



Four-square
method

RTB

User Guide

User Guide to the
Four-Square Method for
Intervening in Root,
Tuber and Banana Seed
Systems

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This user guide is intended to disseminate research and practices about production and utilization of roots, tubers and bananas and to encourage debate and exchange of ideas. The views expressed in the papers are those of the author(s) and do not necessarily reflect the official position of RTB, CGIAR or the publishing institution.

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Acronyms

FGD	Focus group discussion
IPGRI	International Plant Genetic Resource Institute
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
NARC	Nepal Agricultural Research Council
PRA	Participatory Rural Appraisal
RTB	CGIAR Research Program on Roots, Tubers and Bananas
VPC	Vegetatively propagated crop

Overview

This guide presents a step-by-step procedure on how to use the four-square method for intervening in root, tuber and banana seed systems. The four-square method is a research tool that supports the generation of evidence on seed systems diversity so as to formulate interventions to conserve varieties and to improve availability, access, and quality of seed for vegetatively propagated crops (VPC). The tool consists of four squares that are drawn on either the ground or on a chart. Varieties of the crop of interest are mapped in each of the four squares based on their abundance i.e., Each square therefore represents either varieties grown by many households on large area, many households on small area, few households on large area or few households on small area. The data is collected in a participatory way using focus group discussions (FGDs) guided by questions that are framed according to the objectives of the study. The objectives could include, but no limited to, understanding local crop diversity, understanding the economic potential of crop varieties, setting breeding goals and developing plant breeding programs, determining impacts of seed interventions on crop varieties and monitoring crop variety diversity changes over time. Separate FGDs are often held for men and women to capture gender-specific perceptions. The social characteristics of FGD participants such as their age, marital status, level of education, and main occupation are also collected and used in the analysis. The tool can also be used to study on-going and completed seed system interventions.

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User Guide to the Four-Square Method for Intervening in Root, Tuber and Banana Seed Systems

INTRODUCTION

Seed systems include means in which farmers and other stakeholders produce, select, save and acquire seeds of a particular crop. For the root, tuber, and banana crops, seed includes roots (yams), vines (sweetpotato), tubers (potato), stem cuttings (cassava) and suckers (bananas).

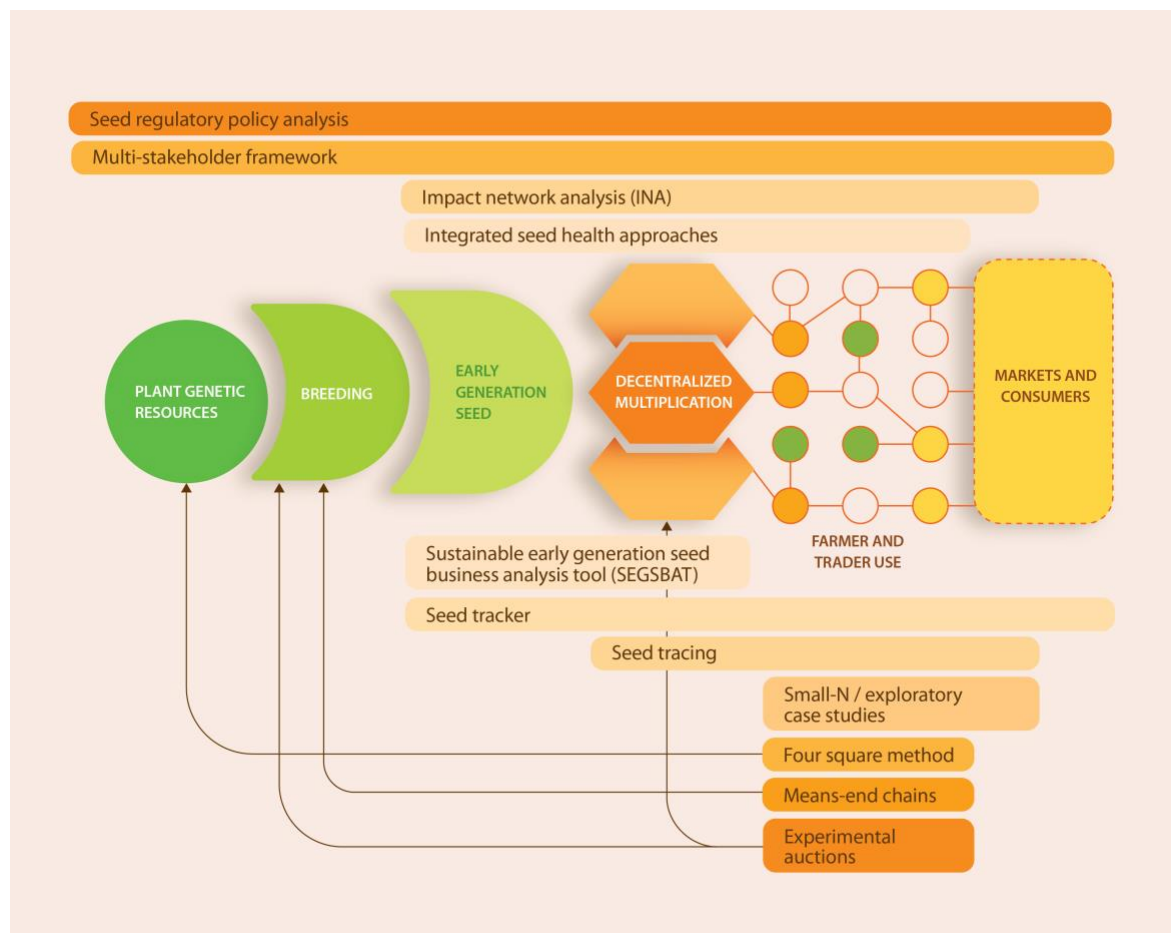
Although seed systems have been well studied, some have received more attention than others. Grain crops, particularly maize and rice, have dominated the research and development agenda more than roots, tubers and bananas, even though these are important staple crops, which contribute greatly to food security and poverty alleviation, especially in developing countries.

Roots, tubers and bananas are unique because they are vegetatively propagated crops (VPC). VPCs generally have no 'seed' in the strict sense of the word since under normal field conditions they are only vegetatively propagated with roots, vines, tubers, stem cuttings or suckers. Vegetative propagation allows multiplying these crops true-to-type, therefore passing on their desirable traits. However, the vegetative planting material itself is more likely to carry pests and diseases. The planting material is also more perishable and bulkier, increasing the costs and difficulty of storage and dissemination. These difficulties have hampered intervention in RTB seed systems which often lack formal seed distribution channels, have weakly organized value chains and poorly documented evidence of the value of interventions.

The objective of this user's guide is to present a tool—the four-square method for intervening in root, tuber and banana seed systems—to help researchers, donors, lobbyists, farmer organizations, NGOs and extensionists and policymakers to improve the design and implementation of interventions in VPC seed systems. The guide presents a step-by-step procedure to shed light on existing seed systems (variety diversity and use, reasons for the dynamic status of varieties) and to identify the interventions needed for conservation and elements to improve availability, access, and quality of VPC seed.

The four-square method should be used in combination with other existing tools (Figure 1) in the Toolbox for Working with Root, Tuber and Banana Seed Systems (Andrade-Piedra et al., 2020) to best understand seed systems and the monitoring and correction of their interventions.

Figure 1. Seed value chain map of the four-square method with other tools for understanding seed systems.

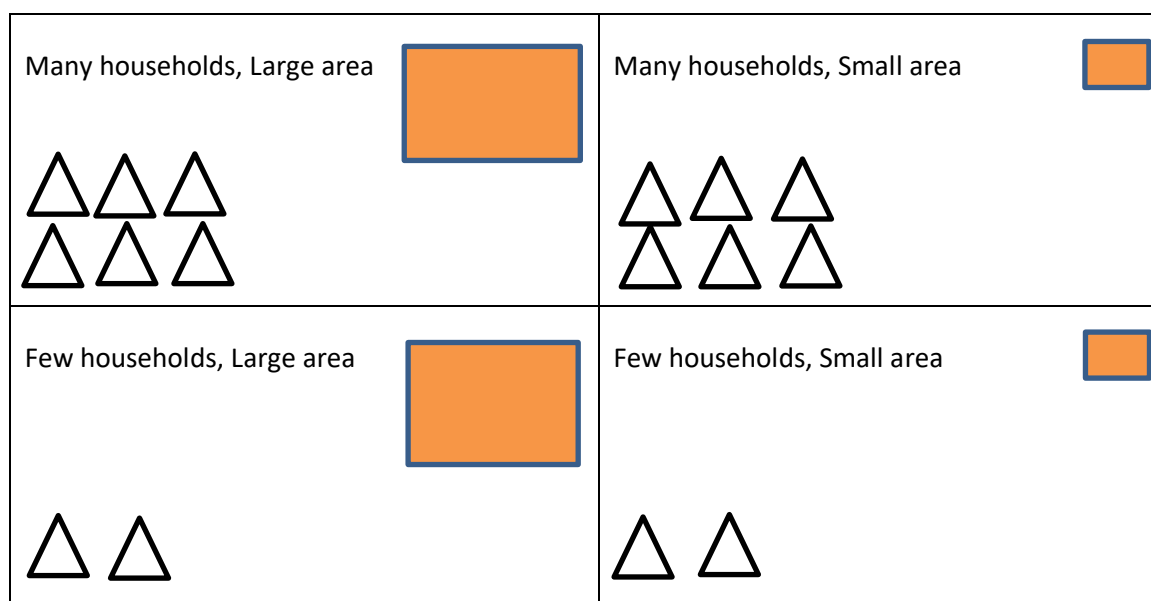


THE FOUR-SQUARE METHOD

In 1996, a team in Nepal comprising professionals from Nepal Agricultural Research Council (NARC), Local Initiatives for Biodiversity, Research and Development (LI-BIRD) and the International Plant Genetic Resource Institute (IPGRI) devised a four-cell method for studying the diversity (richness and evenness) of crops grown in a given location (Jarvis and Hodgkin 1998). A first user guide for the identification of valuable genetic resources was developed by Grum et al. (2008). Since then, this method has been applied in diverse root, tuber and banana seed systems, including Kilwinger et al. (2019) in Uganda, Aini et al. (2017) in Malaysia, Agre et al. (2016) in Benin, Nyadanu and Opoku-Agyeman (2015) in Ghana, Dansi et al. (2013) in Togo and Audi et al. (2008) in Kenya. The tool described in this user guide is a modified version of the four-cell method devised by earlier researchers with VPC crops.

Like its name, the four-square method consists of four squares that are drawn on either the ground or on a chart. Each of the four squares holds varieties of a crop of interest based on their abundance i.e., if many or few households grow a variety and if this is on a large or a small area. Each square therefore represents either varieties grown by many households on large area, many households on small area, few households on large area or few households on small area (Figure 2).

Figure 2: Schematic representation of the four-square method. Triangles represent households and rectangles represent area.



Source: Sthapit et al. 2006

It is essential to place each variety in the right square after reaching a consensus on the cut-off points. The data is collected in a participatory way using focus group discussions (FGDs) guided by questions that are framed according to the objectives of the study. The objectives could include, but no limited to, understanding local crop diversity, understanding the economic potential of crop varieties, setting breeding goals and developing plant breeding programs, determining impacts of seed interventions on crop varieties and monitoring crop variety diversity changes over time. Separate FGDs are often held for men and women to capture gender-specific perceptions. The social characteristics of FGD participants such as their age, marital status, level of education, and main occupation are also collected and used in the analysis.

DEFINITION OF CONCEPTS IN THE FOUR-SQUARE METHOD

SEED SYSTEMS

A seed system is a network of stakeholders involved in planting, using and producing seed of a given crop in a particular area. Seed systems can be formal or informal. The informal, also known as farmer or local, seed system involves methods of local seed selection, production and distribution, where a farmer plants, selects, stores, uses and exchanges seeds with less, if any, regulations. The formal seed system, on the other hand, includes some regulation, inspection and control processes over crop varieties which ensures the health and quality of the available seeds.

FOUR SQUARES

The four squares can either be drawn on the ground or on large charts using two perpendicular axes of 2 x 2 meters. Each square represents crop varieties grown either by many households on large area, many households on small area, few households on large area or few households on small area.

FOCUS GROUP DISCUSSION

A focus group discussion is a facilitated discussion with eight to ten farmers who are knowledgeable about the topic. They can be selected with the help of extension agents or local authorities, taking into account social

characteristics such as the sex, age, economic status and the area planted with the crop of interest. Make sure that you can describe how you selected the participants in any report or publication.

CUT-OFF POINTS

Consider the cut-off points for households (many vs few) and for land area (large vs small). The research team may conduct a baseline survey to collect data for establishing the cut-off-points. Whether a baseline survey is conducted or not, it is useful to discuss within the focus groups and build a consensus on what the farmers consider to be many or few households and large or small areas.

SITUATION ANALYSIS

An initial situation analysis using approaches such as the Participatory Rural Appraisal (PRA) is conducted to obtain essential information such as households growing a given crop, identifying key informants and information for determining cut-off-points. PRA involves use of tools such as a transect walk with a small group of farmers on their land (referred to as a transect walk). A short survey can also be used to generate the initial information.

AREA UNDER CROP PROPAGATION

This refers to the size of land (small vs large) on which each household grows a particular crop. For crops like bananas, which are perennial and might be scattered around farms, the number of plants (or mats) grown by the households can be used instead of the land size.

HOUSEHOLDS

A household is all individuals sleeping under the same roof and eating from the same pot. A household is considered if any of its members grows a crop of interest. “Many” households usually means five or more, but this is arbitrary and depends on the local context.

CROP VARIETIES

A variety is a group of similar plants that by structural features and performance can be distinguished from other varieties within the same species. A crop variety is considered a landrace once it has been farmer developed and adapted to local environmental conditions and have their own local names. Modern varieties from breeding programs can also evolve into landraces if grown by farmers over a period of time, especially when self-seed is used, and selection is practiced.

GENDER

The four-square method is well suited to finding how different men and women know and think about each crop variety and its uses. Separate focus group discussions for women may give them more space to talk than in mixed groups, but the facilitator still needs to pay attention to dominance of a few participants. FGDs may also be separated by age and other social characteristics (young vs old).

FACILITATOR

A facilitator is a member of the research team who guides the focus group interview. For efficient discussions, focus groups of a single gender should be facilitated by a researcher of that gender.

SEED SYSTEM CHARACTERISTICS

In this tool, the seed system characteristics are defined as richness and evenness.

Richness of a crop refers to the number of different varieties in a community. High crop richness implies high availability of seed of different varieties in a community. Abundance of crop varieties is either common, rare or endangered.

Common (or abundant) crop varieties are those grown by many households on large areas within a community.

Safe crop varieties are the ones grown by many households but on small areas.

Limited varieties are grown by few households on large areas.

Rare (or endangered) crop varieties are grown by few households on small area.

Evenness: how close in number the different varieties of a crop are in a given community.

HOW TO USE THE FOUR-SQUARE METHOD

The four-square method should focus on one or two major crops. The method can be used in different seed system contexts including: (1) before an intervention to understand the existing seed systems and to identify key issues for the project, and (2) during interventions to monitor or evaluate them. So far, the four-square method has been used mostly during field visits with farmers to understand seed systems (variety extent and distribution) by looking at how many farmers grow the varieties and on how much land. The four-square method also helps to understand and document why the status of varieties changes within a community, and to identify the level and type of interventions needed to conserve the varieties.

USING THE FOUR-SQUARE METHOD BEFORE AN INTERVENTION

UNDERSTANDING THE EXISTING SEED SYSTEM (VARIETY EXTENT AND DISTRIBUTION)

This section is adapted from the participatory analysis of extent and distribution of landrace diversity by Grum et al. (2008).

First, participants should define how much land they allocate to a crop is perceived as a “large area” and when it is considered a “small area”. They define what people refer to as “grown by many households” and “grown by few households”.

- Start by identifying participants to be included in the group evaluation meetings. The selection can be aided by key stakeholders such as local extension agents, farmer leaders, and agricultural officers. The groups should consist of comparable numbers of men and women from different locations of the community, with an ideal number of eight participating farmers for each group. It is often useful to have separate groups of men and women. Each group requires a facilitator and a scribe. When organizing the event, farmers may be asked to bring samples of each variety to be used in the subsequent exercises.
- Farmers are asked to list all the varieties that they grow, including those that have disappeared in the region.
- Draw two lines of 2 x 2 m drawn in the sand, or on a flip chart or blackboard to make the four squares where you will place varieties (i.e. common, safe, limited and rare). The meaning of the four squares may be shown by drawing different numbers of houses and large or small fields (Figure 2).
- Each variety is then placed in one of the four squares. Farmers may stand or sit around the four-square design. The facilitator holds up the first variety and asks if it is grown by many or few households. As farmers respond, the facilitator indicates the relevant half of the square. The facilitator then asks if the variety is grown on large areas of land or on small areas. When farmers respond, the facilitator places the

variety in the appropriate square, before moving on to the next variety. When a sample of each variety is not available, other objects or cards with the variety names may be used to represent the varieties. In some (but not all) cases, farmers will easily agree on where a variety belongs. When farmers disagree on where a variety belongs, ask comparative questions such as whether the variety in question is grown on larger or smaller areas than variety A. Farmers might not know enough about where their neighbors grow each variety, causing differences of opinion, in which case more discussion may be held or farms can be visited before making the final decision. As the varieties are being placed in the four squares, the scribe takes notes on the comments made on different varieties.

- When all varieties have been placed in squares, discuss the details of each variety one by one. The facilitator may ask when the variety was first introduced to the village, from where, and how it is used. If the variety is no longer cultivated, the facilitator asks when it was last grown. Then the positive and negative traits of the varieties are discussed, taking note of personal experiences with the varieties. Often farmers will say more positive things about some varieties than others. This gives the facilitator an opportunity to ask for more information, often leading to further discussions that shed new light on the variety and on farmers' priorities and strategies. The facilitator should tease out management practices and why each variety has been assigned to its respective square.

Data analysis from the four-square method

There is no explicit method for analyzing data collected by the four-square method since data varies by study objectives. Nonetheless, it is important to keep track of the age (young vs older), gender and other broad characteristics of the participants. This can be used later to see if certain varieties are held in higher esteem by one particular group (e.g. women, youth, commercial farmers, or communities in a specific region) and why. The traits of the varieties can be also ranked using preference ranking (e.g. do farmers prefer high yield, early maturing, or yellow varieties). Social characteristics and variety abundance can be compared if several FGDs were conducted and if the findings were well summarized in tables. Write down the names and phone numbers of at least some of the farmers, so you can telephone them later to ask any specific questions that arise during later analysis.

IDENTIFYING ISSUES FOR INTERVENTIONS

After using the method described above to learn about the existing seed system, the four-square method can be used to identify bottlenecks and define key actions and strategies for the seed system intervention.

The varietal diversity established from the broad distribution analysis (the four-square method) helps one to understand the status of varieties grown (i.e. common, safe, limited and rare) and the underlying reasons for the dynamic status of varieties. Researchers come to understand for example why some landraces are safe, but others are limited. The four-square method helps to identify rare or limited varieties that are vulnerable to genetic erosion and thus require a range of interventions. The method helps to discuss the results with the community and ask how they wish to maintain the rare varieties and particularly vulnerable ones can be sent to ex-situ conservation. It is important for project leaders to understand farmers' perceptions of such distribution patterns before starting to design any interventions to promote seed systems, including on-farm conservation programs.

The following two case studies summarize the use of the four-square method to design interventions.

Example 1: Diversity and production of yams in Southern Ghana (Aboagye et al. 2015)

This study was carried out in four communities in Ghana to survey the number of yam species and varieties cultivated per household, to identify the preferred and endangered ones, challenges facing yam farmers, and to develop strategies for sustainable yam production. In each village, the four-square method was used to record: name of variety, species, early or late maturity, and extent of distribution. Discussions were held on the challenges of yam farming, and each variety was ranked by preference.

Researchers collected 136 accessions (i.e. probable varieties) of yams and six of the seven known species of yams in Ghana. Three-fourths (77%) of the accessions were rare, or vulnerable while 12% were common, or abundant (Figure 3). Challenges facing yam production in southern Ghana include the many rare varieties, suggesting a need to tackle genetic erosion of species and varieties to prevent their extinction. The study concluded that materials should be improved for the preferred yam varieties and production technologies should transferred to farmers to enhance yam productivity.

Table 1. Variability in households and area under cultivation in the 4 communities

Communities	Many households, large areas	Many households, small areas	Few households, large areas	Few households, small areas	Total
Dinkro	6(4.4%*)	3(2.2%)	3(2.2%)	34(25.0%)	46
Mfadwen/Bontrase	2(1.4%)	3(2.2%)	1(0.7%)	14(10.3%)	20
Agou-fie	8(5.9%)	0	4(2.9%)	33(24.3%)	45
Nyankumase	1(0.7%)	0	0	24(17.6%)	25
Total	17(12.4%)	6(4.4%)	8(5.9)	105(77.2%)	136

*: Figures in brackets are percent of overall total (136).

Figure 3. Preferred yam varieties and extent of cultivation

Common	Rare
Ntont, Brass, Orlando, Nyamenti, Pona, Labrakoabrako, Asana	Afasee, Odonon, Baale Otim, Klohiei, Kate, Kukrupa

Example 2: Culturally embedded practices of banana diversity in Central Uganda (Kilwinger et al. 2019)

This study aimed at providing a basis for government, NGOs and other organizations concerned with agricultural development to intervene in seed systems by strengthening the formal seed-supply systems of banana varieties in Uganda.

To strengthen the formal seed-supply system, a clear understanding of the informal seed system was critical. So, the study set out to uncover farmers’ production objectives regarding banana diversity, to understand demand for banana planting materials and how farmers shared and diffused these materials among themselves, and to gain insights into farmers’ evaluation and quality criteria of banana planting materials. The study adopted a four-square method to generate a cultivar inventory, as explained below.

1. Various focus group discussions were organized, including four divided by gender, two for men and women mixed, but with different age groups, economic status and varying amounts of areas planted with bananas. Each group was held with 6–8 participants recruited by a local key informant. The discussions lasted for 2–3 hours. In each group, participants were asked to list all the banana varieties grown. For each one, the use, strengths and weaknesses, year of introduction and origin were discussed.
2. Each variety was then placed in one of the four squares.

The study identified 30 banana varieties, half of which were common, mostly appreciated for their big bunches and high yields. Farmers identified some varieties that were locally extinct or nearly so. Farmers surveyed maintained high on-farm banana diversity because of their many uses, while also adopting new and high yielding varieties. Farmers in the study area used many evaluation criteria to select suckers, with a preference for trusted sources to assure plant quality. The study concluded that a blend of formal and informal

approaches would be best for developing the banana seed system, to meet the multiple needs of households and to support them in improving productivity and dealing with emerging challenges.

Table 2. Four square analysis of banana varieties and their abundance, type and year of introduction, Uganda.

Square 1. Many farmers, large area			Square 2. Many farmers, small area		
Variety name	Type of banana	Year introduced	Variety name	Type of banana	Year introduced
Bogoya	Dessert	Indigenous	FHIA	All	1998
Tombadala	Dessert	2006	Kibuzi black	Cooking	Indigenous
Kibuzi	Cooking	Indigenous	Kivuvu	Cooking	Indigenous
Kisansa	Cooking	1970	Musakala	Cooking	Indigenous
Mpologoma	Cooking	2000	Muvubo	Cooking	Indigenous
Nakitembe	Cooking	Indigenous	Ndiizi	Dessert	Indigenous
Square 3. Few farmers, large area			Square 4. Few farmers, small area		
Variety name	Type of banana	Year introduced	Variety name	Type of banana	Year introduced
			AGT	Cooking	2004
			Bogoya red	Dessert	Indigenous
			Gonja	Roasting	Indigenous
			Kayinja	Beer	1970
			Kisubi	Beer	Indigenous
			Luwaata	Cooking	Indigenous
			Lwandungu	Cooking	2011
			Mbidde	Beer	Indigenous
			Mwazirume	Cooking	Indigenous
			Nakabululu	Cooking	Indigenous
			Nakawere	Cooking	Indigenous
			Nakytengu	Cooking	Indigenous
			Nambi	Cooking	Indigenous
			Namwezi	Cooking	Indigenous
			Nandigobe	Cooking	Indigenous
			Nsalwagiri	Cooking	Indigenous
			Nfuuka	Cooking	Indigenous
			Ndiizi Mfungu	Dessert	1998

USING THE FOUR-SQUARE METHOD TO STUDY ONGOING AND COMPLETED INTERVENTIONS

Over the life of a seed system intervention, bottlenecks will be solved and new issues may arise. The four-square method can help to visualize and document the evolution of seed system functions over time. After the intervention, the four-square method will help to describe the results and impacts, assess contributions to seed systems and define recommendations for follow-up and future projects.

The following case study show how the four-square method was used to analyze a completed intervention on the use of tissue cultured banana planting materials in central Uganda.

Example 3. Farmer preferences for banana planting materials in central Uganda (Mulugo et al. in press)

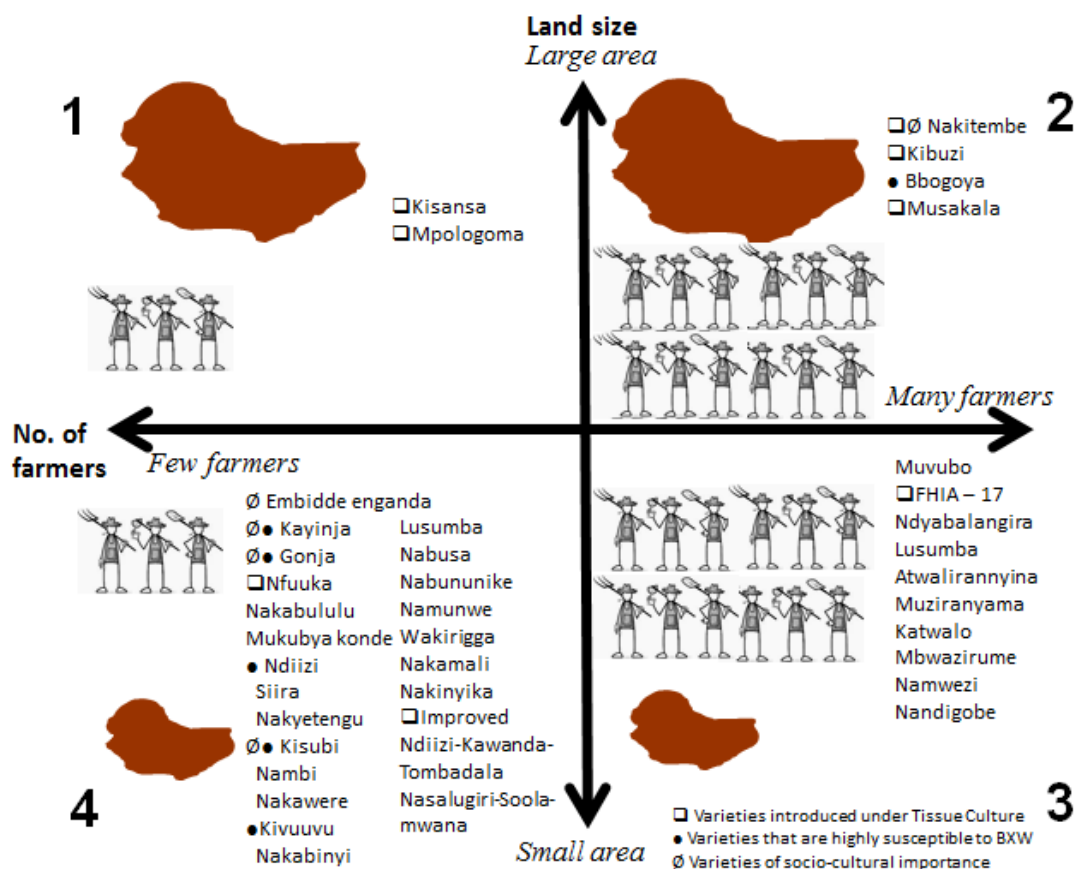
The study aimed to understand why there was still little use of tissue cultured banana planting materials as a source of clean seed to control banana Xanthomonas wilt in central Uganda and to report on what influences farmers' choice of planting materials. The four-square method was used to study varietal diversity in the study communities.

Before using the method, key informant interviews were held to obtain background information on how different types of households produced bananas. The four-square method was then used during focus group discussions, where participants of varying gender and age were included. The varieties grown by farmers were listed and categorized into the four-squares based on number of households growing them and the cultivation area.

A variety was considered to be grown on a large scale if it was cultivated by a farmer on at least 4 acres. After allocating the cultivars to their squares, the team determined which varieties in each cell had been introduced by tissue culture. The groups discussed variety characteristics relating to finger and bunch size, maturity period, tolerance to weather conditions, market value, taste, cultural importance and resistance to pests and diseases. Variety use values and reasons for variety diversity were also discussed.

The study identified 39 banana varieties, mostly rare ones. Farmers said that all varieties under quadrant 1 (limited) were introduced with tissue cultured suckers (Figure 4). In quadrant 2, common varieties also came from tissue culture and there were more of these varieties than in quadrant 1. Most safe varieties (Quadrant 3) were local and only one was introduced with tissue cultured material. Two of the rare varieties (quadrant 4) had been introduced under TC technology and included many local ones. Varieties grown on a large scale had large bunch and finger sizes and higher market value than the ones grown on a small scale. Farmers also reported to be using different criteria when selecting planting material and these were discussed for all quadrants, for example some varieties were resistant to Xanthomonas wilt, and others had special uses, such as brewing beer. The study found that of eight varieties introduced by tissue culture, five were already being grown on a large scale, suggesting that concerns over the lack of adoption of these varieties were unwarranted.

Figure 4: Four-square analysis of the diversity of banana varieties in central Uganda.



CONCLUSIONS

The four-square method is useful for understanding seed systems, and for planning and monitoring interventions. It can be used to characterize variety diversity, to identifying common, safe, limited and rare varieties, documenting why the status of varieties changes, recognizing farmers' experiences with varieties, and identifying types and levels of interventions needed for conservation. The four-square method also sheds light on farmers' priorities for particular varieties. The four-square method can be used across different crops. The tool also allows seed practitioners to communicate and make comparisons within a country and even across different countries that care for and in turn depend on root, tuber and banana crops.

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RESEARCH
PROGRAM ON
Roots, Tubers
and Bananas

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a partnership collaboration led by the International Potato Center implemented jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), that includes a growing number of research and development partners. RTB brings together research on its mandate crops: bananas and plantains, cassava, potato, sweetpotato, yams, and minor roots and tubers, to improve nutrition and food security and foster greater gender equity especially among some of the world's poorest and most vulnerable populations.

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