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CIP Research Guide 5

FARMER PARTICIPATION IN THE SELECTION OF NEW SWEETPOTATO VARIETIES

1994

Cristina Fonseca, Juan P. Molina, Edward E. Carey

INTERNATIONAL POTATO CENTER (CIP)
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FARMER PARTICIPATION IN THE SELECTION OF NEW SWEETPOTATO VARIETIES

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1 INTRODUCTION AND OBJECTIVES

The cultivation of sweetpotatoes is becoming more and more important with each passing day, and the crop has great potential as a food product. It needs few inputs and has potentially high yields, which make it an inexpensive food. In addition, it is well suited for processing into food products for people and animals alike.

The principal goal of research and development programs is to increase not only the size of sweetpotato production areas but also the productivity of areas where sweetpotato is already under cultivation. Careful selection of new varieties, which show greater adaptability and stability as well as excellent agronomic characteristics –those required by farmers and consumers–will help to put that goal within reach.

One of the most important steps in developing technology is the evaluation and selection of improved or native clones for different production zones. A research methodology based on farmer participation–i.e., in which farmers are actively involved in the selection of materials–could guarantee the rapid transfer and adoption of any new technology.

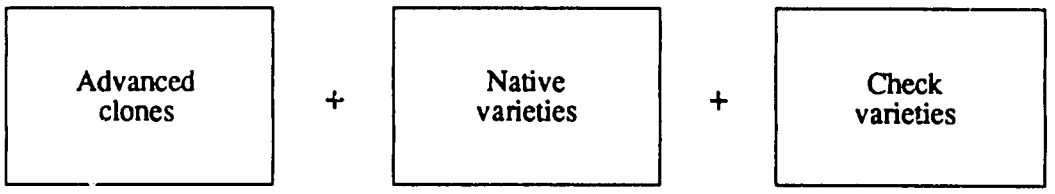
This booklet outlines the methods for evaluating and selecting advanced sweetpotato clones with farmer participation. It is the result of work carried out in the valleys of Cañete, Arequipa, and Piura in Peru. The results of this work have been most promising, culminating in the release of new varieties that display characteristics required by farmers.

Objectives

1. To provide researchers with guidelines for identifying and evaluating sweetpotato clones that farmers will adopt because the clones have characteristics desired by farmers.
2. To encourage farmers to participate in the selection of sweetpotato clones.

2 EXPERIMENTAL MATERIALS

Experimental materials can be made up of promising germplasm consisting of advanced clones generated by breeding programs, and of native varieties that offer some comparative advantages. These materials must also include check varieties that provide a point of reference from which to evaluate the behavior of new materials.



Components of experimental materials

Advanced clones are selected from a large number of improved clones developed by plant breeders in research programs. These advanced clones generally have excellent agronomic characteristics and such good quality that their inclusion in regional trials throughout a given country is justified.

Native varieties are those that are grown traditionally, and are the product of many years of evaluation and selection carried out by farmers themselves. They are widespread in areas where sweetpotato is a subsistence crop. Native varieties can be obtained from germplasm banks, or from farmers' fields.

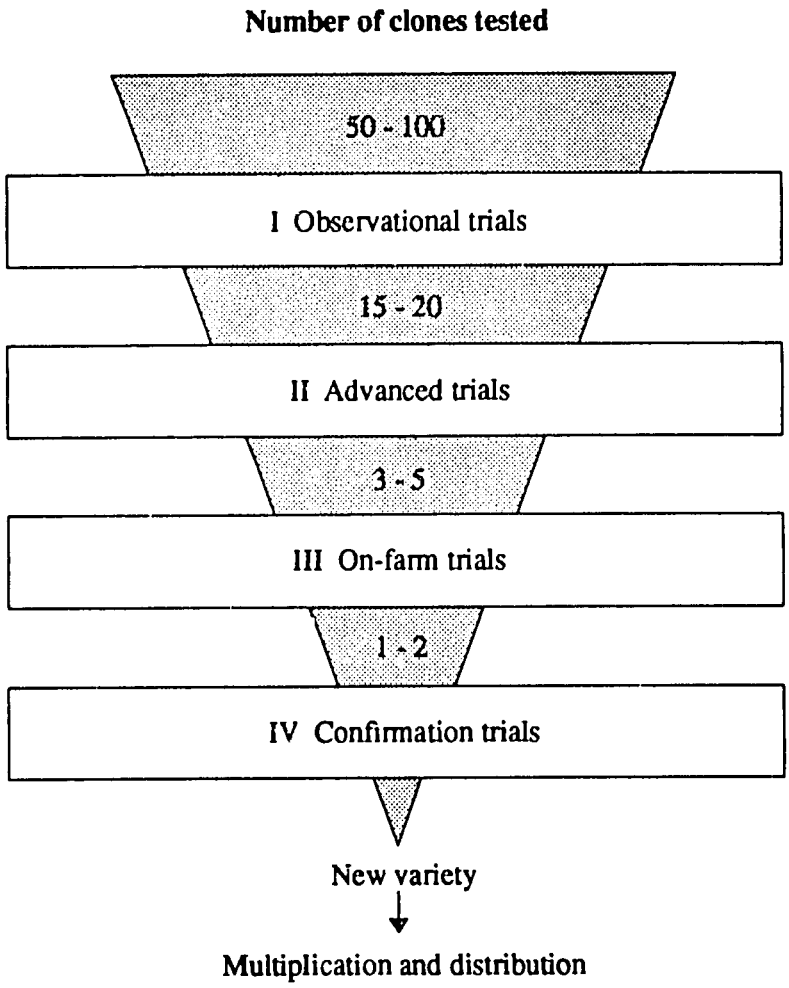
Check varieties are those sweetpotato varieties that are widely grown and are generally of commercial importance in the study area. They might be improved or native varieties, and are used for comparison with the experimental clones included in the regional trials.

It is advisable to retain the experimental codes or original names of the sweetpotato clones during the different evaluation stages. These can be changed to appropriate variety names if and when the varieties are released.

To start up regional trials with improved sweetpotato clones and native varieties, you can request propagation materials (cuttings) at experiment stations where sweetpotato breeding work is being done. You can also approach the International Potato Center (CIP).

3 TRIALS

Evaluation and selection of advanced sweetpotato clones and native sweetpotato varieties are made in the following four stages: 1) *observational trials;* 2) *statistically replicated advanced trials*; 3) *on-farm trials and multiplication of materials*; and 4) *confirmation trials for the release of new varieties.* Initially, the evaluation encompasses a large number of materials, which is then reduced as selections are made, until finally only the 1 or 2 most promising materials remain, as illustrated below:



Evaluation and selection stages for advanced sweetpotato clones and native sweetpotato varieties

We recommend that these trials be repeated during different growing seasons and under varying climatic conditions.

Observational Trials

In this stage of trials, we study the agronomic performance of a large number of clones from: *breeding programs* (*advanced clones*), and *germplasm banks or local collections* (*native and improved varieties*). These clones are distributed and then planted in small plots, without replications (see Table 1).

Observational trials are carried out only in strategic locations representative of sweetpotato production areas or potentially promising agroecological zones.

Besides researchers, evaluations might involve a group of farmers who can help select clones to include in the advanced trials.

Table 1. Basic data for carrying out evaluation trials of sweetpotato clones.

Data	Observational trial	Advanced trial	On-farm trial	Confirmation trial
Location	Exp. station	Exp. station/farm	Farm	Farm
No. of clones	50-100	10-20	2-5	1-3
Cuttings/clone	20-40	60	100-500	6,000-14,000
Length of row (m)*	3-5	5-10	20-100	50-100
No. of rows	1-2	3-4	3-5	20-30
Exp. design	None	RCBD**	None	Unrepl.
Replications	—	3-4	3-5	4-5
Person in charge	Researcher	Researcher	Farmer	R/F
Evaluator	Farmer/Res.	F/R	Farmer	F/R

* Planting density used in this table is 0.18 m^2 per plant (0.9 m between rows and 0.2 m between plants).
** RCBD = randomized complete block design.

Advanced Trials

The objective of advanced trials is to reconfirm the performance of the clones selected through the observational trials. These trials are to be considered "regional trials" and should therefore be carried out in different sweetpotato production areas. The clones are planted using a randomized complete block design with at least three replications (Table 1).

At this stage, farmer participation in the selection of clones is very important. Trials should thus take place in sweetpotato production areas, at experiment stations, or on farms (Figure 1).

Clones selected by farmers at this stage will become part of later on-farm trials.

On-Farm Trials

These trials are carried out on farms, preferably in collaboration with national agricultural research and extension programs or nongovernmental organizations (NGOs).

Each trial consists of a maximum of five clones originally selected from the advanced trials. Because these trials are carried out by the farmers, they themselves decide where the clones should be planted, and how they should be cared for and evaluated. Nonetheless, it is important to make sure that these trials are planted in the farmers' sweetpotato fields, so that the trials will not receive special treatment, and clones will be compared with the farmers' own varieties.

It is also important at this stage to multiply planting materials of selected clones by gradual increases in farmers' fields. At the same time, researchers should also multiply materials, using rapid propagation techniques, so that at least one hectare is planted with each selected clone. These materials will then be used in the final stage of confirmation trials.

Confirmation Trials

In this final stage, the economic advantages of the best clones (selected during the previous stage) are evaluated and compared with those of the check varieties.

These trials are also carried out in farmers' fields, with the researcher supervising. It is recommended that at least four replications of these trials be done per production area. Each replication should cover a semicommercial-sized plot (of 1000 to 2500 m^2), so that a close approximation can be reached of the productivity and economic value of the potential new variety. Table 1 lists other characteristics of these trials.

The results of the confirmation trials will help determine whether all the criteria required for the release of a new variety have been met. For further information, please check with researchers of national programs, who are in charge of releasing new varieties.

After the confirmation trials, the next logical step is to multiply and distribute planting materials of the new variety. These materials should be distributed to farmers as well as institutions interested in sweetpotato cultivation.

Figure 1. The planting of an advanced trial of sweetpotatoes in an Andean valley (Cajamarca, Peru) with participation by local researchers and farmers.

4 EVALUATIONS

In the different trials to evaluate and select sweetpotato clones, two types of evaluations are carried out: *technical* and *participatory*. Researchers and farmers should actively collaborate during these trials. The evaluations have the following characteristics:

	Technical Evaluation	+	Participatory Evaluation
Person in charge :	Research team		Farmers
Variable :	Quantitative		Qualitative
Data :	Measurements		Interviews

Types of evaluations and their characteristics

1. Technical Evaluation

For this evaluation, agronomists use a predetermined set of variables in the observational and advanced trials (Table 2), so that they can compare the behavior of advanced clones at different sites.

The evaluation variables generally apply only to the storage root. This technical evaluation takes place four to five months after planting, so that early varieties can be identified. The actual moment of evaluation, however, is completely dependent on the agroecological and socioeconomic characteristics of the production area. During this evaluation, samples of storage roots of each of the trial clones are also taken to determine dry matter content (for further information, see page 20).

The evaluator should take note of the following basic data: planting date, planting density, number of cuttings transplanted, date of harvest, trial management data (fertilization, irrigation, weeding, etc.).

Table 2. Variables per evaluation type carried out during the selection of clones.

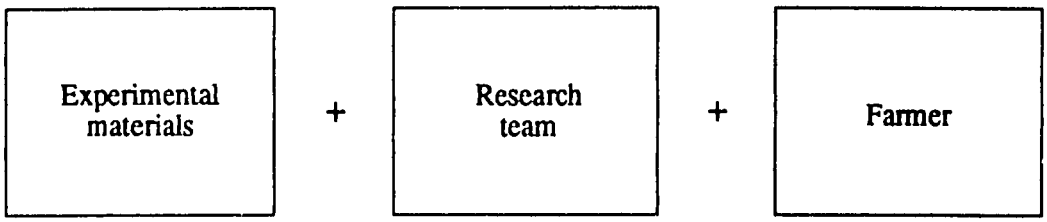
Variable	Evaluation type	Scale*
Harvested plants	number	
Plants with storage roots	number	
Skin color	visual rating	1-9
Flesh color	visual rating	1-9
Pest damage	visual rating	1-9
Cracking	visual rating	1-9
General evaluation	visual rating	1-9
Marketable roots	number and weight	
Nonmarketable roots	number and weight	
Weight of foliage	weight	

* See Appendix 1 for details.

Figure 2. Technical evaluation: counting and weighing roots of sweetpotato clones.

2. Participatory Evaluation

For this evaluation, the participatory research methodology (Ashby et al., 1989) is used, in which three basic elements come together:



Elements of participatory research

This evaluation can be included in every type of trial, and must be adapted to the conditions characteristic of each trial zone. The farmers (men and women) who participate in the evaluation carry out two types of tests: *taste tests* and *agronomic evaluations*.

A taste test is undertaken to determine the culinary quality of the sweetpotato variety. To this end, two or three roots per clone to be tested are taken from the experimental field, placed in net bags, and identified with symbols (letters or numbers) written on identification tags in indelible ink or felt-tipped marker. The roots are then cooked, so that the participants can taste small pieces of each clone. Their assessment can be recorded on a chart, which might look something like the example below:

Clone	Appearance			Taste		
	☺	😐	☹	☺	😐	☹
A	X				X	
B		X				X
C			X	X		
Z	X			X		

Chart for Taste Trial. Example of Results

After the participants have tasted one clone, they should take a sip of water, so that they will have less trouble making a distinction between the taste of that variety and the next.

The agronomic test is done to determine the commercial quality and productivity of storage roots. Each evaluated clone should be identified, preferably with symbols (letters or numbers) written on plot markers.

For this test, it is recommended that groups of two to four farmers be formed, so as to encourage discussion and comparison of their evaluations. Their most relevant observations about the clones can be recorded as follows:

Clone	Preferred	Rejected	Why?
A	X		High yield
B	X		Even shape
C		X	Pale skin
D	X		Good looking
E		X	—

Chart for Agronomic Test. Example of Results

At the end of the evaluations, the participants decide by consensus which clones should be selected. This meeting is also useful for generating discussion on the problems that farmers face in the cultivation of sweetpotato. These problems can then be addressed by local researchers.

- The technique used to acquire comments on and contributions for the selection of clones can be the "informal interview" (Rhoades, 1989), during which simple questions such as the following can be asked:

  - What differences are there between the clones?
  - What advantages or disadvantages do you see?
  - Which clones are good, and which are bad?
  - Others.

Figure 3. Farmers and researchers evaluating advanced sweetpotato clones in an observational trial.

– **Supplies** needed during the trials are:

For the participatory evaluation:

- Forms for both the taste and agronomic trials.
- Identification labels for the clones.
- Pencils for the farmers.
- Notebooks.

For the technical evaluation:

- Forms for recording information on evaluation variables (Appendix 2).
- Labels for identifying the cuttings of the clones to be propagated.
- Nets or bags for storage of roots.
- Appropriate field scale.

5 CONDUCTING EVALUATIONS

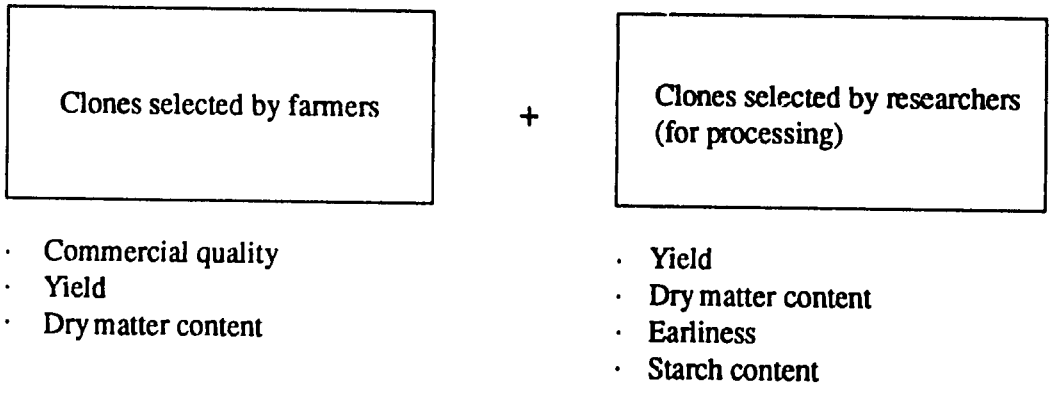
Observational Trials

These trials are carried out using a large number of clones, and therefore require a lot of time and attention. Participation by a group of farmers at these trials, however, will make them more objective.

Participatory Evaluation. Farmer presence and participation are deemed indispensable during the **agronomic test.** The ratio of number of clones to number of farmers will determine how many clones are evaluated per group of 2-4 farmers. The clones that each group selects should be marked with a label.

After these preliminary selections have been completed, all the farmers gather together to evaluate the selected clones, and to choose the most promising ones, which will then be used in the next stage, the advanced trials.

Technical Evaluation. Once the farmer evaluation has been completed, the selected clones undergo the technical evaluation. The research team makes selections based on the clones' potential for industrial use, identifying materials that have high yield and good skin and flesh color. This evaluation uses technical variables (outlined in Table 2 and Appendix 2). These varieties are later used to evaluate other characteristics, as shown below:



Selection of sweetpotato clones by farmers and researchers

Advanced Trials

Advanced trials evaluate a smaller number of clones, which are planted using a randomized complete block design. At this stage, participation by a group of farmers is of utmost importance.

Participatory Evaluation. The participatory evaluation is used here in much the same way as in the previous trial. The only difference is that, besides the agronomic test, a taste test can also be carried out.

Taste Test (Figure 4). This is carried out in the experimental plot. Cooked storage roots, each carefully labeled (see section 4), are placed on a table or board for farmers to taste. It is advisable to carry out this test at the beginning of the evaluation, before farmers have selected their preferred varieties and allow their judgment to be influenced by that choice.

Agronomic Test. This can easily be adapted to the block design, in which varieties are arranged into three replications, as shown below:

Block I	Block II	Block III
All the plants in a row are harvested to show total production of roots.	The storage roots are divided into two groups: marketable and nonmarketable.	The plants are not harvested, to observe and evaluate foliage.

To evaluate these blocks or replications, farmers record on a chart the most important observations about each clone, whether it be preferred or rejected (Figure 5). For this, they use their own selection criteria (Appendix 3).

Finally, the clones selected by each group are identified. The clones that will be evaluated by the entire group of farmers are carefully labeled (Figure 6).

Some farmers will probably wish to take the selected clones to their own fields. This is a good moment to make their acquaintance, in order to include them in the on-farm trials.

Figure 4. Farmers conducting a taste test with sweetpotato clones.

Figure 5. Agronomic test: farmers evaluating sweetpotato clones.

Figure 6. A group of farmers selecting promising sweetpotato clones.

The technical evaluation is carried out on all the clones in the trial, using the technical variables (Table 2 and Appendix 2). After this evaluation has been completed, samples of the storage roots are taken to determine dry matter content.

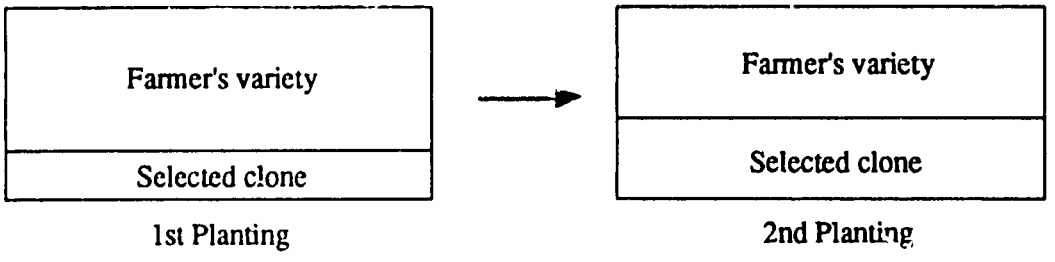
The data are statistically analyzed and differences among means are analyzed (LSD) to identify the clones that yield the most fresh matter and dry matter. Determination of dry matter content–as well as starch content and quality–is important for clones destined for industrial use.

Clones with potential industrial value will continue to be evaluated at an experiment station, to determine their industrial use or their appropriateness for human or animal consumption. The selected materials will be included later in on-farm trials and confirmation trials.

The decision to evaluate materials for industrial use will depend on whether the sweetpotato in production areas already has, or will acquire, industrial importance.

On-Farm Trials

In these trials, farmers evaluate the clones selected from the advanced trials. Each trial clone is planted next to the farmer's own sweetpotato variety, so that they can easily be compared. If the clones satisfy the farmer's requirements, the area in which they are planted will be increased repeatedly in the farmer's field or elsewhere:



The selected clone in the farmer's sweetpotato field

It is recommended that neighboring farmers be invited to the harvest, so as to promote discussion and comparison of the clone's advantages (Figure 7).

The research team will carry out the follow-up for these trials. The information gathered from the farmers is important for helping to determine which clones will become part of the confirmation trials. The researcher should carry a notebook in which to record the following data about the follow-up:

- Farmer's name
- Location of the field
- Names of the clones planted
- Number of plants or area planted per clone
- Dates the clones were planted and harvested
- Yield

Figure 7. On-farm trials: farmer harvesting sweetpotato in her field, to evaluate its characteristics.

Confirmation Trials

This is the most advanced stage in the selection procedure for new varieties. At this stage, yield and economic profitability are measured and compared with those of the most important local variety. The field distribution can be as follows:

New variety	Most important commercial variety

Confirmation trial in farmer's field

The two most important parties in this evaluation are the local researchers, especially extensionists, and the farmers, who will compare the advantages and disadvantages of the new variety with those of the local variety.

This is also a good way to spread the new variety to areas where sweetpotato selection trials are being conducted.

In this last stage, the technical evaluation must also be done, using variables outlined by national institutes to assess the productivity and profitability of the new variety.

Once this variety has been approved for release by the appropriate institutions, the research team will begin extensive multiplication of the seed in experimental or farmers' fields, so that it can provide interested farmers with planting material of the new variety.

Other Trials

1. Determination of Dry Matter Content

The percentage of dry matter in the storage roots is measured for clones selected during observational trials as well as for all clones in the advanced trials.

The following methods are used:

a) Oven method (direct method)

b) Specific gravity method (indirect method)

Both evaluations must be made within 24 hours after the materials have been harvested.

Oven Method. For this method, you must have a controlled temperature oven and a scale with a precision of 0.1 g. The procedure is as follows:

1. Take 3-5 storage roots and cut off their ends, leaving only the midsections of medium size. Cut the sections into small pieces, for a total weight of 200 g.
2. Place the pieces in the oven and dry at 60°C for about 72 hours, until the weight stabilizes.
3. Weigh the dried sample and record the weight.
4. The percentage of dry matter is calculated as follows:

$$\% \text{ DM} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$$

Specific Gravity Method. This method allows a quick estimate to be made of the relative amount of dry matter in the trial clones. It is best to use a precision scale (for example, an HOMS Model 500 g x 5 g Instrument and Laboratory Scale). The scale should be tared and hung on a tripod over a container of water (a bin or a large bucket). Net bags made of nylon, with neutral buoyancy, should be used to hold the roots.

The procedure is as follows:

1. Weigh 3 or 4 kg of sweetpotato storage roots in a net bag. Record the weight in grams.
2. Weigh the same roots in their net bag while they are submerged in water. Record their weight while in the water.

$$\text{SG} = \frac{\text{Weight in air}}{\text{Weight in air} - \text{weight in water}}$$

2. Postharvest Trials

Postharvest trials are conducted for clones selected from the advanced trials and the confirmation trials, so as to determine the resistance of the roots to packing, transport, and storage.

Packing trials: The process of packing is simulated so that the amount of damage suffered by the storage roots during the process can be evaluated.

Transport trials: The bags of storage roots are dropped from varying heights, simulating the treatment the roots receive when they are moved from the field to the transport vehicles. The resistance of the roots to bumping and friction is evaluated.

Storage trials: These are carried out to measure the amount of time that roots can actually be stored. Three factors are important: 1) *loss of weight*, 2) *amount of rotting*, and 3) *amount of sprouting*. These evaluations can be measured on a scale of 1 to 9, from very poor to excellent.

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7 APPENDICES

APPENDIX 1. Rating criteria and scales for storage roots[a].

Skin color[a]

1 White
2 Cream
3 Yellow
4 Orange
5 Brownish-orange
6 Pink
7 Red
8 Reddish-purple
9 Purple

Flesh color[a]

1 White
2 Cream
3 Dark cream
4 Pale yellow
5 Dark yellow
6 Pale orange
7 Medium orange
8 Dark orange
9 Strongly colored with anthocyanins

Pest damage and rotting

1 No damage
5 Moderately damaged
9 Totally damaged

Numbers in between indicate intermediate degrees of damage or rotting.

Cracking

1 None
5 Moderate cracking
9 Heavy cracking

Numbers in between indicate intermediate degrees of cracking.

General evaluation

1 Very poor
5 Average
9 Excellent

Numbers in between indicate intermediate degrees of overall appearance of the roots (skin and flesh color, form, size, surface, yield, uniformity, among others).

a. Huamán, 1991

APPENDIX 2. Variables in sweetpotato clone evaluation.

Block	Clone N°	Clone name	N° of cuttings planted	N° of plants harvested	N° of plants with storage roots	N° of roots		Weight of roots		Root color		Pest damage	Rotting	Cracking	General evaluation
						Marketable	Nonmarket-able	Marketable	Nonmarket-able	Skin	Flesh				

APPENDIX 3. Description of selection criteria for sweetpotato clones used by farmers in Cañete, Peru.

CRITERIA	CATEGORY		EXPLANATION
	ACCEPTED	REJECTED	
	CRITERIA FOR STORAGE ROOTS		
COMMERCIAL QUALITY			
Skin color	Purple, orange, yellow, and red	White or cream	Marketable quality
Flesh color	Yellow-orange	White or purple	Marketable quality
Form	Round, fusiform, oval	Elongated, deformed	Marketable quality and transport
Surface	Smooth	Ribbed, veined	Marketable quality
Pest damage	None, slight	Moderate to heavy	Marketable quality (*Eucepes* sp. and *Botrynus* sp.)
PRODUCTION			
Yield (# of roots/plant)	3-6 roots/plant	Less than 3 roots/plant	Yield and profitability
Weight	150-300 g	<150 g and >300 g	Yield and quality
Uniformity of size	Uniform	Not uniform	Yield and quality
Earliness	4-6 months	> 6 months	Yield and crop rotation
TRANSPORT			
Skin thickness	Thick	Thin	Resistant to transport
Sprouting	Absent	Present	Marketable quality
	CRITERIA FOR FOLIAGE		
LEAF			
Pubescence	Absent or glabrous	Hairy, abundant	Quality
Amount of foliage	High	Low	Quality
Leaf area	Entire leaves	Lobed leaves	Quantity and quality
Color	Dark green	Light green	Quality
STEM			
Consistency	Succulent	Dry and brittle	Quality
Length	1-2 m	Less than 1 m	Quantity
Pubescence	Glabrous	Hairy	Quality

SOURCE: Fonseca et al., 1992.