of income generating revenue in 2002. It was after this training they have decided to create the AVDD. They are very involved in the promotion of processed products.

Case of women's groups of T12's network

She is the general secretary of a network of groups of women farmers. This is a consortium of women groups. She was selected by the ICAT agent of her village to participate in the training of women facilitators of the PICS project. She is active in the women organizations for over five years. She is also a retailer of PICS bags. Her network consists of ten groups of women located in the township of Waragni covering the following villages: Malika, Lanzi, Powai, Waragni, and Lawai. The minimum size of a women's group is 25 women and a maximum is 79 women. The activities of the groups are: agriculture; collection, storage and marketing of food products during the lean period; and sale of seeds. Agricultural production of women's groups focus on the following crops: maize, peanut, soybean, cowpea, and sorghum. The groups save and receive small loans from the Renovated Union of Local Banks and Savings Credit (URCLEC) of the Mutual Treasury of Blitta. Women have also individual activities such as agriculture, small businesses and farming. They produce mostly rice and cassava.

Business consultant

Batana played a key role in the development and functioning of the distribution system of PICS bags in Togo. His main actions included:

1. Contributing to the establishment of the distribution network by suggesting serious and committed actors in the distribution system;
2. Organizing training of semi-wholesalers of Togo (2009, 2010 and 2011);
3. Following the actors and the sales in the distribution network established;
4. Contributing to expand the network;
5. Reporting to IITA and Purdue University on regular basis;
6. Contributing to the synergy effort between different components of the project: technical; media and communication; business and marketing; and coordination;
7. Monitoring of repayments by the semi-wholesalers in the account of the wholesaler;
8. Public awareness of PICS bags through direct marketing; and,
9. Achieving demonstrations and open-the-bags ceremonies in public markets (50 markets, 20 markets in 2010-2011, and 30 markets in 2011-2012).

Batana adds this information that is very important to him: "Farmers wish to have specific bags for storing grain even though they are already using the PICS bags for storing maize. In addition, the most important thing for now is to have an independent wholesaler in Togo." Batana proposed bales of 50 bags instead of 300 bags to reduce the difficulties of transport, handling, and theft of bags in bales during transport.

Volume Buyers

Besides producers and traders, there is a volume buyer, T16, Deputy Director General of New Cotton Company of Togo (NSCT), Atakpamé. He bought 30 bags in total. He uses the PICS bags for the conservation of cowpea. He produces, buys, sells and stores cowpea.

T17 is the semi-wholesaler in Sokodé. He sells to a local NGO—Mission Volunteers against Poverty (MVCP). The NGO buys 75 bags to store dried mushrooms. The mushrooms were produced by the NGO. After storage, the mushrooms were sold to a partner in Ghana. The PICS bags respond very well to the conservation of mushrooms. Currently, MVCP has 50 bags of mushrooms stored in a one of their five warehouses and also some stocks of paddy rice. There are other local NGOs that have expressed an intention to buy the bags. These NGOs direct producers to semi-wholesalers and retailers of PICS bags.

Current major issues at each level of the chain

Complaints from the bags users

There is no complaint in relation to the quality of the bags, but there are about the size of the bags. The size of 100 kg is small for small traders. They want bags of 150-200kg because they are used to bags with similar size. The traders also complain about the sale price with reference with the bags they are used to before. Producers have found that the price is very high (1,100 FCFA). Traders compared the price of the bag at the price of ordinary woven bags with simple of phostoxin. They were completely convinced to switch to PICS bags after the opening-the-bags ceremonies. They saw the effectiveness of PICS bags with lots of testimonials from farmers who compared PICS bags to previous methods (i.e., container, tank). The media also played an important role in information and producers' awareness building. Some producers stored cowpea seeds in PICS bags and the seeds have germinated.

Producers and traders complain about rodent attacks. Their usual methods are not threatened by rodents but, with PICS bags, caution is advised. Some traders have found solutions by using rat poison. The protection of PICS bags in the store against rodents is a problem for users. The solutions found by some producers and traders were the use of cats and glue (product purchased in Ghana).

Constraints faced by wholesalers, semi-wholesalers, and retailers

It is difficult to introduce new practices in people's habits. They did not believe that storing cowpeas without chemicals is possible. It took a long period of awareness before convincing them. Another difficulty is the transaction cost associated with the sale, which reduces the margin.

PICS bags are effective, and the demand for them has been increasing. Since November 2011, there has been a rupture. Some customers even deposit money waiting for the arrival of a new stock of bags. Here is a testimony of a semi-wholesaler: "I no longer have PICS bags for sale, but more surprisingly, radio ads continued directing customers to semi-wholesaler; what contradictions?"

There were some bags with holes. The seller simply changes them. Some other bags were spoiled (torn bags). Bags vendors check the plastic before selling to customers, and, if it is torn, the bag is replaced. The bags with defects were returned to the semi-wholesaler.

There are transportation constraints. First, the bales are very heavy. Transporting a bale of bags from Lomé to Sokodé is 7000 FCFA; and from Anié to Sokodé is 5000 FCFA. Second, Moving bags to the villages is not supported by the project; instead, this cost is supported by the seller. This sometimes limits the distribution of the bags. The thin margin is completely engulfed in the travel expenses and also in the phone calls.

The production of cowpeas in 2011-2012 dropped because of poor rainfall. The price of cowpeas at harvest was 500 FCFA/bowl of 3kg. After 6-9 months, the price rises at 1,200 FCFA/bowl because cowpea is sold at this period as seeds for the next cropping season.

There was some confusion due to poor communication; for example, most people thought that the end of radio ads was the end of the PICS bags business

Some growers stored warm cowpea in PICS bags (cowpea dried in the sun), which damages the plastic bags or tears the bags. The producers who rely on this practice were sensitized about the reasons of the damage. Some producers do not want to give time to sort or winnow the cowpeas properly before storing. They store directly without any sorting and without winnowing. This practice also pierces the bags. For example, T13 said she was sometimes obliged to sort cowpeas before storage in some households to show them how to use efficiently the bags.

Major constraints

The choice of network actors is very important for the success and the sustainability of the distribution chain. In the case of Benin and Togo, the choice of the wholesaler was not a good choice. This wholesaler is ever busy and focused on other activities,

The prices set in the first year (2009-2010) were 955 FCFA for semi-wholesalers, 1,000 FCFA for retailers, and 1,100 FCFA for producers. These prices were broadcasted in radios. The setting of the price did not allowed sellers to speculate on the sale of the bags. The price caps at each level of the chain were an important disincentive factor for chain actors, particularly in the second year.

Ruptures occurred in some regions, districts and villages. The semi-wholesalers have tried to move some stocks of bags from one place to another. Some bags remained with some semi-wholesalers.

Lela Agro delivered bales of 300 bags, but in some bales, we found less than 300 bags. This could vary from five to ten per bale. There were also some surplus, but it was very rare. Some bags were torn.

Purdue University provided direct financial support of 80% of invested capital. This support was to incentivize the wholesaler to invest in the procurement of the bags and to launch the supply chain. This support in fact did not encourage the wholesaler to take risks and to act as a businessman because there was no pressure to repay the capital invested by the project. If the wholesaler were to directly reimburse 80% (30% & 50%) to Lela Agro, the pressure of repayment would be much higher and the wholesaler would find ways out to pay because Lela Agro may find an appropriate enforcement mechanism to have its money back.

The sale of bags is profitable if they are sold in bulk because the transaction costs (i.e., travel expenses, phone calls) are high at the downstream of the chain. For the semi-wholesalers, the sale of PICS bags is simply a service rendered to the community. The margin for the semi-wholesale is very low (75 FCFA/bag without accounting for the travel costs and other fees.

Cowpea production in 2011-2012 was not good because of flooding problems in some villages.

Challenges faced in developing the supply chain

Challenges faced by PICS project

The choice of the wholesaler is a real challenge for the project team. The project has selected a wholesaler who is not interested in trading PICS bags. Gansou prefers other types of markets, other activities with large margins. The margin on the sale of PICS bags is low and did not motivate him. The challenge today is to find a new wholesaler for Togo who is motivated and committed to invest his capital.

Challenges faced by partners

PICS bags commercialization is a risk for distributors in the supply chain (October, November, and December). The solution to assist chain actors is to subsidy the bags to reduce the cost of production or the cost of importation. Analyze and see where and how the importing costs can be reduced to contribute to the reduction of end-users prices and consequently increase the margin for semi-wholesalers.

The government can make the decision, but it is necessary to implement a mechanism that enforces this policy to take place. The agricultural policy and government policies (i.e., tax, subsidy) need to take into account the fact that PICS bags use is seasonal.

Batana advised that the fact that there was no direct national wholesaler based in Togo was a source of most problems in the supply chain. Batana and Djadé sought for a new wholesaler for Togo because the need for a new order of bags was urgent, as the actors started experiencing rupture problems and the wholesaler from Benin was not willing to invest in the procurement of the bags.

Challenges faced by PICS' other actors in developing the supply chain

The transportation of bags for distribution was an important problem for the wholesaler and the semi-wholesalers. Gansou used his own vehicles to dispatch the PICS bags through the network when it was possible and available. In addition, it was very difficult for the wholesalers to dispatch the PICS bags in the network. He noticed that the transportation cost was very high compare to the margin. Along with this, the bales are heavy. Transporting a bale of bags from Lomé to Sokodé is 7000 FCFA; and from Anié to Sokodé is 5000 FCFA. Moving the bags from the semi-wholesaler's store to various villages or localities is very expensive. Lastly, the production of cowpeas this year was low because of the poor or irregular rainfall.

Strategies developed to encourage private actors' investments.

The main strategies developed by the PICS project to encourage private investments are numerous. The first was providing financial support to the wholesaler at the beginning of the project to help the wholesaler procure the bags. About 17,000,000 FCFA was provided. This fund was gradually repaid by the wholesaler. A second strategy was purchasing bags from the semi-wholesalers and retailers for demonstrations. The PICS project, through IITA, has purchased from the wholesaler about 6,000 bags (at a cost of 6,000,000 FCFA) for demonstrations conducted by technicians. The third strategy was hiring a business consultant to help the wholesaler in the development of the distribution chain. Fourth was the recruitment of a media consultant (journalist) to organize and handle the communication component of the project in Benin: radio spots (awareness, demonstration, monitoring, opening, and marketing), radio broadcasts, interactive show on radio, and print media coverage media of the main activities. Fifth was the organization of several training courses in 2010 and 2011 for semi-wholesalers on the initiative of the PICS project. Sixth was sponsoring the technical activities of the project to create and stimulate the demand for PICS bags, including awareness, demos in the villages, open-the-bags ceremonies, markets demos, and training of NGOs and journalists. Last was sponsoring media activities, including radio spots, video, newspaper articles, and media coverage during the opening ceremonies.

Challenges and opportunities to supply chain sustainability

To improve sales of PICS bags, it is suggested to (1) increase the margins of semi-wholesalers and retailers to offset the transaction costs associated with the distribution of the bags; (2) continue to strengthen radio ads and television spots with respect to the cropping season; (3) avoid ruptures by supplying sufficiently the semi-wholesalers and retailers; and (4) ensure timely delivery of the bags to retailers

For sustainability of the chain, (1) make the order not later than July of each year; (2) Partner to become a wholesaler to minimize the risk; and (3) train and strengthen the network actors on a regular basis.

Lessons Learned

The choice of a wholesaler with a pre-existing functional network is not necessarily a guarantee for a success of the chain. It is best to work with people that can create a network. The selection of the main actors in the supply chain is a determinant for the development, evolution and sustainability of supply chain. The PICS bags distribution cannot be developed by a wholesaler as secondary activity. The key lesson is that the PICS supply chain will be develop by actors who consider PICS bags business as a primary activity and are really self-motivated to invest.

A good mechanism for coordination, monitoring and evaluation and planning of the project partners (Purdue University, IITA, ICAT, media partners, business consultant, and the representative resident wholesaler, Akoutou) is an important success factor for the PICS bags supply chain.

The use of distribution network based on social relations is a force for success in the distribution chain in Togo, but it is not sufficient to achieve the best sales results.

Trainings and vendors' meetings, in particular the semi-wholesalers, strengthen the distribution network. A mechanism for strengthening stakeholders is essential for the sustainability of the chain. The training of semi-wholesalers and the creation of a platform linking up all the actors of the chain is essential for better coordination and to the expansion of the distribution of PICS bags.

The establishment of a flexible, efficient, and effective monitoring system may help boost the sale of the PICS bags. The business consultant and the sales representative of the wholesaler were expected to play this role in the network. The consultant's role is very crucial in the development and evolution of the supply chain. The business consultant of Togo had played his role and was able to strengthen the network.

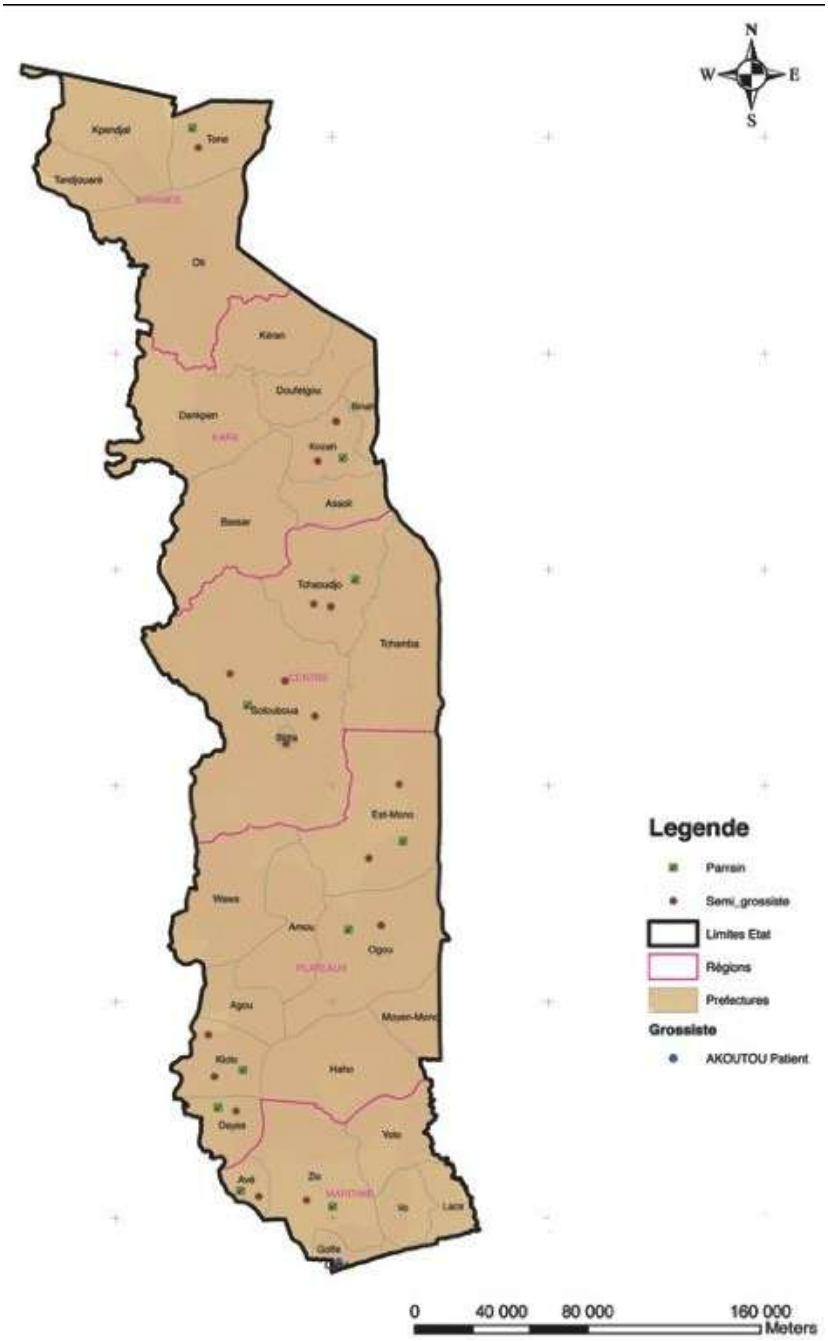
Setting the price of PICS bags for actors across the chain during the first year and the dissemination of these prices on radios is one of the factors that hampered the development and sustainability of the distribution chain. Indeed, the reference price helped launch the sale of bags in order to create the demand at the producer and other end-users' level, but this strategy failed to continually motivate chain actors, including the semi-wholesalers and retailers, especially those located at the remote villages. The majority of these actors were discouraged given the high transaction costs. The reference prices did not taken into account the additional costs of transport, communication, handling, and taxes at the downstream of the chain. Even though this promotional price is just for the first year, that fact that the price was advertised on radios without any additional explanation has impacted the sales.

The financial support of the PICS project to the wholesaler during the first order is a good initiative to motivate the wholesaler to invest but this is not a sufficient condition. It is important that the wholesaler contributes at least to 50% of the investment and discuss directly with the manufacturer the terms of payment. This may improve his commitments for the sale of the bags. He can benefit from the support of Purdue University if necessary as a moral guarantee vis-a-vis the manufacturer.

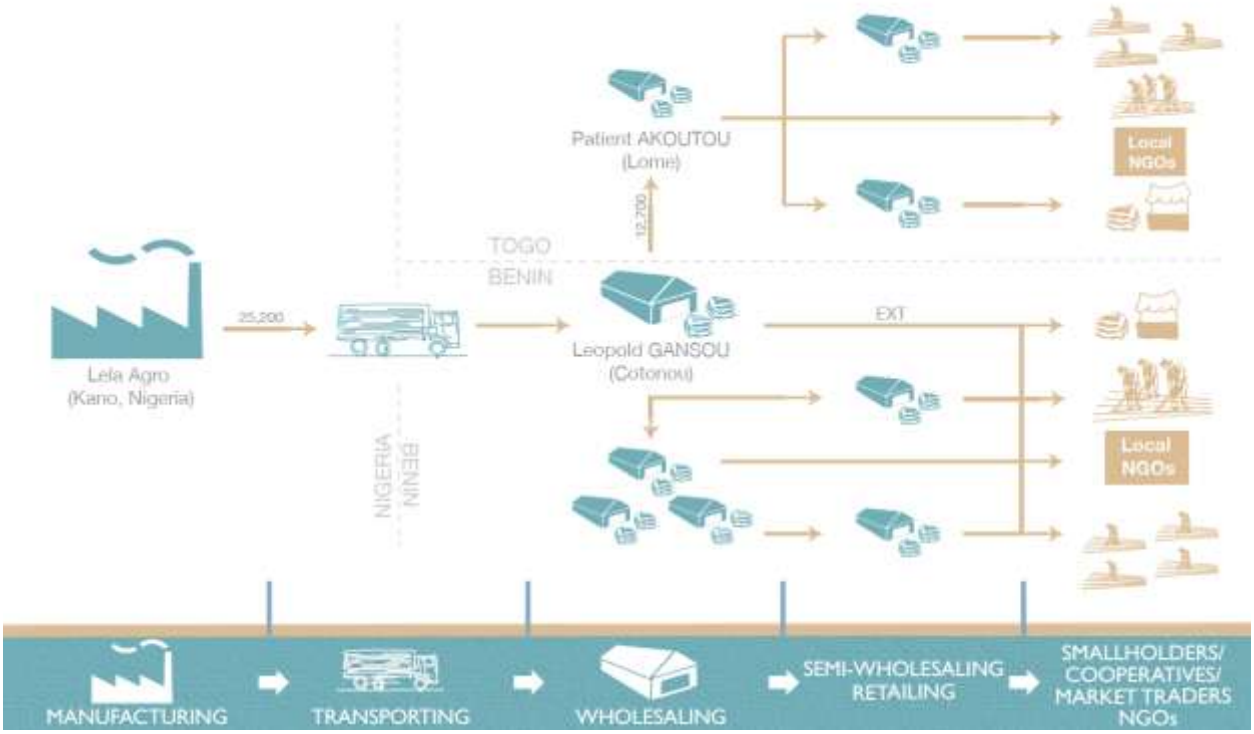
Promotional activities of the PICS technology such as sensitization, demonstrations, public open events, radio messages, articles published in newspapers, and media coverage of events have contributed greatly to inform people about the bags and to stimulate the demand of bags. The major constraint was that the radio spots were conducted with delays regarding the cropping season, which offset the effects of the promotional activities in 2009-2010 and 2010-2011.

ANNEX

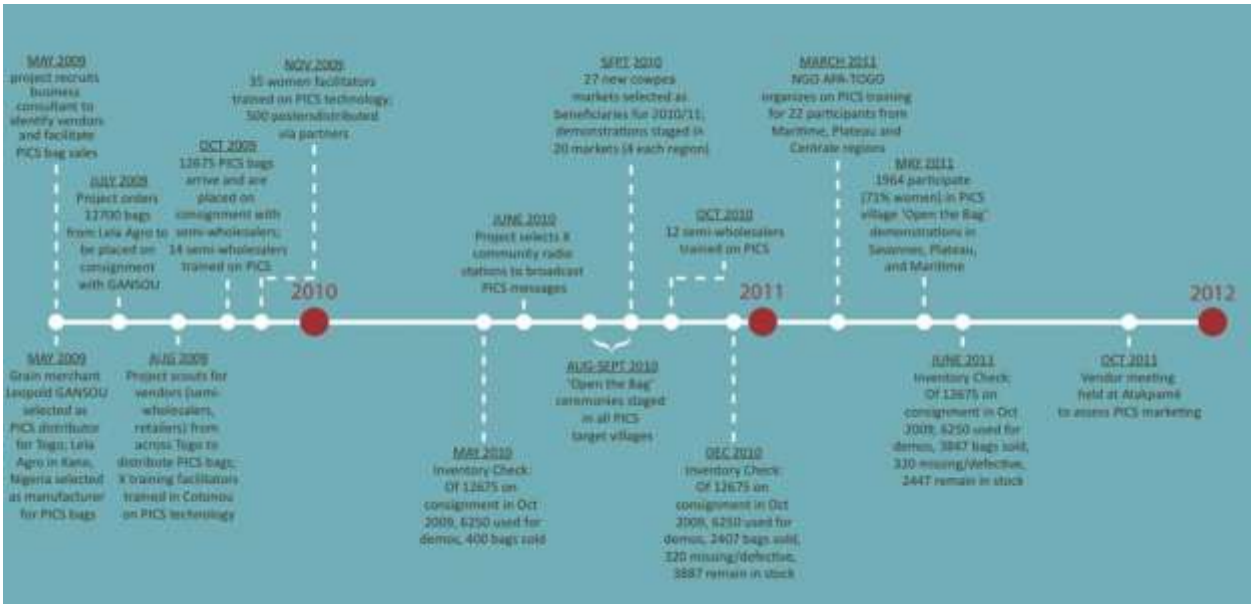
Figure 1: Map presenting the distribution network of PICS sack in Togo



<u>Figure 2:</u> Supply chain of PICS bags in Togo



<u>Figure 3</u>: Evolution of PICS project in Togo: 2009-2012



CONCLUSION: LESSONS LEARNED

Funded with support by the Bill and Melinda Gates Foundation, the PICS project has, since 2007, been pioneering investments across ten countries in West and Central Africa in the development of commercially driven supply chains for its innovative on-farm storage technology. The project has been testing various strategies designed to encourage investments by manufacturers and local, independent vendors to expand the PICS supply chain. There have been a number of successes, yet progress across the PICS landscape has been uneven. This study is an effort by the project and its partners to document and learn from the experience to date. The following is a list of key lessons learned based on a cross-country analysis of the ten case studies presented in the previous chapters. Critical bottlenecks and notable achievements are highlighted along with, where suitable, some prospective recommendations on how best to support the future growth and sustainability of supply chains for PICS bags and other agricultural innovations. Lessons learned include:

1. **PICS bags are well adapted to smallholder farmer storage needs** - The PICS triple-ply, hermetically sealed storage bags were designed specifically to meet the needs of smallholder farmers for affordable on-farm storage of cowpea. Evidence of strong and growing demand for PICS bags across the region suggests that the technology responds well to farmers' needs, offering them a compelling value proposition. Data also suggest that price does not significantly impinge upon the average farmer's willingness to invest his or her limited resources in PICS technology.

2. **PICS bags are not as well accepted by large scale traders** - The high, up-front cost of PICS technology relative to other conventional, chemical-based storage methods is a significant obstacle, and adoption has been relatively limited. This is especially true among high-volume traders who want to maximize their profits and who view storage expenditures as a sunk cost. Based on a rough comparison of initial costs and not taking into account the storage period, PICS bags are 80-90% more expensive per 100kg of stored cowpea. In addition, anecdotal evidence from Northern Nigeria, Benin, and elsewhere suggests that many cowpea traders view PICS technology as a threat to their business model, which includes insecticide sales. Nonetheless, growing health concerns about the use of pesticides for the storage of cowpea could in time increase the demand for untreated, chemical-free cowpea, and thus, the use of PICS technology among cowpea traders.

3. **Incremental rollout was a good strategy** - The PICS project benefited from a progressive rollout over five years (2007-2012) and ten countries. This step-wise expansion became a significant learning asset and contributed to an ever-expanding knowledge base of best practice over time. As the project's geographical scope expanded into new cowpea producing countries, improvements in the project's design and approach were made based on notable successes and setbacks encountered and associated lessons learned from past experience. This allowed for a gradual refinement and validation of strategies, an evolution that becomes evident when looking at the experience across the entire PICS timeline. Future expansion into new cowpea production areas within the region as elsewhere will no doubt benefit from this existing knowledge base. Yet, markets dynamics vary considerably from one place to the next. Any future expansion should thus be preceded by a comprehensive market study to determine potential surplus storage capacity, to identify manufacturers and other supply chain partners, to target major production zones, and to better understand the competitive

landscape and market preferences (e.g., consumer, norms/standards), among other information key to planning and strategy development.

4. **Risk sharing needed for manufacturers and vendors -** Investing in new technologies like PICS bags poses considerable risks for manufacturers, vendors, and other supply chain actors. Strategies are needed to help them address these risks via risk sharing, risk transfer or risk mitigation mechanisms. How to structure and finance the procurement also poses a significant challenge. The project's initial engagement in tripartite arrangements with manufacturers and vendors involved direct financial support for the procurement of PICS bags. This approach carried significant risks for the project. Such risks were beyond the scope of the project to manage effectively and led in some cases to considerable but temporary supply chain disruptions (e.g., Burkina Faso, Niger). Zero-risk or no-risk approaches such as "guaranteed markets" (e.g., via the direct purchase of demo bags from vendors or use of vouchers) and cost-sharing of promotional activities offer alternative approaches that carry limited risk but may be effective in incentivizing private sector participation and investments in the supply chain.

5. **What type of vendors sells the most PICS bags? -** Full-line agro-dealer networks selling a range of complementary inputs such as seeds, fertilizers, and crop protection products can be effective distribution channels to get PICS bags into the hands of rural farmers; however, they are not the only game in town. Evidence suggests that alternatives such as mobile cell phone scratch card and school supply vendors can be equally effective in marketing PICS bags. The most crucial qualities are that vendors' business model is appropriately oriented toward the provision of good and/or services rather than toward output markets. For example, the PICS experience in Benin and Nigeria suggests that grain traders' output market orientation and revenue model is in many respects inimical to the activity of marketing PICS bags. Many grain traders see the PICS technology as a direct threat to their business. In Niger and Togo, by contrast, successful vendor networks have piggy-backed on the channel distribution of mobile phone cards and school supplies.

6. **Is there a public sector role in the PICS supply chain? -** The PICS project worked closely with national research institutes and public extension services in all ten countries. These partnerships were vital to securing necessary local commitment and reaching farmers. Yet, while such institutions can be an effective way to expose farmers to the technology and broaden awareness, they do not constitute a viable long term distribution channel. Extension agents, in particular, are close to farmers and wield considerable influence over farmers' technology adoption and investment decision-making. Thus, the project worked closely in partnership with RDAs in most countries to facilitate local, "last mile" distribution to farmers in rural areas on a consignment stock basis. However, widespread incidences of non-payment of cash collected from sale of consigned bags presented significant challenges to the supply chain's viability. In some countries, however, agents acting independently from the RDAs and sourcing directly from PICS bag vendors on an ad-hoc basis became effective mobile vendors of PICS bags at the village level. Scope exists to leverage extension agents more broadly as retail sales channels by facilitating direct relationships between individual agents and local PICS bag vendors.

7. **Credit is not a key constraint, but low profitability for vendors and risk are -** Lack of access to institutional credit does not in itself constitute a binding constraint to supply chain growth. Many vendors active in the PICS supply chain, particularly those operating

upstream at the wholesale and semi-wholesale levels, have banking relationships and are able to meet basic collateral requirements. However, high interests rates, the slow rate of turnover, and risk discourages vendors from using borrowed capital to finance their stocks. An analysis of borrowing costs indicates that at prevailing rates vendors would need to more than double their current sales volume in order to simply meet their loan repayment obligations. General distrust and lack of understanding about how banks work further discourages institutional borrowing, most notably among retailers. In such an environment, identifying ways to more fully leverage informal social capital already established within vendor networks is fundamental to supply chain development. Identifying ways to encourage wholesalers to sell PICS bags more broadly on credit or partial credit and on consignment stock could be explored. Vendor training to increase book-keeping, inventory management, and communications skills is one example.

8. **First year reference prices have surprisingly long run effects** – Reference price strategies designed to protect buyers and discourage market speculation can significantly dampen investment in the supply chain in subsequent years, especially downstream. In all countries, the project in collaboration with vendor partners identified a price ceiling at which PICS bags would be marketed to farmers the first year. This price was initially communicated to the market via promotional events and advertising. In many cases, these price targets carried over into subsequent years, orienting consumers around a target "benchmark" price. An analysis of how margins are distributed across the supply chain in all ten countries suggests that upstream vendors (e.g., wholesalers, semi-wholesalers) capture (on a proportional basis) the vast majority of available margins, and this pattern is exacerbated under any reference price plan. Retailers have difficulty in securing sufficient margin from the sale of PICS bags to cover their marketing costs and make a reasonable profit from their activities. Facilitating open market price discovery after the first year is preferred. In particular, reference prices should not be part of the project supported advertising and promotional materials in the second and subsequent years.

9. **Crop forecasts are key to timely availability of bags -** Demand for PICS bags in any given year depends on the harvest, but manufacturers and distributors lack the information and tools to forecast inventory needs. In many cases, distributors waited until after harvest started to order bags. This contributed to delayed delivery of bags, debilitating ruptures in supply, and unsatisfied demand. Miscalculations of demand also led to costly "dead stock" when poor and uneven rainfall in many areas contributed to significant declines in bag demand. The project addressed this challenge in part by facilitating yearly vendor meetings when supply chain actors meet up to discuss challenges and set up a procurement plan for the coming season. In order to strengthen the ability of vendors to procure and stock the right amount of bags at the right time, further and deeper investments are needed in procurement and inventory management. Facilitating access among vendor groups to information from weather and crop forecasting agencies and public extension agencies that can help vendors better gauge planting acreages, expected output, and thus, demand for PICS bags is illustrative of such investments.

10. **Trademarking the PICS logo was a useful step, but it is no substitute for patent protection** – At the suggestion of PICS manufacturers and distributors, the project initiated the process of trademarking the PICS logo in 2009. The trademark provides one tool for the PICS supply chain to discourage substandard bags. Patent protection would have been an even stronger tool, but it was originally not pursued by the university and is no longer an

option since the unpatented technology is already out in the public domain. Anecdotal evidence from Burkina Faso suggests that farmers seeing value in the PICS brand as a certification of quality are willing to pay a slightly higher price for PICS-branded bags over competing, lower priced products. Potential scope may now exist to leverage the PICS trademark via innovative licensing arrangements to safeguard PICS quality standards and encourage new investments in PICS bag production and distribution in the region as elsewhere.

11. **Project business consultants played a key role which should be gradually shifted to the private sector** - Beginning in 2007, the project recruited one or more local consultants in nine of the ten PICS countries to assist with supply chain development efforts. Input from stakeholders indicates that PICS business consultants have made a significant contribution to the project's success in most countries. Their role has focused on working with manufacturers and wholesalers to identify new downstream vendors and expand distribution networks, facilitate bag procurement and delivery, and increase bag sales. Given their important role, incremental cost-sharing arrangements with manufacturers and/or wholesalers should be explored to ensure an appropriate and non-disruptive exit strategy for the project and its funding.

To be competitive in today's globalized food markets, smallholder farmers need new and better technologies. Once developed, agriculture innovations need to be mainstreamed into the marketplace to make them available to rural farmers when and where they need them. In addition to reliable and timely delivery, affordability and accessibility are key. Near-farm availability and access to information on their use are also critical to uptake. In order for innovations to have a positive impact on farmer productivity and income, supply chains must effectively get these tools to the right place, at the right time, in the right quantities, and at the right price. The PICS project provides important ag input supply chain development examples which should be the foundation for future improvements in seed, fertilizer, pesticide, and other farm input marketing in Africa.

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