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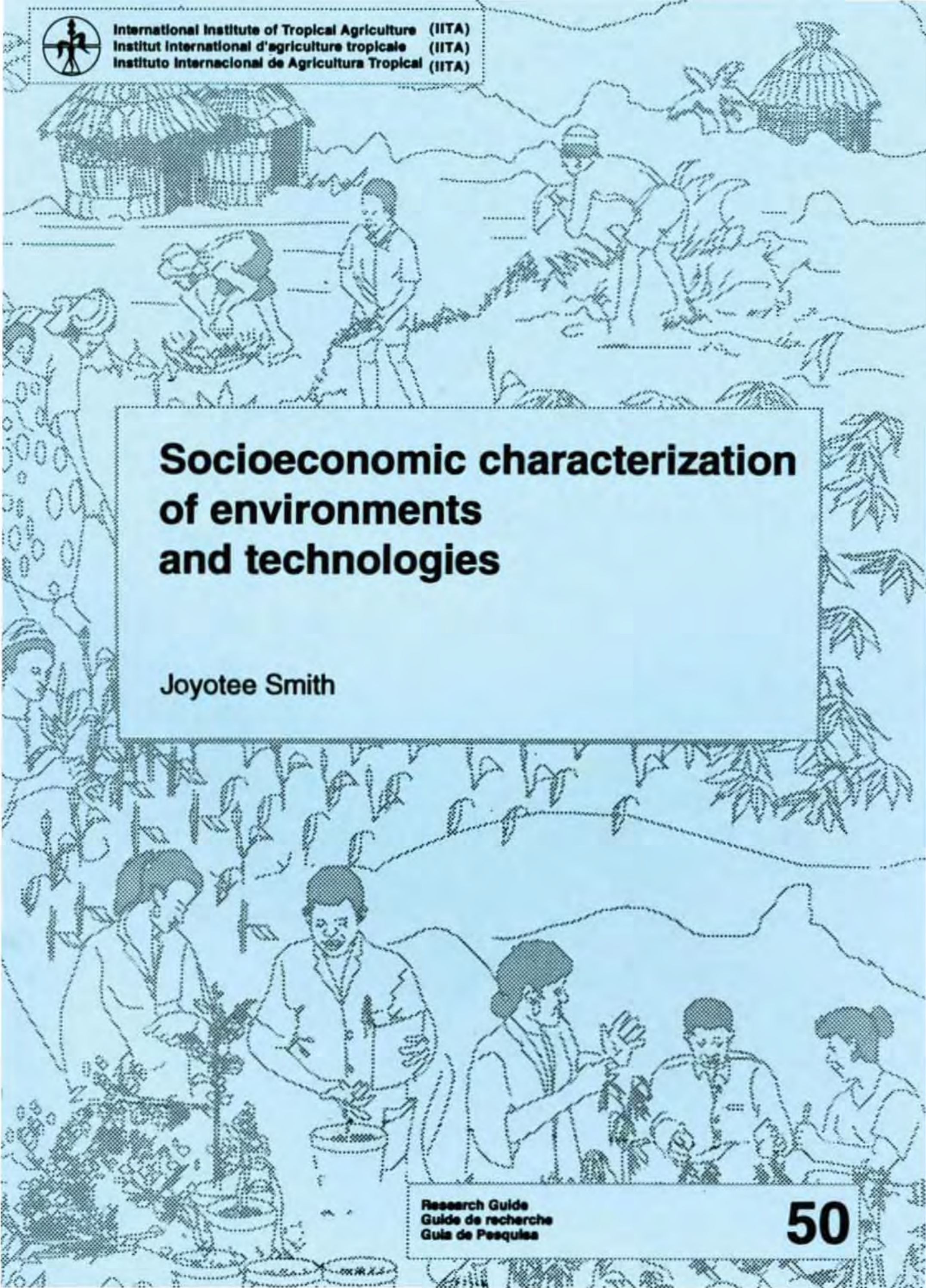

Socioeconomic characterization of environments and technologies

Joyotee Smith

Research Guide
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50

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IITA Research Guides

IITA Research Guides provide information and guidance to agricultural researchers, technicians, extension specialists, educators and students involved in research and training. The Research Guides are periodically updated to meet advances in scientific knowledge.

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Socioeconomic characterization of environments and technologies

Objectives. This guide is intended to enable you to:

- discuss the rationale of socioeconomic characterization;
- characterize environments;
- characterize technologies;
- match technologies and environments;
- describe interactions with biophysical and policy factors and access to technology;
- draw conclusions on the development of technologies under different socioeconomic, agroecological, political and cultural conditions.

Study materials

- Maps.
- Population statistics.
- Color slides of technologies described in Section 3.

Practicals

- Practice socioeconomic characterization of environments and technologies for certain areas of your country. Relate your conclusions with the specific socioeconomic, agroecological, political and cultural conditions.

Questions

1 What information does socioeconomic characterization provide?
2 What is the basic assumption underlying the criteria for socioeconomic characterization?
3 What condition precludes a stepwise approach of biophysical and socioeconomic characterization?
4 What three factors are the major determinants of relative prices?
5 How can you define levels of population density and access to markets?
6 How can you divide environments into three categories?
7 In this document, what do LPD, HPD, PAM, and GAM stand for?
8 Why has LPD/GAM not been considered as a category?
9 Why do farmers in LPD/PAM areas demand technologies which are land-intensive?
10 Why are interest rates high in LPD/PAM areas?
11 Why are labor markets undeveloped in LPD/PAM areas?
12 What technologies are demanded in HPD/PAM areas?
13 Why are loans relatively easily available in HPD/GAM areas?
14 Why does fertilizer save land, labor, and machinery?
15 Why are fertilizer-responsive varieties unlikely to be attractive in LPD/PAM and HPD/PAM areas?
16 How do ecological differences interact with socioeconomic variables?
18 Into what categories can you classify government policies?

Socioeconomic characterization of environments and technologies

Abstract. Socioeconomic characterization provides information for setting research priorities, extrapolating research results, and targeting existing technologies to appropriate areas. Farmers adopt technologies which economize scarce, and hence, expensive resources, and make use of abundant, cheap resources. This document divides environments into three categories, based on combinations of population density and access to markets, and identifies types of technologies likely to be appropriate in each category.

1 Socioeconomic characterization

International Agricultural Research Institutes (IARCs), such as IITA, are confronted with the task of developing technologies for mandate areas that span ecological zones, countries, and continents. To fulfill this task efficiently requires an understanding of how technological requirements vary across the mandate area. This can be achieved by characterizing in biophysical and socioeconomic terms both environments and existing/potential technologies.

Characterization provides information which can be used to set research priorities, extrapolate research results, and target existing technologies to appropriate areas for extension purposes.

Characterization of environments and technologies requires:

- a conceptual model from which the factors to be used for characterization can be derived,
- data on the incidence of these factors.

The factors constituting characterization, and, therefore, the data requirements, change as characterization progresses. A first cut at broad macro-characterization, for instance, would rely heavily on theory and secondary data.

A meso-level characterization would involve broad-based primary data collection. Detailed micro-characterization would require in-depth studies. Each of these levels could be used to validate and refine the earlier stages. Characterization, therefore, involves a continuous process of upgrading information and understanding.

Methodologies for socioeconomic characterization are not as highly developed as those for biological and physical characterization. Nevertheless, considerable advances have been made in recent years at IARCs. Most of this work has focused on the meso-level characterization of environments based on primary data collection, through village level group or individual interviews, and observation.

This document focuses on first cut socioeconomic characterization which can be carried out with secondary data, prior to more detailed characterization based on field work. Drawing heavily on the work of Binswanger (1986) as a conceptual framework, it develops criteria for the socioeconomic characterization of environments and technologies, and explores the interaction between biophysical and socioeconomic criteria.

The basic assumption underlying the development of criteria is that, within bio-physically homogeneous areas, farmers adopt technologies which economize scarce, and hence, expensive resources, and make ample use of abundant, cheap resources.

If environments were categorized according to relative resource endowments, and technologies according to relative resource requirements, it would be possible, within ecologically uniform areas, to target technologies to appropriate socioeconomic environments. This may seem to imply that biophysical and socioeconomic characterization can be carried out independently and sequentially. Significant interactions between the two categories, preclude this step-wise approach.

Existing technologies interact with ecological factors, such as soils and rainfall, to determine the resource requirements of these technologies, or the quantity of resources, such as land, labor, or fertilizer required to produce one unit of output. These resource requirements, combined with the prices of each of these resources, determine the cost of producing one unit of output under these technologies. If it is assumed that a new technology will not be adopted unless it lowers the unit cost of production, then the implication is that technologies which increase the resource requirements of high-priced resources are unlikely to be adopted.

Accurate data on the prices of inputs and outputs are difficult to collect and are subject to considerable fluctuations over time and space. As a result, most of the literature makes a reference to the importance of socioeconomic characterization, but usually eliminates it from first cut characterization, on the grounds of its ephemeral and site-specific nature.

Economic theory can, however, be used to predict relative endowments (and by implication, relative prices) of resources, and the literature on intensification shows that these predictions can be made from factors which are more stable over time and space.

The change from extensive to intensive agriculture has been hypothesized to occur as a result of population density, access to markets, and government policy. This Research Guide argues that these three factors are the major determinants of relative prices, and can therefore be used in combination with ecological factors, and access to technology, to characterize environments *according to the type of technology likely to be demanded* by farmers in the area (Figure 1).

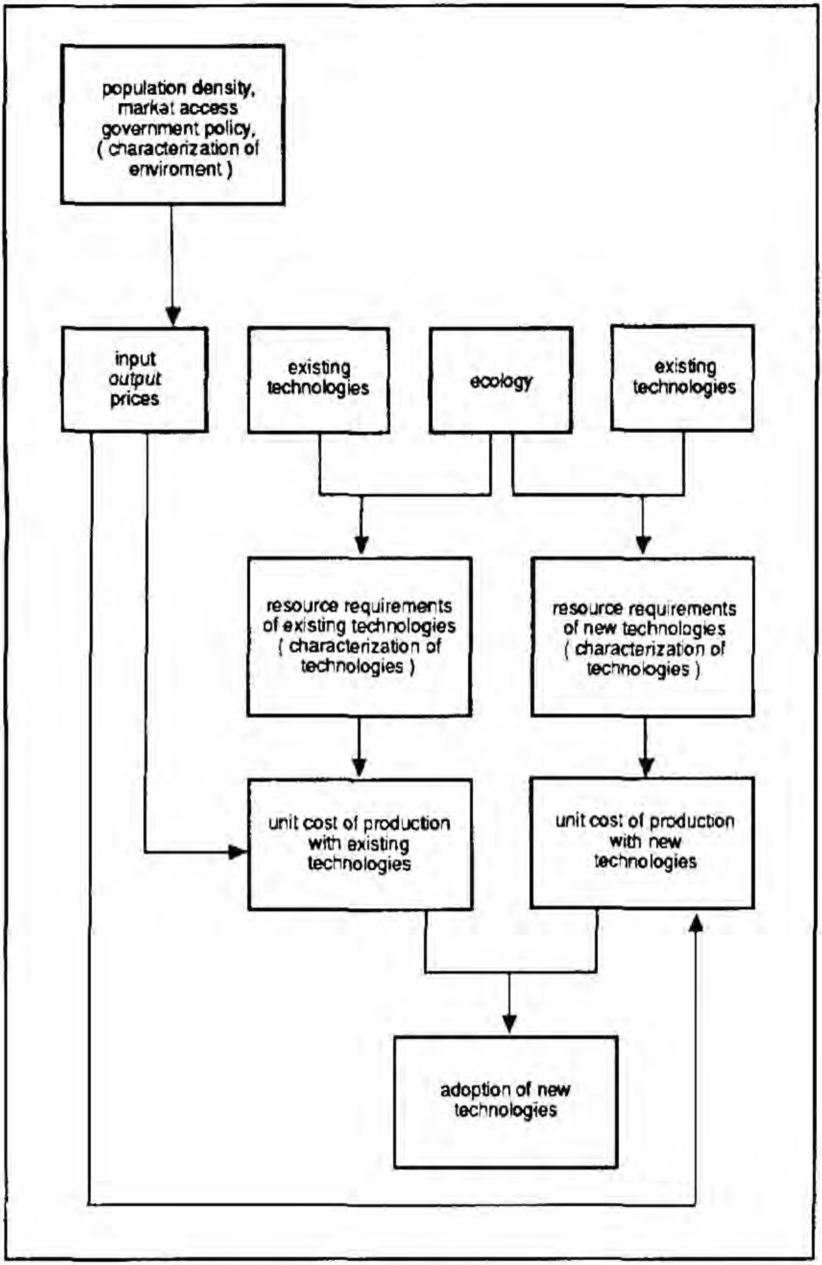

Figure 1. Technology adoption and the characterization of technologies and environments.

Technologies can similarly be characterized according to their resource requirements. Environmental - technological matches can be identified which allow for wider adoption of technologies.

The framework can be used on an ex-ante basis to guide technology development. It can also be used by extension services to target available technologies to appropriate environments.

The practical application of this framework for the categorization of environments will require guidelines on the definitions of high and low levels of population density and access to markets.

Taking the case of population density first, Binswanger and Pingali (1988) show that it is essential to take differences in soil and climate into account, in order to capture the abundance of land relative to population. They adopt FAO's estimates of potential calorie production at an intermediate level of technology, and relate that to World Bank population projections for the years 2000 to 2025. (This time horizon reflects the long gestation period for the development of agricultural technologies).

Binswanger and Pingali then define high density as 250 people per million kilo calories of potential production by the year 2025. Only one country (Nigeria) in the humid and subhumid tropics of West and Central Africa falls into this category. Nigeria however accounts for 46 % of the population of this region. The medium density countries are Sierra Leone, Togo, Ghana, and Benin (100 people per million kilo calories of production). Low density countries are Liberia, Zaire, Congo, Côte d'Ivoire, Cameroon, Central African Republic, and Gabon.

This exercise could be taken as a starting point. It would be important, however, to the extent data are available, to subdivide each country as much as possible, and at least by agroecological zone.

On access to markets, the methodology of Carter and Jones (1989) could be used as a starting point. The target area is divided into 12^0 latitude and 12^0 longitude grid cells. Grid cells which have a road, navigable river, or railway are defined as areas of good access. Clearly this can be refined and corrected at later stages of characterization, based on field verification.

Looking first, for simplicity, at the situation where ecological factors, government policy, and access to technology are constant, environments are divided into three categories:

- low population density and poor access to markets (LPD/PAM),
- high population density and poor access to markets (HPD/PAM),
- high population density and good access to markets (HPD/GAM).

Low population density with good access to markets has not been considered as a category because it is unlikely to be stable, as in-migration is likely to shift it into category HPD/GAM.

The types of technologies likely to be demanded by farmers in each of these environments are given in Table 1. Desired technologies are categorized according to the intensity with which they use resources.

All columns in Table 1 refer to resources or the ratio of resources per unit of output. Column 1, therefore, refers to the ratio of land and labor required to produce one unit of output, while column 7 refers to the quantity of land required to produce one unit of output.

The first row shows that LPD/PAM farmers demand technologies which are land-intensive, i.e., with high ratios of land use relative to the use of labor, purchased inputs (such as fertilizer), and machinery (columns 1-3). This is because land is abundant relative to labor in areas of low population density, and purchased inputs are difficult to locate and costly to transport, and therefore expensive, in areas of poor access to markets.

Table 1. Types of technologies desired by farmers in different categories of socioeconomic environments.

Environment	Resource use of desired technology per unit of output									
									Capital	
	Land/ labor (1)	Land/ purchased inputs (2)	Land/ machinery (3)	Labor/ purchased inputs (4)	Labor/ machinery (5)	Purchased inputs/ machinery (6)	Land (7)	Labor (8)	Purchased inputs (9)	Machinery (10)
Low population density and poor access to markets (LPD/PAM)	H	H	H	H	H	*	H	L	L	L
High population density and poor access to markets (HPD/PAM)	L	*	*	H	H	*	L	H	L	L
High population density and good access to markets (HPD/GAM)	L	L	*	**	H	H	L	H	H	L

H = high, L = low

* Ratio can be high or low, but level of both inputs per unit of output should be low.

** Ratio can be high or low, but a high level of both inputs per unit of output would be acceptable.

Capital markets are also poorly developed in LPD/PAM areas, because land, being low in value, cannot serve as collateral.

In the absence of collateral, interest rates are prohibitively high, and loans difficult to obtain. This further inhibits the use of purchased inputs and machinery. Land abundance also leads to undeveloped labor markets. Labor cannot be hired to augment family labor. Demand for output, and therefore output price, are low in areas of poor market access. Farmers are consequently interested only in technologies which use low levels of resources, such as labor, purchased inputs, and machinery per unit of output (columns 8-10).

Either a high or a low ratio of purchased inputs to machinery is acceptable as long as the quantity of both units per unit of output remains low (column 6). The only input they are willing to use in abundance is land, because it is plentiful and therefore of low value.

Farmers prefer an extensive agricultural system, where production is increased by expanding the area under cultivation and labor productivity is high. Note that since farmers prefer high land/output ratios and low ratios of all other inputs to output, the implication is that they are unlikely to be interested in technologies which increase yield/ha by increasing inputs such as fertilizer.

The second row shows that in HPD/PAM areas, technologies with low levels of land relative to labor are demanded (column 1). This is because land is scarce relative to labor. As population density increases and land becomes scarce, fallow periods decline, and farmers try to increase output per unit of land, i.e., intensification occurs. Yield-increasing technologies become more attractive.

Farmers in the HPD/PAM category are interested in technologies that increase yield by increasing labor use (column 8). This is because labor is relatively cheap in HPD areas. Also land scarcity leads to the development of labor markets This makes labor hiring possible.

Farmers are not, however, likely to adopt technologies which increase yields by using high levels of purchased inputs (column 9), because in these environments access to inputs is not easily obtained. Nor are they interested in labor-saving machinery, because labor is cheap.

The last row shows that in HPD/GAM environments, farmers are interested in making use of purchased inputs, as well as labor, for increasing yields (columns 8 and 9). This is because of the improved access to input markets in this category. Also, improved access to markets increases output demand, and therefore output price. This increases the marginal return to the use of all types of inputs, and induces farmers to use high levels of inputs to produce a marketable surplus. This increases the availability of cash, and further encourages the use of purchased inputs.

The effect is further augmented by the development of capital and labor markets, resulting from the increased value and scarcity of land. Interest rates therefore decline, loans are more easily obtained, and labor can be hired to augment production. All these factors combine to produce a transition to an intensified agricultural system, where farmers are interested in using high levels of labor and purchased inputs, in order to increase yield.

As intensification progresses, and farmers' incomes increase, a substantial proportion of their incremental income is spent on locally produced, labor-intensive goods and services. This increases labor demand and wages, and ultimately makes it economical to use labor-saving machinery.

Today, there is very little evidence that intensification in West and Central Africa has increased sufficiently for this phenomenon to occur. Therefore, farmers in HPD/GAM areas are unlikely to be interested in high levels of machinery use (columns 5 and 10). Note that seasonal labor shortages can and do occur at periods of peak labor intensity. These factors, however, require an in-depth understanding of the farming systems and cannot be captured in a first cut characterization exercise.

It should be pointed out that the three categories of environments in Table 1 are not necessarily in sequential order. Areas can move from LPD/PAM to HPD/PAM or directly to HPD/GAM, if increases in population density are accompanied by governmental efforts to improve infrastructure, particularly roads. It also implies that the movement to intensive agriculture is not necessarily autonomously achieved by increases in population density, because access to markets can remain undeveloped.

While HPD does stimulate infrastructural development to some extent, if population growth is very rapid as in Africa, governmental intervention in infrastructure development may be required to shift areas into the HPD/GAM category.

In this section, an *a priori* first cut application is presented for illustrative purposes. Specific technologies are now categorized (Table 2) according to the intensity with which they require different resources, per unit of output. The column headings are the same as those in Table 1.

It should be noted that what is given below is an *a priori* first cut characterization of technologies. The objective is to provide a framework for characterization and to illustrate its application. In many cases, information may already exist to refine the characterization given here. In all cases, later stages of meso- and micro-characterization will be expected to upgrade the first cut characterization.

The first technology, fertilizer or fertilizer responsive varieties, saves land, labor, and machinery, and increases the use of purchased inputs (columns 7-10). Fertilizer saves land by increasing yield/ha, which reduces the quantity of land required to produce one unit of output. In addition, balanced fertilization saves land by enabling the same plot of land to be cultivated for longer without fallowing.

Savings in labor and machinery occur because of the lower land requirement, which saves all the labor and machinery required for cultivating the saved land. As a result, columns 1 and 3 are marked neutral, since labor and machinery are saved exactly in proportion to land. It has been assumed here that fertilizer involves no additional labor use/ha.

This is because, under upland farming conditions in Africa, the extra labor required to apply fertilizer can be assumed to roughly equal the labor-saving resulting from decreased weed competition due to the added crop vigor induced by fertilizer application. The situation is quite different when semi-dwarf varieties of rice, for instance, are grown in lowland conditions, and the analysis can then be adapted accordingly.

The second technology, resistant crop varieties, increases average yields over time by avoiding damage by pests, diseases, drought or other hazards. The increase in yield more than compensates for any additional inputs. No additional inputs are generally required. Therefore this technology saves land, and saves all other inputs in proportion to the savings in land.

The situation is very similar for the use of predators in the biological control of pests. Varieties with better eating quality are also neutral with regard to the use of inputs. However, they save land by producing the same income from a smaller quantity of land, if they can be sold at a higher price.

The effect of early-maturing varieties on yield depends on agroecological factors. If early maturity allows better adaptation to the rainfall pattern, average yields increase. If there is no particular advantage to be captured from early maturity, yields are likely to be lower than those of full season varieties.

In all ecologies, however, early varieties save land by freeing land earlier for the following crop. They can also usually be sold at a higher price because they are available before the full harvest floods the market. Overall therefore, they usually save land by producing a higher revenue from the same size of plot.

Crop husbandry practices, such as improved weeding or plant density, increase yield, either by using more labor, (as in the case of weeding), or by using more of both labor and purchased inputs. (An example is increased planting density which is usually effective only if fertilizer is also applied).

Crop husbandry therefore saves land, and is intensive in the use of either labor, or both labor and purchased inputs. Machinery is usually not required, and machinery is saved in proportion to the savings in land.

The substitution of herbicides for hand weeding does not increase yield, and therefore is not land-saving. Instead it saves labor, and increases the use of purchased inputs.

The issue of ox-plows is more complex. The shift from hand hoeing to ox-plows cannot be regarded as a simple matter of substituting other inputs for labor, as in the case of herbicides. An important reason for the adoption of ox-plows is that it enables farmers to increase the intensity of land cultivation, by making it possible to overcome the labor constraints that prevent the cultivation of a larger land area. This means that a smaller proportion of the farmer's total holding needs to be left fallow each year. Ox-plows are therefore land-saving as well as being labor-saving.

Technologies which increase the sustainability of production, by making long term improvements in soil quality, are next illustrated by alley cropping. In alley cropping, hedgerows of leguminous trees are planted at intervals on farmers' fields. Arable crops are grown in the alleys between the hedgerows.

Table 2. Characterization of technologies by resource use per unit of output.

Technologies	Land/ labor (1)	Land/ purchased inputs (2)	Land/ machinery (3)	Labor/ purchased inputs (4)	Labor/ machinery (5)	Purchased inputs/ machinery (6)	Land (7)	Labor (8)	Capital: Purchased inputs (9)	Capital: Machinery (10)
Fertilizer/fertilizer-responsive varieties	N	L	N	L	N	H	L	L	H	L
Resistant varieties/ biocontrol (predators)	N	N	N	N	N	N	L	L	L	L
Early-maturing varieties	N	N	N	N	N	N	L	L	L	L
Crop husbandry*	L	N (L)	N	H (N)***	H	N (H)	L	H	L (H)	L L

High quality varieties	N	N	N	N	N	N	L	L	L	L
Herbicides	H	L	N	L	L	H	N	L	H	N
Ox plows	N****	N	L	L	L	L	L	L	L	H
Alley farming (establishment and maintainance phases)	N***	N	N	H	H	N	H	H	L (H)**	L (H)**
Alley farming (productive phase)	L	N	N	H	H	N	L	H	L	L

H = high, L = low, N = Neutral

* Letters in parenthesis refer to crop husbandry technologies which require additional purchased inputs.
** Letters in parenthesis refer to high cash requirements, due to delayed benefits.
*** Both inputs likely to increase.
**** Both inputs likely to decrease.

During the cropping season the hedgerows are pruned, and crops are mulched with prunings. The objective is to increase the possibility of more intensive cultivation by increasing soil quality, through biological nitrogen fixation and mulching.

Alley cropping consists of three stages: establishment (when the seedlings of leguminous trees are established), maintenance (when hedgerows are nurtured), and the productive period, when the benefits in the form of increased yields are obtained. In the first two stages, alley cropping is land-using and labor-using. In the productive stage, it becomes land-saving and labor-using.

Since benefits only become available after a period of time, the technology will not be attractive in environments where farmers discount the future at a relatively high rate. This feature is accommodated in the framework by characterizing capital requirements as high (columns 9 and 10).

Although alley cropping is not capital intensive in that it does not require purchased inputs or machinery, it is cash intensive in the sense that it creates an intertemporal liquidity problem, by cutting down income in earlier years in order to obtain higher gains in future. This is a feature of any technology characterized by delayed benefits.

Tables 1 and 2 are now matched with each other to predict the type of technology likely to be acceptable in different socioeconomic environments.

Technologies which are characterized as high (H) in any of the last four columns of Table 2 are unlikely to be adopted in environments which are categorized as low (L) in the same column in Table 1. This is because the technology is intensive in an input which is expensive (or scarce) in that environment. Thus, fertilizer responsive varieties are unlikely to be attractive in LPD/PAM or HPD/PAM because the technology uses a high level of purchased inputs (column 9 in Tables 1 and 2).

Technologies characterized as L in the last four columns of Table 2 save the corresponding inputs. Some of these inputs are saved only in proportion to the land saved, and this is indicated by a neutral (N) characterization in the first three columns.

Thus, for fertilizer responsive varieties, labor and machinery are saved only because land is saved (columns 1 and 3 in Table 2). But the technology is intrinsically land-saving, and therefore gives the largest savings in HPD environments, where farmers are anxious to save land because it is scarce or expensive (column 7 in Table 1).

Technologies also need to be compared with others which achieve the same objective. For example, yield can be increased by either a resistant variety or a fertilizer responsive variety. In HPD/GAM environments, both technologies would be compatible with the resource base.

However, if incorporation of resistance involves a sacrifice in fertilizer responsiveness, farmers in HPD/GAM would prefer fertilizer responsive varieties. This technology enables them to take advantage of purchased inputs which are relatively cheap in that environment because of GAM. Note that we are still considering environments which are internally homogeneous from the biophysical point of view. This assumption will be relaxed later.

A comparison of Tables 1 and 2 shows as follows.

- Fertilizer and fertilizer responsive varieties, also hybrid maize, are likely to be most suited to HPD/GAM environments.

- Resistant varieties, varieties with higher eating quality, and the use of predators in the biological control of pests would be attractive to farmers in all environments.

  Early-maturing varieties would be most rapidly adopted in land-scarce environments, and in areas where they reduce the risk of unfavorable weather/pest conditions.

- Crop husbandry technologies which require only additional labor would be attractive in both HPD environments. However, if they also require purchased inputs, they would be adopted only in HPD/GAM areas.

- Herbicides, even though labor-saving, would be unlikely to be adopted in LPD areas, because of poor access to inputs. They are most likely to be adopted in HPD/GAM areas, but even here they would be adopted only if they were highly effective and cheap. This is because the resulting labor-savings are small, since labor is cheap in HPD areas.

- Ox-plows, even though labor-saving, would be most likely to be adopted in HPD/GAM environments. This is because the major objective of adopting ox-plows is to increase the size of the area cultivated, which is most attractive to farmers in GAM areas, facing an elastic demand for their products.

  The land-saving characteristic of ox-plows gives higher benefits in HPD/GAM areas, not only because land is scarce, but also because labor and purchased inputs/ha are higher than in other areas. Therefore, the savings in labor, which are obtained by saving land, are also higher.

- Alley cropping would be attractive to farmers in HPD areas, in the productive phase, because it is land-saving and labor-using. A problem arises, however, in the establishment and maintenance stages, which are intensive in land as well as labor. This is unlikely to be attractive in HPD areas where land is scarce.

  The lower the rate at which the future is discounted, the more likely are farmers in HPD areas to accept the unattractive features of the first two stages. Discount rates are likely to be lower in HPD areas when compared with LPD areas because of the better development of capital markets.

Farmers in HPD/GAM, however, might prefer to attempt to maintain soil fertility through the use of purchased inputs, since access to markets is good. Alley cropping is therefore most likely to be adopted in HPD/PAM areas.

Note that if alley cropping is regarded instead as a method of controlling erosion, it may also be attractive to farmers in HPD/GAM areas, because erosion cannot be easily controlled by using purchased inputs.

The basic problem with alley cropping is, however, the conflict in the use of resources between the earlier and later phases. Discount rates would therefore have to be very low before alley cropping is adopted).

5 Interactions

The analysis so far has looked at variability in socioeconomic environments holding constant:

- ecology,
- government policy,
- farmer access to technology.

The implications for relaxing each of these will be considered briefly in turn.

Ecological factors. Ecological differences interact most significantly with socioeconomic variables via their impact on the marginal products of inputs. Climatic and edaphic factors may cause differences in the marginal products of different inputs applied to the same crop, as well as differences between crops. This gives certain environments a biophysical comparative advantage in the production of a particular crop.

These differences in comparative advantage interact with the socioeconomic factors discussed so far. For instance, in a particular ecology, fertilizer may not be used even in areas with HPD and GAM, if low solar radiation results in a very low response of maize to fertilizer.

It is also important to use agroecological information to build up a picture of the farming system as a whole, and carry out the economic characterization within this context. For example, agroecological data will indicate the crops which have a comparative advantage. The other crops are likely to be grown as subsistence crops, and therefore without the HPD/GAM types of technology, such as high levels of fertilizer, even in HPD/GAM areas. An example is the forest zone of Nigeria, where tree crops such as cocoa and oil palm have a comparative advantage. Even though many of these areas have HPD/GAM, foodcrops are generally not cultivated with HPD/GAM type technologies.

Government policy. Government policy plays a significant role in promoting or impeding intensification, and therefore the adoption of HPD/PAM and HPD/GAM type technologies. Government policy is classified into categories for the purpose of this exercise :

- policies that distort prices,
- policies that relate to infrastructure and the provision of services,
- polices that affect the distribution of resources.

Examples of distortions are over-valued exchange rates, subsidized input or output prices, and export taxes. The distinguishing feature of these policies is that they prevent prices from reflecting the relative scarcity of resources in the country. Therefore they create inefficiency by inducing the increased use of scarce resources, or inhibiting the use of abundant resources.

It would be dangerous and irresponsible to allow distorted incentives to guide the characterization of environments and the setting of research priorities. For example, the adoption of labor-saving devices such as herbicides and machinery may be induced in HPD areas, even though foreign exchange is scarce, via subsidies or over-valued exchange rates. This adoption should not be used to justify research on screening herbicides, or the development of machinery, because these technologies would be contrary to the resource base of the country, and therefore an inefficient use of resources for the country as a whole.

Characterization of environments should therefore be corrected for distortionary government policy, and be based on the relative scarcity or abundance of resources.

Characterization should, however, take into account government policy on infrastructure and services. Much of this, such as road construction and marketing infrastructure, will have been taken into account in the assessment of access to markets. Others are similar in impact to a change in the availability of resources. Health services, for example, make an area more labor-abundant. Certain other policies are similar in impact to a change in prices. A stable economic climate, for example, can be interpreted, in effect, as a more favorable price environment.

In addition to the quantity of resources, the distribution of resources within a country can also affect the relative prices of resources. In a comparison of two countries with the same population density, the ratio of land to labor prices would be higher in the country with a more unequal distribution of land. Land-saving technologies would therefore be more attractive in areas of highly concentrated land ownership. Land ownership in most of West and Central Africa is relatively equitable.

However, examples of unequal access to loans and purchased inputs are not difficult to find. This would increase interest rates and the prices of purchased inputs, and inhibit the use of HPD/GAM technologies. Government policy on the distribution of resources, therefore, should be incorporated into the analysis.

Farmer access to technology. Farmer access to technology and training affects farmer demand for technology. Fertilizer, for example, will not be adopted even in HPD/GAM areas, if fertilizer responsive varieties are not available, either because the technology does not exist, or because it has not been extended to farmers. Nor will ox-plows become widespread in HPD/GAM environments, if none of the existing arable crop varieties can be grown profitably for a marketable surplus.

Technologies requiring sophisticated management skills, such as economic thresholds for insecticides, will not be adopted unless farmers have access to the necessary training.

The interactions described above show that socioeconomic characterization has to be integrated with:

- agroecological characterization,
- government policy,
- farmer access to technology and training,

before farmer demand for technology can be determined.

6 Conclusion

An analytical framework for the socioeconomic characterization of environments and technologies was developed, based on the theories of induced innovation and intensification. The analysis divided environments into three categories, based on combinations of population density and access to markets, and identified the types of technologies likely to be appropriate in each category.

The exercise illustrated that there are substantial differences in the types of technologies likely to be demanded by farmers in different socioeconomic environments. Interactions between agroecological and socioeconomic characterization were discussed, and ways of incorporating the policy environment and farmer access to technology were illustrated. Clearly, characterization involves an integration of these different aspects.

Because this Research Guide provides a framework and illustration of characterization, rather than characterization *per se*, the empirical conclusions must be regarded as indicative. Nevertheless, the results illustrate that technologies such as resistant varieties, early-maturing varieties, varieties with high eating quality, and biological control of pests through the use of predators, are likely to be most easily adopted.

Yield-increasing technologies such as fertilizer responsive varieties, hybrid maize, and crop husbandry technologies are most likely to be adopted in areas of high population density and good access to markets. Such conditions exist in parts of West and Central Africa, an example being the northern Guinea savanna of Nigeria, where intensive forms of agriculture are practiced. Yield-increasing technologies should therefore be carefully targeted to these areas.

Even if the occurrence of such areas is rare in West and Central Africa, the development of technologies appropriate for these areas should not be neglected because:

- the potential for production increases is high,
- increasing production in these areas would relieve pressure and degradation in marginal areas.

The analysis also illustrates that it may be difficult to find a niche for alley cropping, because of the conflict between the types of resources required in the earlier and later phases. Developers of technologies, such as alley cropping, where an initial period of investment is required before benefits become available, should endeavor to have the same pattern of resource use in both the "investment" and "productive" stages. Technologies which require investments in land quality are most likely to be adopted in areas of high population density, and should match the resource endowments of high density areas.

Characterization is a continuous process. The analytical method described here can be considered as a first cut at characterization which can be used for developing broad guidelines for research priorities. It is incapable of exploring the complexities of farming systems, which are important determinants of technologies acceptable to farmers.

As more detailed studies using primary data are carried out, and these complexities are related to systematic factors, modification and refinement of research priorities arising out of the first cut characterization should take place. It should be emphasized that this exercise has concentrated purely on the demand for technologies. Research priorities can only be set after supply side factors, such as the cost of developing technologies, have also been taken into consideration.

Characterization exercises of this nature can contribute significantly to the efficient allocation of scarce research resources, and greatly enhance the potential for agricultural research to make a positive contribution to food production in sub-Saharan Africa.

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If you use this Research Guide in training ...

Generally:

- Distribute handouts (including this Research Guide) to trainees one or several days before your presentation, or distribute them at the end of the presentation.

- Do not distribute handouts at the beginning of a presentation, otherwise trainees will read instead of listen to you.

- Ask trainees not to take notes, but to pay full attention to the training activity. Assure them that your handouts (and this Research Guide) contain all relevant information.

- Keep your training activities practical. Reduce theory to the minimum that is necessary to understand the practical exercises.

- Use the questions on page 4 (or a selection of questions) for examinations (quizzes, periodical tests, etc.). Allow consultation of handouts and books during examinations.

- Promote interaction of trainees. Allow questions, but do not deviate from the subject.

- Respect the time allotted.

Specifically:

- Ask trainees about their experiences with socioeconomic characterization (10 minutes).

- Present and discuss the content of this Research Guide, using the study materials listed on page 3 (1 ½ hours). You may photocopy the tables onto transparencies for projection with an overhead projector.

  Note: The subject on socioeconomic characterization is complex and complicated. Involve all trainees in intensive discussion. Do not purely lecture.

- Conduct field visits to practice socioeconomic characterization as suggested on page 3. You may assign different locations to different groups. Have resource persons available for each group. Ask groups to prepare, present and discuss their findings.

International Institute of Tropical Agriculture (IITA)
Institut international d'agriculture tropicale (IITA)
Instituto Internacional de Agricultura Tropical (IITA)

The International Institute of Tropical Agriculture (IITA) is an international agricultural research center in the Consultative Group on International Agricultural Research (CGIAR), which is an association of about 50 countries, international and regional organizations, and private foundations. IITA seeks to increase agricultural production in a sustainable way, in order to improve the nutritional status and well-being of people in tropical sub-Saharan Africa. To achieve this goal, IITA conducts research and training, provides information, collects and exchanges germplasm, and encourages transfer of technology, in partnership with African national agricultural research and development programs.

L'Institut international d'agriculture tropicale (IITA) est un centre international de recherche agricole, membre du Groupe consultatif pour la recherche agricole internationale (GCRAI), une association regroupant quelque 50 pays, organisations internationales et régionales et fondations privées. L'IITA a pour objectif d'accroître durablement la production agricole, afin d'améliorer l'alimentation et le bien-être des populations de l'Afrique tropicale subsaharienne. Pour atteindre cet objectif, l'IITA mène des activités de recherche et de formation, divulgue des informations, réunit et échange du matériel génétique et encourage le transfert de technologies en collaboration avec les programmes nationaux africains de recherche et développement.

O Instituto Internacional de Agricultura Tropical (IITA) é um centro internacional de investigação agrícola pertencendo ao Grupo Consultivo para Investigação Agrícola Internacional (GCIAI), uma associação de cerca de 50 paises, organizações internacionais e regionais e fundações privadas. O IITA procura aumentar duravelmente a produção agrícola para melhorar a alimentação e o bem-estar das populações da Africa tropical ao sul do Sahara. Para alcançar esse objetivo, o IITA conduz actividades de investigação e treinamento, fornece informações, reúne e troca material genético e favorece a transferência de tecnologias en colaboração com os programas nacionais africanos de investigação e desenvolvimiento.