Scott Pearson is Professor Emeritus of Agricultural Economics at the Food Research Institute, Stanford University. He has participated in projects that combined field research, intensive teaching, and policy analysis in Indonesia, Portugal, Italy, and Kenya. These projects were concerned with studying the impacts of commodity and macroeconomic policies on food and agricultural systems. This effort culminated in a dozen co-authored books. These research endeavors have been part of Pearson’s longstanding interest in understanding better the relationships between a country’s policies affecting its food economy and the underlying efficiency of its agricultural systems.

Pearson received his B.S. in American Institutions (1961) from the University of Wisconsin, his M.A. in International Relations (1965) from Johns Hopkins University, and his Ph.D. in Economics (1969) from Harvard University. He joined the Stanford faculty in 1968 and retired in 2002.

The top row of the Policy Analysis Matrix is introduced in this lecture. Details can be found in Eric A. Monke and Scott R. Pearson, *The Policy Analysis Matrix for Agricultural Development* (hereafter PAM), 1989, Chapters 8, 9, and 10, pp. 131-187.
The Opportunity Cost Principle

- PAM analysis – based on opportunity cost principle – value of resource – from worth in alternative use

- private opportunity costs – reflect market choices
  - private opportunity cost of labor
    - hired – market wage rate, plus meals, transportation
    - family – market wage rate – if off-farm jobs available
  - private opportunity cost of land – land rental rate – or land rent equivalent of share-cropping arrangements

- social opportunity costs – reflect foregone national income – illustrated in lecture 4
  - social opportunity cost of land planted to rice – social profitability of land in best alternative user

In making estimates of private and social prices in farm budgets for PAM, the principle of opportunity costs needs to be applied consistently and widely. The opportunity cost principle – that the value of resources is best reflected by the worth of those resources in alternative uses – is the main underlying conceptual principle in budget-based analyses, such as the PAM approach.

Private opportunity costs reflect market choices. The opportunity cost of hired labor, for example, is given by the market wage rate, adjusted for any meals and transportation provided by the farmer, trader, or processor. In contrast, the opportunity cost of family labor is approximated by the market wage rate (if the worker otherwise could find a job off the farm at that rate). The rental value of a certain quality and location of land depends closely on the productivity of that land in producing various crops – as reflected in the land rental rate or in the land-rent equivalent of share-cropping arrangements.

Social opportunity costs, in contrast, reflect foregone national income (as explained and illustrated in lecture 4). The social rental rate for land devoted to producing rice, for example, is given by the social profitability of that land in its best alternative use.
The empirical application of the Policy Analysis Matrix (PAM) begins with an assessment of revenues, costs, and profits in private (actual market) prices. Data on private revenues and costs are entered in the top row of the PAM, called the “private row.”

**The entries for the top row of PAM contain measures in private prices** (the observed market prices). The symbol A measures revenues in private prices, the symbol B stands for tradable input costs in private prices, the symbol C represents domestic factor costs in private prices, and the symbol D is private profit.

Application of the profitability identity \((D = A - (B + C))\), introduced in lecture 2, to private revenues and costs gives private profits.

The purpose of this lecture is to explain how an analyst goes about the practical task of deciding what data to use in the top row of PAM and how to find that information.
Entries in the Private row of the PAM are illustrated in this slide.
Agricultural policymakers are concerned with farmer welfare. Therefore, they are interested in understanding competitiveness and efficiency at the farm-gate.

But comparable world prices are needed to assess efficiency (as explained in lecture 4). For many agricultural commodities, there are no comparable world prices until after the raw commodity has been processed (e.g., converted from paddy to milled rice). Comparable world prices for processed goods are available only at the nearby wholesale markets.

Hence, PAM analysts need to define commodity systems to include four activities – farm production, farm-to-processor transportation, processing, and processor-to-wholesale-market transportation.
Structure of a Commodity System

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FARM PRODUCTION</td>
<td>Inputs and outputs for production of raw materials (evaluation stops at farm gate)</td>
</tr>
<tr>
<td>FARM-TO-PROCESSOR</td>
<td>Commodity moves from farm gate to processing site (may include storage and handling as well as transportation costs)</td>
</tr>
<tr>
<td>PROCESSING</td>
<td>Commodity processed into consumer acceptable form (may involve physical transformation or just packing, handling, and quality control)</td>
</tr>
<tr>
<td>PROCESSOR-TO-WHOLESALE MARKET</td>
<td>Commodity moved from processing site to nearby wholesale market (where domestic activity is comparable to tradable product)</td>
</tr>
</tbody>
</table>

This slide gives a visual representation of the four activities in a single commodity system and summarizes the content of each activity.
The numeraire (unit of account) typically differs across the four activities within a commodity system.

In most instances, the analyst chooses the numeraire for the processed product in the nearby wholesale market (e.g., Rupiahs per kilogram of milled rice). Occasionally, it is appropriate to use instead a numeraire that measures revenue per hectare (e.g., Rupiahs per hectare), the farm-gate unit of account.

In either case, it is necessary to use conversion ratios as one moves from the budget for one activity to another within a commodity system. These conversion ratios contain important physical information, such as yields (tons of paddy per hectare) and milling conversion ratios (tons of rice per ton of paddy).
Selecting Representative Commodity Systems

- number of systems – depends on policies studied
  - if rice tariff – cover wide range of rice production costs
  - if fertilizer subsidy – cover range of crops using fertilizer

- stratification variables – choice of sites, farmers
  - commodities of interest (crops, animal products)
  - geographic regions or agro-climatic zones
  - seasons of production and cropping rotations
  - agricultural technologies (water control, inputs, seeds)
  - areas cropped (owned, rented-in, rented-out)

- limit variables (maximum 4) and PAMs (< 16)

PAM analysis is carried out at the individual commodity level (for rice, soybeans, coconuts, or cloves). An early issue that PAM researchers confront is how many agricultural commodity systems to study. (The selection of commodity systems is discussed in PAM, Chapter 8, pp. 131-150.)

This decision depends critically on the nature of the questions to be addressed in the study. If the policy of interest were a tariff on rice, for example, the analysts would want to choose a wide range of rice-production systems, including some marginal ones that might require tariff protection to maintain private profitability. Or if the question were a subsidy on chemical fertilizers, the researchers would want to select a range of crops that use fertilizer, including some systems that might have negative profits without the subsidy.

Researchers need to stratify the population of farmers according to a subset of several variables – the commodities of interest, the geographic regions or agro-climatic zones (distinguished by rainfall, soils, elevation, and slope), the seasons of production and cropping rotations (one wet season and one or two dry seasons), the agricultural technologies (differentiated by water control, inter-cropping, high-yielding seeds, modern inputs, and mechanization), and the areas cropped (owned, rented-in, and rented-out).

By choosing a subset of these stratification variables, researchers can select a workable number of agricultural systems for which to create PAMs. These variables need to be chosen carefully, because the choice of only four variables, for example, leads to sixteen commodity systems. That number is near the maximum that any study can easily cover, and it is usually preferable to narrow the system coverage to half that number or even less.
Construction of Private Budgets for PAM

- top (Private) row of PAM – data from budgets
  - revenues and costs – data inputs
  - profits – research results – from profitability identity

- four budgets – for each commodity system
  - farming
  - marketing – from farm to processing center
  - processing
  - marketing – from processing center to wholesale market

Empirical application of the PAM approach is based on the compilation of data in budgets. Because the PAM approach is based on budgets, PAM input data are revenues and costs. Profits are found by subtraction as a research result.

Four different budgets are put together for each commodity system – one on farming, a second on marketing (from the farm to the processing center), a third on processing, and a fourth on marketing (from the processing center to the wholesale market).

Before beginning the search for budget information, the PAM analyst needs to select the representative commodity systems that will be studied. That choice depends on the policy questions that will be addressed by the results of the study.
A number of guidelines assist the compilation of farm budgets. (The construction of farm budgets is discussed in *PAM*, Chapter 9, pp. 151-170.)

For most PAM analyses, the **farm budgets should be based on actual data** from a recent time period, **not on optimal performance**. The budgets are intended to be representative of current average farming behavior, not that of the best and most progressive farmers.

**The data in the budgets should be measures of average costs and returns.** In this important respect, PAM analysis differs from efforts to build supply schedules of agricultural commodities, which are based on marginal (incremental) costs of production.

**The numeraire (the units used to denominate entries in the PAM) is usually domestic currency units per quantity (ton or kilogram) of output,** since only farming budgets (and not marketing and processing budgets) can be done using domestic currency units per hectare.

Empirical PAM analysis usually begins with the compilation of **synthetic budgets based on secondary data collected by other researchers**. These early budgets are synthetic in two senses – they **are not the result of original fieldwork** and thus are somewhat artificial, and **they are syntheses of existing work**.

The purpose of compiling **synthetic budgets** is to **guide the researcher toward essential missing or conflicting information**. Actual fieldwork ideally then can focus on completion, verification, and updating of the synthetic budgets rather than starting from the beginning and building all new budgets. The computation of synthetic budgets also encourages researchers to carry out a systematic review of existing work on their commodities and regions of interest and thus grounds their research reports firmly in the existing literature.
Fieldwork for Farm Budgets

- field data crucial, but expensive – interview farmers, traders, transporters, processors – but how many?
- PAM entries – modal values – small sample sizes – check with expert opinion – conserve field resources
- seek clarity in questions and answers
  - cross checks in interviews – reliability of answers
  - check key responses (yields, prices) – with local experts
- search for inconsistencies in responses
  - check yields – applications of fertilizer, labor inputs
  - check consistency – milling rates, output qualities
  - apply uniform guidelines – to clean raw data

Most of the field time of PAM researchers is devoted to interviewing farmers, traders, transporters, and processors. Careful fieldwork is crucial to understanding the farming systems, but is expensive in consuming scarce manpower and other project resources.

The budget data needed for PAM entries can be based on relatively small samples of farmers, traders, and processors. PAM entries are modal values (central tendencies), not econometrically-estimated parameters drawn from statistically valid samples. Field observations and the allocation of researchers’ time in fieldwork take advantage of this property. Researchers are encouraged to seek a wide range of informed and expert opinion about the agricultural systems rather than to meet imposed standards of large sample size.

The key to successful fieldwork is to make every effort to ensure that respondents understand the questions asked. To verify their responses it is important to check key answers (yields, fertilizer applications, output prices, wage rates, and land rental rates) with local experts – traders, brokers, the village head, agricultural officials, and local representatives of the Central Bureau of Statistics. But errors inevitably creep into all field investigations.

PAM researchers carrying out fieldwork thus need to be aware of ways to cross check the reliability of the data they are collecting. If private profits are negative, the farmer must be able to explain this result (usually because of unexpected poor weather or interrupted marketing of inputs or outputs).

Researchers also need to check for possible inconsistencies in data from various respondents. Variations in yields (output per hectare) need to be consistent with applications of fertilizers and labor. In processing, conversion factors (e.g., quantity of milled rice per quantity of paddy) and qualities of outputs (e.g., percentage of broken kernels in milled rice) need to be analyzed consistently across processing units.
In cleaning their raw data, **PAM researchers should** search for inexplicable outliers and then **formulate and apply consistent rules for accepting or rejecting interview data**. Particularly with small sample sizes, however, researchers should be cautious before rejecting the results of an apparently inconsistent and inaccurate interview.
Constructing Post-farm Budgets

- post-farm budgets (processing, transportation) – most principles, procedures – same as in farm budgets
  - activities selected – based on policy issues studied
  - data on revenues, costs – based on opportunity costs
  - all cost data – based on average, not marginal, costs
  - begin with synthetic budgets – use small sample sizes
  - cross check responses – for data accuracy, quality

- post-farm budgets differ from farm budgets – 3 ways
  - numeraire – Rp/processed product (post-farm) – Rp/ha (farm)
  - small samples – capture most post-farm actors
  - post-farm economies of size and capital costs – important

The principles and procedures for putting together post-farm (processing and transportation) budgets are similar to those used for farm budgets. (The construction of post-farm budgets is discussed in PAM, Chapter 10, pp. 171-187.)

In both instances, researchers select representative activities (farm and post-farm) based on the policy issues under study. Budgets for both on-farm and post-farm activities require careful compilation of data on revenues and costs and strict application of the opportunity cost principle. The other procedures outlined for farm budgets apply for post-farm budgets. Both are based on average, rather than marginal, cost data. Analysts in both cases should begin by compiling synthetic budgets from secondary information and then verify results through field surveys. In both types of budgets, researchers can rely on small sample sizes to construct the budgets.

All PAM activity budgets need to be crosschecked for data accuracy and quality.

Post-farm budgets differ from their on-farm counterparts in three main ways. The post-farm budgets require different numeraires than those used for on-farm budgets (as explained earlier in this lecture). Because typically there are far fewer processors and transporters than there are farmers, primary surveys are easier to carry out for the post-farm activities and coverage in the post-farm sample is wider. Further, most farmers in Indonesia use little, if any, fixed capital equipment. In contrast, processing and transportation usually involve high fixed capital costs. Hence, economies of size – declining costs per unit handled as quantities processed or transported increase – are much more important in the post-farm activities than in farming. Measuring the effects of size economies and estimating depreciation and returns to capital thus are critical issues in post-farm budgets but of little importance in farm budgets.
Once the PAM researcher has compiled the secondary (based on others’ studies) and primary (field-based) information on private revenues and costs for farm and post-farm budgets, s/he is in position to complete the top row of the PAM.

The PAM for a commodity system is the summation of the PAMs for the four component activities (farm, farm-to-processor, processing, and processor-to wholesale-market).

Application of the profitability identity \( D = A - (B+C) \) gives private profits, an indicator of competitiveness in private (actual market) prices. This calculation is identical to that done for private benefit-cost analysis. The usual indicator is the private benefit-cost ratio \( \text{PBCR} = \frac{A}{B+C} \), which gives a numeraire-free ranking of private profitability.
Tutorial Example of Private Profitability

• computer tutorial – high-yielding paddy system
  • calculates private revenues, costs, and returns
  • to be completed in parallel with lecture series

• three steps – private row in PAM
  • construct table of physical input-output relationships
    – summarizes technology of production function
  • compile table of private (actual market) prices – for all outputs and inputs – representative of base year
  • create private budget – multiply quantities (I-O table) by prices (private prices table)

The computer tutorial contains a full explanation of how to calculate private costs, returns, and profits in PAM analysis. The illustrative example used is a high-yielding paddy system in Indonesia.

The analysis proceeds in three steps that are summarized here. The reader is encouraged to carry out the computer exercise after completing this lecture, because the tutorials are designed to complement the discussion here.

The first step is to construct a table of physical input-output relationships for the paddy system. This numerical description of the production function summarizes the technology used in this system.

The second step is to compile a table of private (actual market) prices for each of the inputs used and outputs produced in the system. These prices should be representative of the base year of the study.

The third and final step is to create a budget in private (actual market) prices by multiplying the quantity entries in the input-output table times the price entries in the private prices table.