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Project Methodology: Using Markets to Promote the Sustainable Utilization of Crop Genetic Resources

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Introduction

Ultimately, the question of how well local markets provide farmers with access to crop genetic resources is an empirical one. Hence, beginning in 2004, the United Nations Food and Agriculture Organization (FAO) undertook a major research effort to identify and gather the requisite information. This ambitious effort included partnering with the Consultative Group on International Agricultural Research (CGIAR) centres of Bioversity International, the International Food Policy Research Institute (IFPRI), the International Maize and Wheat Improvement Centre (CIMMYT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the M. S. Swaminathan Research Foundation in India, the Institut d'Economie Rurale (IER) in Mali and Fundación Promoción e Investigación de Productos Andinos (PROINPA) in Bolivia to design and execute five field studies that would provide insight into local markets and the access to crop genetic resources that they offer farmers. A key part of the research focuses on how the characteristics of local seed markets affect the price, availability and information about crop genetic resources exchanged therein.

Since, ultimately, the research is designed to provide policy guidance, attention was also paid to how policies, regulations and programmes might affect the access observed across cases. In short, the case studies were designed to provide a novel window into how access to crop genetic resources in local markets varies for a sample of farmers and markets across five countries, and the degree to which policies and regulations could be driving these differences.

We utilized a combination of quantitative and qualitative tools and analyses, combining methodological approaches from several disciplines, including economics, anthropology, sociology, geography and genomics. The research methodology was developed through a series of project workshops held at FAO headquarters in 2004, 2005 and 2007. The participants in the workshop included members of the research team from each of the case study sites, core FAO staff working on the project and external experts. Smaller working groups were established that focused on specific methodological aspects, including developing the sampling and instruments for the market and household surveys, the value chain analysis and the participatory focus groups, and, perhaps most innovatively, estimating the diversity of crop genetic resources in local markets.

Defining the boundaries of the study

We sought to employ a fairly standardized methodology across five very different case studies, without attempting to control for variables such as differences in crop species. Even across crops within a single country, differences in agro-ecological zones can drive differences that cannot reasonably be anticipated or accounted for – such as harvest times and average yields. And institutional differences are so vast that to infer any results across five country studies is suspect. Rather, our case selections are designed to provide as much descriptive detail as possible across a range of interesting cases. Within each case, attention was paid to sampling issues to ensure variation across factors of interest (e.g. market characteristics), and to control across factors expected to be significant but not under study (e.g. population densities).

Site selection

Country study sites were chosen based on several considerations. Our selection offers examples that cover a range of development: from fairly commercialized agricultural systems in Mexico to more subsistence-oriented ones in Mali. It includes both major (e.g. maize and potatoes) and minor (e.g. pigeonpea, sorghum and small millets) crops. The cases illustrate the effects of different types of policies and regulations, from emergency seed relief to government seed subsidy programmes. Because our goal for this work is to feed into the policy process, countries where policy-makers have an interest in seed regulation and/or the management of local seed markets and crop genetic diversity were

Table 3.1 *Selected case study countries and crops*

Mexico	*Kenya*	*Mali*	*Bolivia*	*India*
Maize	Pigeonpea	Sorghum and millets	Potato	Small millets

Source: chapter authors

attractive. Other considerations such as cost and the availability of funding, local partners with the capacity for implementing the research, and site-specific risks were factored in as well. The final selection of countries and crops is presented in Table 3.1.

Table 3.2 provides some key country indicators in agricultural development and statistics related to the case study crops. The values range considerably

Table 3.2 *Key indicators of case study countries and crops*

	Bolivia	*India*	*Kenya*	*Mali*	*Mexico*
Population					
Total population (2006 estimate) (thousand)†	9354	1,151,751	36,553	11,968	105,342
Percentage rural population†	35.3	71.1	79.0	69.0	23.4
Percentage agricultural population†	28.9	50.8	72.6	53.8	20.0
Agricultural population per hectare of arable and permanent crops land (persons/ha, 2003–2005)•	0.8	3.4	4.5	1.3	0.8
Rural poverty (%) (various years, 1997–2004)‡	83.5	30.2	53.0	75.9	27.9
Economy					
GDP per capita, PPP (constant 2005 international US$)•	3816	2393	1421	1025	11,801
Agriculture value added as percentage of GDP (2003–2005)•	15.2	19.3	28.2	37.2	3.9
Agriculture value added US$ per agricultural worker (2003–2005)•	300	219	169	161	1091
Agricultural value added per capita (US$, 2003–2005)•	121	107	114	139	231
Crop					
Case study crop†	*Potatoes*	*Millet*	*Pigeonpea*	*Sorghum*	*Millet*	*Maize*
Area harvested (ha, 2006)†	135,577	11,752,000	196,261	902,682	1,472,137	7,337,937
Production 2006 (tonnes)†	754,851	10,566,000	110,662	730,040	1,060,244	21,764,652
Yield (tonnes/ha, 2006)†	5.57	0.90	0.56	0.81	0.72	2.97
Export unit value (US$/tonne, 2006)†	114.17	219.61	n.d.	0 (no exports)	305.84	202.62

Note: n.d. = no data.
Source: † = FAOSTAT (2009); ‡ = World Bank (2009); * = FAO (2008); • = World Bank (2008)

Table 3.3 *Summary of Kenya Working Group on Site and Crop Selection*

	Crop no 1 Pigeonpea	*Crop no 2 Sorghum*	*Crop no 3 Green vegetable*
Substantial local diversity	YES	Fairly limited	YES
Evidence of genetic erosion	Yes: replaced with maize	Yes: replaced with maize	Not clear
Importance to food security	YES (subsistence and income)	YES (subsistence and income)	YES (famine food and income source)
Traded in markets	YES	YES	Output market is strong; seed market weaker
Availability of improved varieties	Available	Available	Available, but selection is weak and mostly from external sources
Substitute crops	Maize	Maize	?
Agro-ecological zone	Arid/semi-arid – low potential	Arid/semi-arid – low potential	High potential
Existing FAO/crop genetic centre work	ICRISAT	ICRISAT	IPGRI work on diversity
Policies to consider	Emergency seed relief New Kenyan seed law	Emergency seed relief New Kenyan seed law	

Source: FAO (2005)

across countries, with Mexico the greatest outlier in terms of gross domestic product (GDP) per capita and agriculture as a percentage of GDP.

The sites represent areas where the chosen crops, to varying degrees:

- have importance for food security;
- are believed to contain a significant level of local genetic diversity, with genetic erosion occurring; and
- reveal some market integration.

As is often the case, the selection of the specific study sites within countries was also opportunistic, building upon existing work in the field of partner institutions. In particular, sites and crops where agro-morphological and genetic characterization work had already been conducted were considered highly desirable since this process is expensive and time consuming.

While site selection seems a fairly simple step in the research process, it is actually highly complicated by crop- and country-specific issues. Table 3.3 gives a summary of the very lengthy deliberations around three crops considered for a Kenya case study, informed by individuals working in country. The decision among crops necessarily involves trade-offs between practicality, generalizations

and normative opinions on which criteria (e.g. evidence of genetic erosion or importance to food security) are most important.

Research team members identified four potential crop sites in Kenya, Mali, India and Bolivia, and the full project methodology was implemented for each of these cases. The Mexico case study was initiated by CIMMYT during the 1990s, with FAO entering into collaboration in 2005. While the methodology and dataset are different in this case, unique insights on the main project questions were possible to obtain with the Chiapas time series data that are unavailable from cross-sectional data alone.

RESEARCH QUESTIONS

Our overarching research question is how access to crop genetic resources varies across local markets as a function of market characteristics and the institutional environment. Its corollary is how variations in market crop genetic resources (CGR) access affects farmer welfare and on-farm crop biodiversity.[1]

As a start, defining markets and diversity became a prerequisite to designing a standardized methodology and sampling principles. Two preliminary questions were:

1 How do we define a market and what is a valid measure of access?
2 How do we measure diversity?

Markets: A location or transaction?

The term markets is used to convey a wide range of concepts, ranging from a physical location (the local market), to a form of exchange that allocates resources primarily via a price mechanism. Our focus is on the transaction: exchanges between a farmer as buyer and a seller in a voluntary transaction that may involve seeds from either the formal or informal sector (e.g. certified seed of improved varieties, or local landraces). In most of the case studies, and, indeed, in many developing countries, local agricultural markets (a physical location) are the site where these types of transactions are mostly likely to occur. Local agricultural markets comprise periodic (weekly, daily or other periodicity) gatherings of buyers and sellers in a fixed location. Frequently these are open-air markets, although more permanent structures and cover can also be found. The definition of the market varies in each case study; but across all of them the analysis is conducted at the 'top' of the market chain, the retail or 'micro-retail' (Fafchamps and Vargas, 2005):

> Markets are defined as a local institution where a conglomeration of buyers and sellers meet on a periodic basis to exchange commodities and seeds or other planting material (and, thus, crop

genetic resources). Local means that farmers are buyers and/or sellers in the transaction.

The case studies offer contrasting views and unique features of market structure and performance. In all case studies with the exception of Mexico, the focus was on weekly or daily local markets for agricultural products where seed was exchanged. In Mali, millet trade conventions reveal the role of cultural norms in distributing crop genetic resources. In Kenya, pigeonpea trade highlights the variation and quality of information of seed types and lots available through different marketing channels. Output market forces in Bolivia have created distinct marketing channels that demand specific qualities and attributes of potatoes that affect the portfolio of varieties selected by farmers. Imperfect communication between retailers and buyers about the characteristics of grains sold to farmers and a limited availability of modern varieties creates both information and physical failures in small millet markets in India. In Chiapas, Mexico, the effects of trade and seed policy on the price of hybrid maize seed from input shops and *despachos*,[2] relative to the price of seed of landrace varieties, affects farmer sourcing decisions.

But all of these cases illustrate three important components to crop genetic resource access. Access is the ability to acquire the desired quality and traits embodied in the seed, which depends upon the physical availability of a diverse range of crop genetic resources, the information provided about them, and the costs associated with their acquisition. More ample definitions of what is included in each of these three dimensions of access is as follows:

- *Availability:* defined as the quantity and diversity of the seeds of adapted crops and varieties on supply in a market, including the range of genetic resources that they embody and the attributes they provide. Availability includes timing: that seed and the genetic resources of seed are available in the market at the time they are needed by farmers.
- *Cost:* expressed by the affordability of the seed (e.g. the extent to which the benefits or returns associated with the seed and its genetic content are higher than the costs of obtaining the material through the market). Sale prices of seeds comprise one key component; but, in addition, factors such as financing arrangements for obtaining seed, transportation and other costs that may be involved in obtaining it are also included.
- *Information:* the degree to which a farmer will benefit from available and affordable seed in local markets depends on whether they know that the seeds are available, if they have information about the genetic content and/or quality of the seed, and its potential adaptability and interaction with the farm micro agro-ecology. Maintaining varietal identity in seed transactions and providing information about its provenance, genetic content and quality of the seed itself are all included in this dimension of access.

Measuring crop genetic diversity in local markets

This project breaks new ground in estimating the amount of crop diversity, and its distribution and structure, in seed markets. The research design required developing and applying methodologies to measure diversity in retail market outlets and to relate those measurements to farm levels of diversity. Our primary interest is within (intra-) species (genetic) diversity measurement. However, the amount and distribution of genetic diversity of any crop in a production system will often be affected by changes in the number and types of crops grown. Estimates of inter-crop diversity may also be important to understanding intra-crop diversity patterns. Determining the physical availability of genetic resources involves describing the diversity of crops, of varieties within crops, and of genetic variability within and between varieties. Three main types of information useful to these estimations are:

1 variety numbers and quantities;
2 agro-morphological variation for selected traits;
3 molecular (or biochemical) genetic data.

Variations in the crop reproductive system and seed physiology give rise to differences in the type of data that is most useful. For example, varietal identity is considerably more complicated to establish with crops that are cross-pollinated (maize and millets), compared to those which are reproduced through clones (potatoes); thus, each case study collected data relevant for measuring crop genetic diversity specific to their crop. In all cases, however, data was collected on both the numbers and the distribution of varieties and characteristics.

Varietal identity

Establishing variety identity or, more accurately, the way in which variety identification works and the extent of an agreed common identification of varieties, is central to obtaining the required estimates of diversity. The number and amount of varieties can themselves be used to provide useful first estimates of genetic diversity. Provided that varieties are commonly and consistently identified, they provide information on the structure and organization of diversity within a given system, providing the framework to link to individual farm populations or seed lots. Obtaining an understanding of the degree to which errors occur in varietal identification (e.g. the extent to which market vendors correctly identify the varieties that they sell) is another important aspect of establishing varietal identity in a market setting.

The procedures adopted in the case studies were designed to ensure that information on seeds from both the formal and informal sectors was obtained. The problems of variety determination, especially for traditional varieties, are well known. Farmers and market vendors may differ in the names they give to

their varieties, using the same name for different varieties, different names for the same varieties, or even no particular names at all. These problems become more common as one moves from the farm to the market level of analysis and are particularly acute for less common varieties.

Prior information from the study sites indicated that variety identity was treated more casually in markets than on farm, thus creating significant identification problems. Even when the same names were used within a marketplace and a community for the same agro-morphological entity, there was much more contamination or mixing within markets. The project response to dealing with this issue varied depending on specific characteristics of the crop and seed; however, some general principles were established to guide the process. First, we adapted an approach based on the 'seed lot' concept from farm-level studies (Louette and Smale, 1996), where the physical entity sold by vendors was the study focus, and these could be grouped into varieties or types through interviews as well as characterization. Several different sources of information and analysis were employed, including focus group discussions with seed sellers, seller surveys and key informant discussions. These interviews were then supplemented with agro-morphological trials for Kenya, India and Mali and with molecular studies in the cases of Mexico, Kenya and Bolivia.

Varietal diversity

The number of varieties and the quantities grown, available or sold provides the basis for estimating variety diversity in terms of richness and evenness and for comparing diversity present across households, communities, sellers and markets. Divergence between farms within a community and between communities within an area can also be calculated. Varietal diversity measures will allow studies of some of the factors (access, wealth, landholding, etc.) that might be related to the distribution of diversity. However, varietal diversity will not fully reflect many aspects of the genetic diversity within an area. Varieties may be more or less similar, differing in a few or many characters, and may diverge significantly in the amount of genetic (agro-morphological and molecular) variation within or between them.

Agro-morphological variation

Field trials carried out within the community or in similar agro-ecological zones were used to obtain information on variation within and between samples for agro-morphological traits of interest. This analysis is particularly interesting for crops with low heritability (e.g. that are to some extent cross-pollinating). Traits of interest include important highly heritable characters (e.g. seed colour and panicle type) and quantitative traits (e.g. height and earliness). The information was used to confirm variety identification as well as to provide measures of diversity based on traits. Field trials included three to four replications. Comparisons of farm and market samples were also part of the agro-morphological study.

Genetic variation

A complete measure of diversity requires substantial genetic analysis, preferably using molecular markers. Given the expense of this step, samples can be maintained and used for specific questions once the analysis of variety and agro-morphological data have been carried out.

Molecular markers are particularly useful for determining such questions as the extent to which different samples of a variety (from sellers, households, locations, etc.) differ; effective population size; the origins of specific populations or varieties; the extent of differences between varieties; and the total genetic variation in a community.

SAMPLING AND INSTRUMENTS

The interdisciplinary nature of the research questions being addressed called for a varied set of research tools. For the analysis that is being presented in this volume, three main methodological tools were employed: a value chain analysis, an analysis of the policy and regulatory environment, and a quantitative vendor sample survey.[3] Table 3.4 summarizes these components, the methodological approaches used to implement them and their sequencing.

Value chain analysis in the context of seed systems analysis

Value chain analysis (VCA) is used to map out relations and flows of crop genetic resources (e.g. varieties) and seeds in formal and informal markets and how they relate to flows in output markets. Several research tools were employed in the VCAs, including farmer focus groups, key informant surveys and market observation surveys.

The flow of seed to farmers (e.g. the input market) and grain or tubers from farmers to the market (e.g. the output market) occurs along chains. These are referred to as value chains because as the product moves from chain actor to chain actor (e.g. from producer to intermediary to consumer), it gains value. A value chain can be defined as *the full range of activities that are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final customers, and final disposal after use.* The chain of actors who actually transact a particular product as it moves through the value chain includes input (e.g. seed suppliers), farmers, traders, processors, transporters, wholesalers, retailers and final consumers.

One of the most important aspects of the VCA is to help untangle the relationships between inputs and outputs in the agricultural markets (e.g. to what extent is seed distinguished from grain, or food product, in the case of potato, in the market?). The VCA is very useful in identifying the various actors in the market chains – both input and output – and their respective roles. The VCA

Table 3.4 *Steps in implementing the project methodology*

Activity	*Description*
Value chain analysis (VCA)	First research activity to be implemented as it yields important information needed to design the subsequent analysis. The objective is to map both input and output market channels for the target crop and to provide a basis for understanding how crop genetic diversity is being transmitted through the market chain and why. Results are used to select the sample of retail market sites and vendors for market surveys. The VCA should also highlight key policy, regulatory and other types of blockages in the system warranting further investigation in the policy and regulatory analysis. The method involves the use of both qualitative and quantitative data collection methods, including farmer focus group meetings and key informant interviews. Farmer focus groups are also to be used to identify the entire range of seed sourcing channels (e.g. both market and non-market), their strengths and weaknesses, and to describe the markets. Specific information to be collected: • Identify various market participants and their functions. • Identify channels in seed and grain markets at project sites going from consumer (e.g. farmer) to source (e.g. local, national and international). • Indicate volumes, quantities, grades, varieties and attributes and marketing margins for seed at various points in the chain. • Include formal and informal seed sector.
Quantitative vendor and household surveys	Data to be collected on market structure, performance and conduct, including measures of crop genetic diversity. Three instruments have been developed for data collection: the market observation, key informant and vendor surveys. The key informant survey may be thought of as a part of the VCA using a structured interview protocol. Timing for collecting these data is critical. The vendor survey must be done when seed is actually being sold on the market (after harvest) and this period needs to be determined via the value chain and focus group or pre-survey. It should be done. Samples should include both participants and non-participants in the market for seed of the focus crop. The surveys are intended to gather information on market participants, crops, varieties, attributes, seasonality, labels, regulations, quantities, and prices for the retail market outlets for seeds. The data collected in these surveys is used to develop market measures of diversity, information and prices for quantitative analysis.
Policy and regulatory analysis	Could be done at any point after the VCA. Covers not only seed regulation, but also broader policies affecting the supply and demand of agricultural products and inputs and the development of agricultural markets.

Source: Lipper et al (2007)

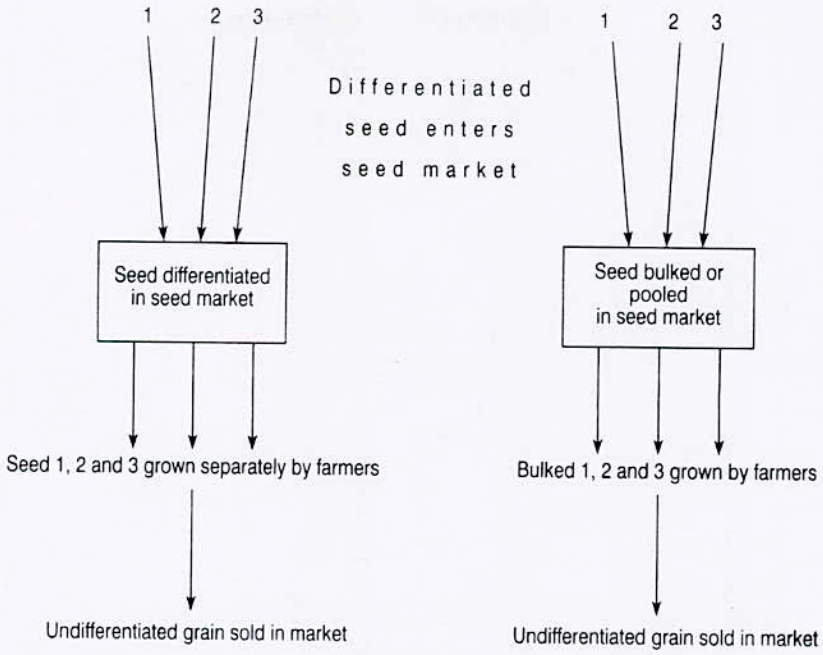
also provides important insights into pricing behaviour in the markets. In cases where market participants considered the information being sought as too sensitive to make a systematic survey feasible (e.g. the Bolivia case study), the VCA was a very useful tool for teasing out information that could not easily be obtained in sample surveys.

The first step in the VCA is developing a 'market map' to build up an understanding of the different players or actors in the seed and product (e.g. grain or tubers) and the relationships between them, along with the factors that determine how well or poorly the chains are working. An understanding of the role of different actors in these chains was useful in identifying where some of the other research tools, such as the vendors' survey, should be applied. The market map is made up of three interlinked components:

1 value chain actors;
2 enabling environment (infrastructure, policies, institutions and processes that shape the market environment);
3 service providers (the business or extension services that support the value chains' operations).

The enabling environment consists of the critical factors and trends that shape the value chain environment and operating conditions, but that may be amenable to change. These are also the focus of much of the policy and regulatory analysis described below. These 'enabling environment' factors are generated by structures (national and local authorities, research agencies, etc.) and institutions (policies, regulations and practices) that are beyond the direct control of economic actors in the value chain. The purpose of charting this enabling environment is not simply to map the status quo, but to understand the trends that affect the entire value chain, and to examine the powers and interests that are driving change. This knowledge can help to determine avenues and opportunities for realistic action, lobbying and policy entrepreneurship. The third component of the market map framework is concerned with mapping these services that support, or could potentially support, the value chain's overall efficiency. The services that can potentially add value are many and include market information (prices, trends, buyers and suppliers); financial services (such as credit, savings or insurance); transport services; quality assurance – monitoring and accreditation; and support for product development and diversification.

Once a clear understanding of the value chain is established through the market map, VCA can be used to identify key bottlenecks in accessing seeds and crop genetic resources. An example was discussed in the project workshop in 2005. The right hand side of Figure 3.1 depicts cases where seed is pooled in the market, versus cases such as in Chiapas, where the seed market maintains differentiated seed.



Source: Hellin and Meijer (2006)

Figure 3.1 *Two examples of seed and grain value chains*

The bottleneck described here is information lost about individual varieties that occurs with bulking of the grain or seed. The VCA can then be used to understand the factors that give rise to the problem as well as possible solutions to overcome it. Questions to key informants to gather this type of information included why is the seed pooled in the market? Do traders mix up varieties because they do not know what the differences are? Do traders mix seed because it is cheaper for them to deal with the seed this way? Are there extraneous policy issues that account for why traders bulk seed (i.e. a government subsidy for the number of bags of seed sold irrespective of what type of seed it is)? Why do farmers in the left-hand chain sow seed lots separately when the grain they sell is pooled by the grain merchants?

Analysis of the policy and regulatory framework

The purpose of this study component was to provide an in-depth analysis of the policy and regulatory framework that could affect access to crop genetic resources in agricultural markets. The institutional environment determines the rules of exchange in markets and affects all components of CGR access either directly (e.g. seed subsidies, national research and development), or indirectly (e.g. providing market physical infrastructure and, intellectual property rights). Additionally, understanding this policy environment helps to separate out market measures from the impacts of seed system interventions such as emergency seed relief, seed-sector regulation and seed and diversity fairs.

Key policies and regulations that affect the market chain identified in the VCA analysis include:

- a review of the legal and regulatory regime in the formal seed sector, with a focus on the targeted crops, including seed legislation (i.e. legislation on development, imports, evaluation, release, production and distribution of seed varieties);
- an assessment of any other national legislation or policy that may have an impact upon the development of agricultural input and output markets – this includes regulation/legislation on agricultural inputs, including legislation on agricultural landownership, farm credit programmes and input supply, as well as regulation or legislation affecting agricultural commodity production (e.g. price or quantity controls/support; deregulation under structural adjustment etc.);
- an analysis of the potential impact of existing legislation and policies on the content and size of seed flow in the formal and informal sectors and to the extent possible, quantitative estimates of the supply of local and improved crop genetic resources available to seed insecure farmers through different seed supply channels.
- an analysis of pending policy or regulatory reform that may affect agricultural markets and potential impacts upon access to crop genetic resources in agricultural markets.

Quantitative market sample surveys

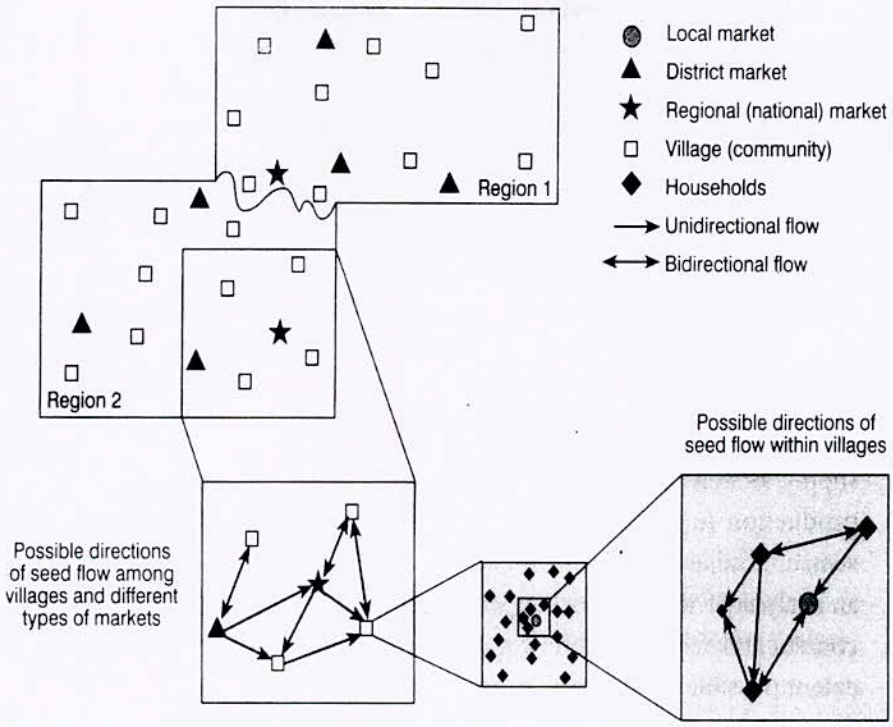
The project methodology called for the collection of quantitative market data through market observation and vendor sample surveys.

Sampling strategy and market-sheds

Two key principles to guide the selection of market sites for sampling were agreed upon:

1 Market sites were selected to have significant differences in crop genetic diversity (e.g. markets within and outside areas with seed system interventions likely to affect market functions).
2 All other factors that could have an impact upon farm-level diversity and welfare were kept as constant as possible by selecting markets in similar agro-ecological zones and population densities.

As teams began conducting the VCAs, it quickly became apparent that there were significant flows of traders, seeds and crop genetic resources between various markets in any particular location, and these could have very different characteristics (e.g. weekly retail versus daily wholesale). This gave rise to the need for a concept of the 'market-shed'. A market-shed is defined for this



Source: Toby Hodgkin and Monica Rodriques

Figure 3.2 *Distribution of markets and villages and seed flows in a market-shed*

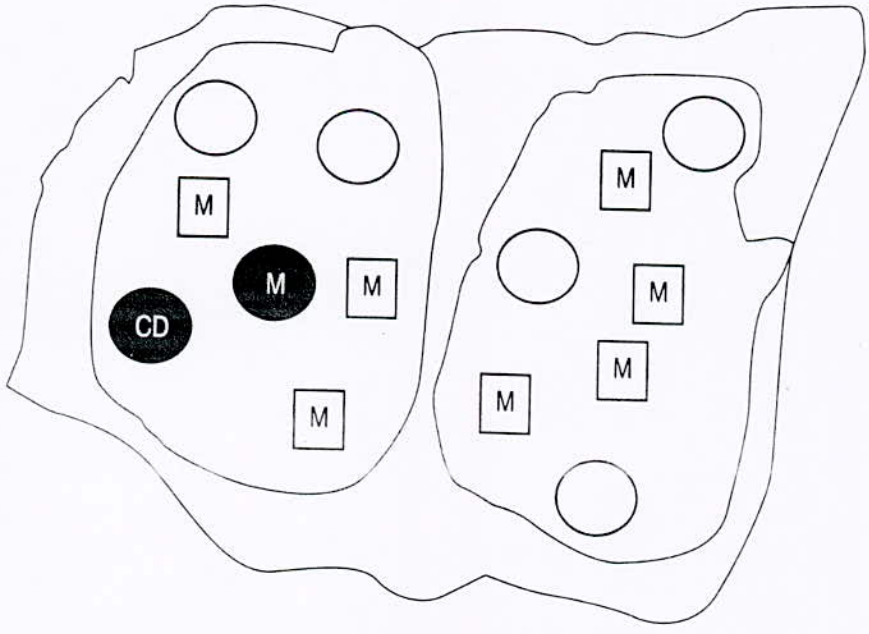
project as a geographical area and associated population that has real or potential trade relationships with a market centre. Within the market-shed there may be several market outlets of varying size and scope, although usually one is dominant in terms of size and function. We use the term market-shed to give the sense of a system or network of market flows within a given area (e.g. it is not just a zone with some markets located in it; rather, it is a trading network with links between market outlets). In the course of the value chain study, the structure of the market-shed was revealed (e.g. the links and nodes between the market outlets within a market-shed, as well as the size and nature – variety characteristics and sources – of seed flows in and out of these markets).

We strove to sample at least five markets within each market-shed. Variations in market characteristics are an explanatory variable – hence, the important issue is selecting enough markets to get meaningful variation in the characteristics of interest. To the extent that characteristics are correlated (so, for example, all markets within the market-shed that have a large number of buyers and sellers also have a similar heterogeneity of product), fewer market observations are necessary. If these characteristics are independent across markets, more market observations are likely to be necessary to pick up meaningful variation. Figure 3.2 illustrates a hypothetical distribution of markets and villages in adjacent regions, and the resulting seed flows in the market-shed, both among and within villages.

Control and treatment market-sheds

The Mali and Kenya case studies used the presence of a project or intervention (e.g. emergency seed relief and diversity fairs) to distinguish between market-sheds with and without the impacts of a project intervention. To avoid the problem of 'programme placement' bias, it was important to know, understand and document the reasons why the intervention was placed where it was placed; and to hold constant (between control and treatment zones) observable factors that are expected to play a major role in the impact of the intervention, such as the presence of another development programme, ethnicity, agro-ecology and overall level of development of market infrastructure. There is an imaginary boundary around both treatment and control zones (see Figure 3.3).

In the Mali site the sampled markets were weekly retail markets. The intervention defining control and treatment zones were diversity field fora and diversity fairs. In Kenya, two types of interventions for pigeonpea were used in defining the market samples. One was a non-market intervention of direct emergency seed distribution. The other was a market-based intervention, consisting of producer market groups and community seed production for sale. In Bolivia, the activities of PROINPA, a local non-governmental organization (NGO) working to strengthen potato seed supply, was used to inform the market sampling. The India case study used another approach to sample contrasting markets. In the Kolli Hills, the M. S. Swaminathan Research Foundation has intervened in a number of ways to develop the market channel



Note: Ovals are villages and boxes are retail weekly markets. The two interventions are shaded in dark grey (diversity field and seed fair). The overall zone should be as homogenous as possible in terms of agro-ecology and population density.
Source: Melinda Smale in FAO (2007)

Figure 3.3 *Diagram of control and treatment market-sheds*

for minor millet products; but farmers are largely autarkic with respect to seed sourcing. However, in Dharmapuri District, the major millet-producing district of Tamil Nadu in the nearby plains, there are well-developed markets for grains, but not for seed, and there have been no specific seed system interventions for small millets.

Sampling vendors

The seed vendor survey was the primary instrument used to collect quantitative data on the three dimensions of access: varietal diversity, information and prices that were present in the market. All data from the seed vendors were gathered over the relevant season for seed sales; indeed, in all of the case studies with the exception of Mexico, the timing of sales was one of the key means of distinguishing seed from grain sales.

It was not possible to implement quantitative vendor surveys in all sites due to the unwillingness of vendors to participate. Market data are highly sensitive and protected, and this is an issue that must be carefully addressed in research on market interactions. Long-term participant observation is one means of overcoming this problem, but not an option for a study with a relatively short time frame such as this. The use of key informants and structured interviews via the VCA and, to the extent possible, secondary sources of data to support conclusions was the route adopted in Bolivia when it became apparent that sample surveys of vendors were not feasible. The Mexico case study also relied on this method, due to the difference in the type of market outlet surveyed (e.g. commercial seed dealers), as well as differences in the study design (e.g. built upon and on-going CIMMYT–FAO collaborative research project). However, for the Kenya, India and Mali case studies, an innovative approach to sampling markets and vendors was applied.

The specific procedures used for sampling vendors varied in each of the case studies, depending on local circumstances; yet here again some main principles were established by the project to guide the work of each case study team. These were:

- Identify the main groups of vendor types within the market.
- Establish the period at which vendors selling seed were most likely to be active.
- Compile a list of the total number of vendors in each category that were likely to be present at the time the sample would be taken.

The VCA was used to collect the information necessary. Box 3.1 illustrates how these principles were applied in the Kenya case.

For the cases where agro-morphological characterization was deemed to be necessary (Kenya, India and Mali), the need to collect physical seed-lot samples from the vendors to use in the diversity analyses gave rise to a further dimension

Box 3.1 Vendor sampling protocol for Makueni, Eastern Kenya

The value chain analysis (VCA) indicated that seed vendors in local markets fell into five main groups: agro-vets; grain stores; local shop vendors; market hoppers; and farmer traders. The first three sold seeds from fixed locations over a well-defined period of time. The last two were itinerant, with variations in both the timing and locations of their market participation. Thus, two different sampling strategies were designed to capture information from each.

Fixed traders: Agro-vets, grain stores and local shop vendors

- A detailed inventory of the number of agro-vets, grain stores and local shops present in each of the market locations to be sampled in Makueni District was made. From the list, vendor shops selling pigeonpea along with other grains or crops were identified.
- A total of 160 vendors dealing with pigeonpea (either as grain or seeds) in over eight market locations were counted for these three vendor categories, ranging from small, medium to large in terms of their transaction volume and the number of crops they deal with.
- All 160 (belonging to all three types of vendors, including agro-vets) were included in the sampling frame.

Itinerant traders: Market hoppers/farmer traders

- Determine the period at which seed would be sold on the market. On the relevant 'market day', all open-air traders who brought pigeonpea solely or with other crops were counted.
- Care was taken to count itinerant vendors at the appropriate time of day (peak time of trading) to get the maximum number of participants.
- In market locations with less than 15 traders, a census was conducted (all were included in the survey).
- Where 15 traders or more were found, 60 per cent were selected for the sample. The sample was drawn by assigning each of the traders a number. Usually all these traders are seated next to each other in an open-air market at a certain part of the market that sells food grains/seeds. Traders for interviewing were selected randomly depending on whether their number was even or odd.
- This sampling and interviewing procedure was implemented for two market days in each market.

in designing the sampling strategy. The question was whether it was necessary to obtain seed samples from all the interviewed vendors, or whether seeds collected from a sub-sample of interviewed vendors would be sufficient. Again, the approach varied by the specific case study and the ability of traders to distinguish varieties. Previous research in India indicated that traders were able to differentiate types of millet crops, according to characteristics of the grain, whether it was a modern variety or farmer variety, but not by variety name (Nagarajan and Smale, 2005). However, this was not the case for pigeonpea in eastern Kenya. While traders reported some differences by colour and grain size, visual examination of the grain (peas) in the sacks showed no appreciable differ-

ences. Among those who sold in the open air, variety names were reported only when sold by a farmer trader or by a vendor who learned it from the farmer from whom it was obtained. This was important in determining the sampling strategy for the seed lot.

The Mali case provides a good illustration of how the seed-lot sampling was conducted. The research team noted that is was crucial to have good local partners to make this part of the survey work: people knowledgeable about local crop genetic resources for the selected crop, and who would take responsibility for the samples and the agro-morphological analyses. The Mali team put together a census of all varieties (or seed lots) sold by vendors in each of the sampled markets. They then calculated the log value of the total number of varieties sold by vendors on the day of sampling and used this as the basis for sampling seed lots.

The Mali approach adjusted for dominant and rare types by 'smoothing' the number of lots with the logarithmic function. In doing so, it reduced the number of lots that needed to be characterized but enabled good analyses of the between- and within-type diversity. Vendors from all groups were sampled based on market share and variety share. Drawing the sample for the seed-lot collection was built upon information derived from the VCA on the degree of variation to expect among each of the vendor groups in their pricing behaviour, variety labelling and information transmission (e.g. the two other dimensions of access to crop genetic resources in markets aside from crop genetic diversity).

Data collected in the market and vendor surveys

Survey data were collected from market observations and vendors on the characteristics of the exchange (where, what, with whom, price, quantity, timing, etc.), characteristics of the market (number of buyers and sellers, costs of entry and exit, regulation, range of products, size, location, frequency, etc.) and the information available. Together these define the institutional and physical dimensions of access to CGR in markets: availability through the quantity, diversity and timing of the seeds of adapted crops and varieties and other planting material on offer; affordability through their prices, the prices of other complementary inputs, acquisition costs (distance to market, market density, frequency and timing of sales, etc.); and information via labelling and the difficulty and cost of obtaining and verifying the quality and traits of the seed for sale.

Conclusions

Developing the methodology for this research project generated an important research outcome in and of itself by bringing together the concepts and tools of several disciplines to provide in-depth and innovative research on a complex, but highly important topic. The actual implementation of the methodology varied in each of the case studies in response to the specific characteristics of the site,

crop and people involved in the study, as well as previous work on the topic available in each case. The results provide us with very useful information not only on the markets themselves, but also on the way in which we can integrate the questions and approaches of a wide range of disciplines in order to tackle a complex research issue. At the same time it is important to note the limitations of the work: the case studies provide a rich insight into the status of access to crop genetic resources in a little researched but very important part of the seed system; however, they do not provide a comprehensive understanding of the role of local markets in the seed system or the ability to make inferences. The results of the studies are suggestive of where the key issues, bottlenecks and questions for future research lie and the application of the project methodology generates considerable insights into how such questions can be addressed. Future research, however, is still needed to provide a comprehensive view of this all important portion of the seed system.

Notes

1 The research involved in answering the second question is based on household level surveys and will appear in future publications.
2 *Despachos* are private individuals or organizations who provide agricultural services, and who assist (farmers) with the provision of credit and inputs and with soliciting funds from government assistance programmes.
3 Household-level surveys were conducted at all sites; the results are to be published separately.

References

Fafchamps, M. and Vargas, R. (2005) 'Selling at the farmgate or travelling to market', *American Journal of Agricultural Economics*, vol 87, no 3, pp717–734

FAO (United Nations Food and Agriculture Organization) (2005) *Using Markets to Promote the Sustainable Utilization of Crop Genetic Resources*, final workshop report, available at: www.fao.org/es/esa/en/wkshp_01.htm

FAO (2008) *The State of Food and Agriculture 2008: Biofuels: Prospects, Risks and Opportunities*, www.fao.org/sof/sofa/index_en.html, accessed 8 June 2009

FAOSTAT (2009) *FAO Statistical Databases*, www.faostat.fao.org, accessed 22 May 2009

Hellin, J. and Meijer, M. (2006) 'Guidelines for value chain analysis', unpublished report, FAO, November

Lipper, L., Anderson, L., Smale, M., Hellin, J., Hodgkin, T., Dalton, T., Almekinders, C., Audi, P., Bellon, M., Cavatassi, R., Diakité, L., Jones, R., Meijer, M., Nagarajan, L., Paz, A., Rodriguez, M., Sidibé, A., van Heerwaarden, J. and Winters, P. (2007) *Using Markets to Promote the Sustainable Utilization of Crop Genetic Resources: Project Methodology*, Agricultural and Development Economics Division, Food and Agriculture Organization of the United Nations, pp9–10, available at www.fao.org/es/esa/

Louette, D. and Smale, M. (1996) *Genetic Diversity and Maize Seed Management in a Traditional Mexican Community: Implications for In Situ Conservation of Maize*, NRG Paper 96-03, CIMMYT, Mexico

Nagarajan, L. and Smale, M. (2005) *Local Seed Systems and Village-Level Determinants of Millet Crop Diversity in Marginal Environments of India*, IFPRI Discussion Paper no 139, www.ifpri.org/divs/eptd/dp/papers/eptdp135.pdf

World Bank (2008) *World Development Report 2008: Agriculture for Development*, http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2008/0,,menuPK:2795178~pagePK:64167702~piPK:64167676~theSitePK:2795143,00.html, accessed 8 June 2009

World Bank (2009) *Country Statistical Information Database*, http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20541648~menuPK:64133152~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html, accessed 22 May 2009