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EXPRESSING IDEAS WITH TABLES AND CHARTS

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Introduction

They say a picture is worth 1000 words. But the picture has to be in focus. It usually helps if it's in color. And the eye should be drawn naturally to a central point. After looking at the picture, you should come away with an image that lasts, something that stays with you.

Charts and tables can do the same things. Their eye appeal can't compete with a color picture from National Geographic. But they can get your attention; make a point clear; capture an idea in visual form. Interest rates are falling at an increasing rate. Words can't say that as well as a one line chart. A mixture of numbers, graphs, words and illustrations is more lively than any of these by themselves.

Purpose

The purpose of this report is to encourage authors to develop and use more interesting and more understandable tables and charts. If there's a point to be made, a table or chart can help. Some guidelines and examples are offered here to help authors criticize and improve their own efforts.

After a little study it's easy to see that making a table or chart is not science. There's a lot of ART and EXPERIENCE involved. Most readers can tell you what the central point of a good chart is. If a table is poorly organized and cluttered with data, readers will pass it by. Clearly, good charts and tables make a difference. There is no standard that everyone accepts as to what is right and wrong, but there are some basic principles to follow. This report will try to illustrate the major points to consider and show differences between good efforts and those which fall short. Putting together a chart which makes a point will provide both you and others satisfaction. It will save a reader time. You will get your message across.

Types of Tables and Charts

Tables and charts are familiar concepts to nearly everyone. A table is a formal presentation of numerical information. It is set-off from written material. It should be complete enough to stand by itself. Thus it will have its own title, telling what the table is about, as well as where and over what time span the table provides information. The units of measurement will be clear. Descriptions of the data will be included in the captions and stubs provided for each column and row. A number for identification will make text reference to the table clear and concise.

The source of the data, if not the author's own work, will be indicated. And the way the data are organized or ordered should help the reader understand some basic ideas or find information for his own use.

Tables have different purposes and uses. One type provides original data or compilations of such data for reference and further analysis. These are the general tables one finds in most U. S. Census publications, the Statistical Abstract of the United States, or as an appendix to the Council of Economic Advisers' Economic Report of the President. Often these tables were compiled by special agencies of government, the Federal Reserve Board or well recognized industry groups. They follow standard procedures for organization and presentation. Most of us take them for granted because they are easily accessible, straightforward, complete and dull. Appendix tables presenting original data you have collected should be equally accessible, clearly documented and detailed. Reference materials by their nature must be complete, orderly and unexciting.

Most tables are included in a report or book for a specific purpose. They can be a simple frequency distribution to show variability. They may show a relationship between two variables like size and income. They may document change between two or more time periods. These are the kinds of tables most of us prepare to help explain what we have done and to document our conclusions. Whether they are called analytical, descriptive or special purpose is unimportant. It is to this kind of table that attention is directed in this report.

Charts include that substantial array of drawings and maps that help readers get perspective on numerical data. Bar charts, pie charts and line graphs are the most familiar and widely used. Pictographs liven up popular stories. Maps help a reader put numbers together with locations. If one is looking for good examples of a range of ways to use charts successfully, U.S.D.A.'s annual Handbook of Agricultural Charts is an excellent source. Of special interest is the Federal Reserve Chart Book issued quarterly. The line graphs using both arithmetic and logarithmic scales are particularly good.

A Few Basic Rules

The primary reasons for using tables and charts in a written or oral report is to help the reader or listener understand what you have to say. They should aid clarity. They should create interest. They should brighten up the presentation. But they should not reduce accuracy or create confusion.

1. Any chart or table should be complete enough to stand by itself.
2. There should be a central idea or impression which the reader can easily grasp.
3. The units of measure should be clearly identified.
4. Sources of information, time period covered and geographic location should be clearly stated.
5. The amount of detail presented should support the central idea but not overwhelm or obscure it.
6. Be sure the digits presented are significant.

These six simple statements are deceptively easy. They argue for clear, straightforward tables and charts to help a reader understand what has happened or the reasons for conclusions drawn. In the sections that follow, these generalizations will be illustrated in a variety of ways. Examples of poorly organized tables and charts will be presented and revised. Examples of good charts will be examined. Ideas for developing combinations of tables and charts will be considered. Readers should look at ideas and approaches rather than specific rules. We can always find ways to improve our illustrations and supporting evidence. This is our basic objective.

TABLES

The most obvious reason for making a table is to present some numerical information in an orderly manner that will help make a point or answer a question. These are the specific purpose tables which most of us use and prepare for research reports, newspaper stories, classroom presentations or tables to the general public. Usually the numbers and information come from reference tables prepared by some agency of government or statistical organization. Sometimes they summarize our own work and tabulations of primary data. Regardless they seek to tell a story or make a point.

Rudiments of Making a Simple Table

Let's assume you want to inform a group of people interested in the American dairy industry the current ranking of states for milk cow numbers and production. The reference data are published annually in the February issue of Milk Production issued by the Crop Reporting Board, Economics, Statistics and Cooperatives Service, U.S.D.A. They are reproduced here just as they were issued as table 1.

Table 1. ANNUAL MILK COWS AND MILK PRODUCTION

STATE	MILK COWS 1/		MILK PER COW 2/		MILK PRODUCTION 2/		
	1978	1979	1978	1979	1978	1979	:1979 % CHANGE :FROM 1978
	THOUSANDS		POUNDS		MILLION POUNDS		PERCENT
ALA	81	78	7,790	7,731	631	603	96
ALAS	1.4	1.2	10,571	10,833	14.8	13.0	88
ARIZ	68	71	13,324	13,127	906	932	103
ARK	89	88	8,191	8,182	729	720	99
CALIF	846	871	14,018	14,408	11,859	12,549	106
COLO	72	72	12,111	11,903	872	857	98
CONN	50	49	12,240	12,347	612	605	99
DEL	11.7	11.7	11,026	11,026	129.0	129.0	100
FLA	193	188	10,093	10,457	1,948	1,966	101
GA	129	127	10,116	10,268	1,305	1,304	100
HAW	12.9	12.8	11,628	11,719	150.0	150.0	100
IDAHO	140	141	11,664	11,979	1,633	1,689	103
ILL	231	234	10,403	10,342	2,403	2,420	101
IND	203	200	10,729	10,875	2,178	2,175	100
IOWA	377	372	10,504	10,538	3,960	3,920	99
KANS	136	126	10,110	10,349	1,375	1,304	95
KY	269	255	8,454	8,706	2,274	2,220	98
LA	128	121	8,305	8,438	1,063	1,021	96
MAINE	58	56	11,052	11,393	641	638	100
MD	134	131	11,493	11,603	1,540	1,520	99
MASS	48	45	11,896	12,511	571	563	99
MICH	403	397	11,893	12,166	4,793	4,830	101
MINN	837	843	10,859	10,848	9,089	9,145	101
MISS	106	100	7,887	8,140	836	814	97
MO	277	270	9,913	10,174	2,746	2,747	100
MONT	27	27	11,333	10,630	306	287	94
NEBR	124	120	10,234	10,792	1,269	1,295	102
NEV	14.7	15.0	12,721	13,267	187.0	199.0	106
N H	31	30	11,000	11,400	341	342	100
N J	45	41	11,667	12,049	525	494	94
N MEX	33	35	13,879	14,457	458	506	110
N Y	906	905	11,488	11,800	10,408	10,679	103
N C	143	141	10,888	11,099	1,557	1,565	101
N DAK	100	95	9,030	9,200	903	874	97
OHIO	384	377	11,133	11,313	4,275	4,265	100
OKLA	113	110	9,646	9,727	1,090	1,070	98
OREG	93	94	11,452	11,734	1,065	1,103	104
PA	700	701	11,259	11,532	7,881	8,084	103
R I	4.7	4.4	11,702	11,364	55.0	50.0	91
S C	54	50	9,556	10,480	516	524	102
S DAK	170	168	9,412	9,577	1,600	1,609	101
TENN	209	211	10,163	10,005	2,124	2,111	99
TEX	311	311	11,039	11,051	3,433	3,437	100
UTAH	76	76	12,368	12,474	940	948	101
VT	186	183	11,484	11,907	2,136	2,179	102
VA	172	170	11,058	11,371	1,902	1,933	102
WASH	186	192	14,349	14,641	2,669	2,811	105
W VA	37	37	9,243	9,649	342	357	104
WIS	1,811	1,813	11,735	12,107	21,252	21,950	103
WYO	11.1	11.0	10,541	10,636	117.0	117.0	100
U S	10,841	10,777	11,218	11,471	121,609	123,623	102

1/ AVERAGE NUMBER DURING YEAR, EXCLUDING HEIFERS NOT YET FRESH.

2/ EXCLUDES MILK SUCKED BY CALVES.

FROM: Crop Reporting Board, E.S.C.S., U.S.D.A., Milk Production, February 1980.

A great deal of information is presented in this reference table. States are listed alphabetically. Information for two years can be compared for three key characteristics. The units of measurement are clearly stated. But most general readers would appreciate some assistance in pointing out the key ideas you would like them to observe from these national statistics.

One alternative is to simply organize an ordered list of the top states in dairying as part of the text you prepare. This is commonly done in news stories if the list is short. For example one could state that the top five states in 1979 in terms of milk cow numbers were:

Wisconsin	1,813,000
New York	905,000
California	871,000
Minnesota	843,000
Pennsylvania	701,000

These states had 47.6 percent of all the dairy cows in the United States.

In most cases one or more special purpose tables will serve most effectively to organize the information you want to present. The top ten states in cow numbers are presented in table 2. The ranking of states and proportion of the national total in each is emphasized.

Table 2. PRINCIPAL DAIRY STATES: MILK COWS
 United States, 1979

State	Cow numbers	Percent of total
Wisconsin	1,813,000	16.8
New York	905,000	8.4
California	871,000	8.1
Minnesota	843,000	7.8
Pennsylvania	701,000	6.5
Michigan	397,000	3.7
Ohio	377,000	3.5
Iowa	372,000	3.5
Texas	311,000	2.9
Missouri	270,000	2.5
40 other states	<u>3,917,000</u>	<u>36.3</u>
United States	10,777,000	100.0

SOURCE: Crop Reporting Board, E.S.C.S., U.S.D.A., Milk Production, February 1980.

This simple table consists of three columns of information. One can quickly see that Wisconsin is the leading dairy state by a large margin. The top five states have nearly half of the cows. The second five state group has fewer dairy cows than does Wisconsin.

As soon as one tries to present more information in one table the problems of organization become more complex. Rank order may change. The purpose or central point may be more difficult to grasp. Consider a table which presents both cow numbers and production for 1979. A choice must be made about which series is more important. That will determine the order in which states are listed and where the columns of numbers are placed.

Table 3. COW NUMBERS AND MILK PRODUCTION
State Statistics, 1979

State	Milk cows	Milk production
	<u>thousands</u>	<u>million pounds</u>
Wisconsin	1,813	21,950
California	871	12,549
New York	905	10,679
Minnesota	843	9,145
Pennsylvania	701	8,084
Michigan	397	4,830
Ohio	377	4,265
Iowa	372	3,920
Texas	311	3,437
Missouri	270	2,747
40 other states	<u>3,917</u>	<u>42,017</u>
United States	10,777	123,623

SOURCE: Crop Reporting Board, E.S.C.S., U.S.D.A., Milk Production, February 1980.

In table 3, only the position of California and New York in the order of states is changed if milk production is given priority. Compared with table 2 there are a number of changes. Percent of total has been dropped. If a reader wished to make these calculations all the necessary information is still present. Milk cow numbers are expressed in thousands and milk production in million pounds, the format followed in the original reference table. The procedures used in both tables are correct. The method of presentation is a matter of personal preference. Adding three zeros to the data for cow numbers is not difficult. When the figures are correct to the nearest million the procedure used in table 3 is preferred.

A few comments on significant digits are appropriate now as well as later. For most situations three significant digits are all that will be important to provide understanding. In table 3, most dairy economists would talk about national milk production as falling between 123 and 124 billion pounds. Cow numbers would be described as 10.8 million head. For most audiences milk production by states could be listed in billion pounds with rounding to the nearest tenth. Thus Wisconsin and California would be 22.0 and 12.5 respectively or at the most 21.95 and 12.55. The central point of the table would determine how much detail to show. If the emphasis was on relative ranking and proportion of the total from the leading states then three significant digits would be sufficient.

Table 4. DAIRY COWS, YIELDS, AND PRODUCTION
Leading States, 1979

State	Milk cows	Average production per cow	Total production <u>billion pounds</u>
Wisconsin	1,813,000	12,100	22.0
California	871,000	14,400	12.6
New York	905,000	11,800	10.7
Minnesota	843,000	10,800	9.1
Pennsylvania	701,000	11,500	8.1
Michigan	397,000	12,200	4.8
Ohio	377,000	11,300	4.3
Iowa	372,000	10,500	3.9
Texas	311,000	11,100	3.4
Missouri	270,000	10,200	2.7
40 other states	<u>3,917,000</u>	10,700	<u>42.0</u>
United States	10,777,000	11,500	123.6

SOURCE: Crop Reporting Board, E.S.C.S., U.S.D.A., Milk Production, February 1980.

One final table has been constructed from the original data on page 4. All three characteristics for the 10 leading dairy states are presented in as simple a manner as possible to assist reader understanding. Cow numbers are expressed to the nearest thousand by adding three zeros to each original number. Milk per cow has been rounded to three significant digits. After all, these ratios are calculated values based on total production and cow numbers. Finally production is presented in billion pounds. In the process of rounding

it was necessary to increase one number (California's) by one digit to make the column add to a consistent total. As long as the original data source is listed this procedure is acceptable, particularly when the table is intended for a general audience.

What about expanding table 4 by presenting two or more years of data for each of the states for each of the three series? It is at this point that difficulty will arise. The number of columns will be difficult to handle. A reader will easily be turned off by the number of numbers. Most important, the central point of the table may be lost. If the emphasis is on change from one year to the next and where it occurs then that deserves central attention. Each data series may need to be handled separately to insure clarity. Most analysts know what they are able to see in a set of data they have studied carefully. The trick is to present the supporting numerical data in a fashion that helps the reader see that evidence clearly. Most tables should support one or two points at a time. One large presentation of supporting data is less likely to succeed.

Parts of a Table

It is easier to discuss repairing a car if we recognize the names of the important parts such as the carburetor and radiator. For the same reason the parts of a table have been given commonly accepted names.

Every table has a title and most tables are given a specific number. Captions are used to describe the materials appearing in each of the several columns. There are other names used as well such as "boxheads". Stubs are the descriptive words used in the first column of a table. They identify each row that is used in the body of a table. The body of a table is the central portion where the numerical data are presented. All the other parts of the table are used to explain and identify these numbers or words. At the end of a table are placed footnotes to give further explanations about numbers or definitions. A source note is included to identify where the basic materials came from unless they are primary data developed by the authors.

The various parts of a table are designated in table 5. A standard format is followed. Most of the procedures generally accepted in presenting tables are used. If one seeks to be simple, direct and clear in terms of purpose and presentation, and then follow a standard format, the results should be acceptable to a wide range of readers.

Table 5. FARM SIZE: CROPLAND HARVESTED
New York State, 1974

Acres harvested	Number of farms reporting	Percent of total
1 - 9	4,264	10
10 - 19	3,569	9
20 - 29	3,480	9
30 - 49	<u>5,777</u>	<u>14</u>
Subtotal	17,090	42
50 - 99	9,741	24
100 - 199	8,914	22
200 - 499	4,674	11
500 - 999	593	1
1,000 - 1,999	98	*
2,000 and over	<u>11</u>	<u>*</u>
Subtotal	24,031	58
Total	41,121	100

* Less than one-half of one percent.

SOURCE: U. S. Bureau of the Census, Census of Agriculture.

Table Construction

The first and most important task in making a table is to decide what it is the reader should gain by studying the table. The key point should be clear. The title and organization of the data should all reinforce that effort. If different people independently look at a proposed table and get different ideas of what the table says, then more effort is necessary to present the data more effectively. It may mean that too much information has been presented or that the title doesn't fit what follows. All the parts should add to an integrated whole.

Format

The format of a table should help the reader understand what is presented. Authors, who prepare excellent tables, have differences in style. There is no single form which is always best. But an author should be consistent. All the tables in one publication should follow one basic form.

1. White space -- Avoid the look of crowding information into a small box. Use white space to separate information, to indicate that a change has occurred or provide balance on a page.

Too much space between columns of numbers is worse than too little. It should be easy for a reader to follow across a row of numbers. Comparisons should be made easily. Small tables can be incorporated into the text rather than using the whole width of the page for two columns of numbers.

2. Horizontal lines -- Commonly three horizontal lines are used to set off the major parts of a table: the title, the captions and the body (table 5). Some books use no horizontal lines; others use two under the title and again under the body of the table. The larger or more complex the table, the more these horizontal lines will help the reader.
3. Vertical lines -- The use of vertical lines should be reserved for reference tables or appendices. The Statistical Abstract of the United States used vertical lines in nearly all of its 1600 tables. So does the Census. But for most special purpose tables the need for a vertical line may mean trying to do too much in too little space. There are always exceptions. If two parts of a table are separate then a vertical line calls attention to the separation. As a practical matter vertical lines are difficult and expensive for typists and printers. Avoid them if you can.

Title

The title of a table is analogous to the title of a book. It should create some interest to look at what follows. It should be short, clear and tell the purpose for which it was constructed.

Most titles are too long. A desire for completeness may override everything else. Short titles can be accurate and complete. The central idea can be emphasized by the title as well as the body of the table. Good titles like good literature are difficult to define. Following a set of rules will not guarantee good titles but it should prevent most bad ones.

Specific Suggestions

1. Content -- Titles should answer the questions, what, where and when. In some cases the method of classification within the table may be indicated as well. Usually the question, what, is answered on the first line. The sub-title or second line indicates where and when.

2. Length -- A title, which takes more than two lines, is usually too long. Some of it will not be read. Either use a footnote for part or something can be omitted. Phrases rather than full sentences should be used.
3. Form -- Titles should take the form of inverted triangles. Whenever possible the first line, describing what the table is about, should be longer than the second.
4. Capitalization -- The first line of a title should be set off from the sub-title whenever possible. Full capitals or bold face type achieve this effectively. The words in the sub-title or second line usually are given initial capitals. Since lower case type has been found to be easier to read than full capitals, consistent use of initial capitals throughout a title is also quite acceptable.
5. Abbreviations -- Avoid abbreviations. An exception may be "U.S." when followed by some agency or department. Standard acronyms like USAID or UNICEF are generally accepted.

A few examples illustrate some of these points. Actual titles for tables as they were published illustrate what was done originally and some suggestions for improving or clarifying these titles are made.

Example 1
(Length and Form)

Original

Table 8. Allocation of the Total Value of Farm Production Among Paid Expenses, Capital Charges and Residual Returns to Tenant and Landlord on Grain Farms 340 to 650 Acres in Size, With Soils Rated 93-100, and Rented Under Crop Share Leases. A Comparison of 1978 with 1967 and 1974 through 1977. Source of data is Table 13 a and b.

Revision

Table 8. RETURNS TO LANDLORDS AND TENANTS: 340-659 ACRE GRAIN FARMS
65 Illinois Farms, Soils 93-100, 1967 and 1974-78

Comment

The original title certainly tries to tell the reader what is in the table. But it is easy to get lost in the detail. Procedures on calculation can be presented in the text or a footnote. The central point concerns how much residual income goes to the tenant and the landlord. The revised title focuses on what, where and when.

Example 2
(Central Idea)

Original

Table 1. Number and Percentage Distribution of Commercial Farms with Annual Gross Sales of \$2500 or More by Economic Size Class, Nebraska and the U. S., 1964, 1969 and 1974.

Revision

Table 1. CHANGES IN SIZE DISTRIBUTION OF COMMERCIAL FARMS
Nebraska and United States, 1964, 1969, 1974

Comment

The original title is factual and correct, but long. The reason for developing the table is not highlighted. The revision gives emphasis to the purpose and the essential information as well.

Example 3
(Table Number and Form)

Original

Table 2
Percentage Changes (Over Previous Census)
In Improved Agricultural Acreage By
Region in Canada

Revision

Table 2. PERCENT CHANGES IN AGRICULTURAL ACREAGES
5 Regions in Canada, Census, 1951-1971

Comment

One way to emphasize a table number is to put it on a line separated from the title. The original title takes up more space than necessary. This format will bring white space into a publication if it is heavy with writing. But the original form takes 4 lines when 2 would be sufficient. Adding the time period covered as part of the title is encouraged.

Example 4
(Lack of Information)

Original

Table 10. Life Satisfaction

Revision

Table 10. SATISFACTION WITH FARM LIFE
933 Iowa Farm Wives, 1977

Comment

In the original publication tables 9 and 10 have the same title, Life Satisfaction. One reports for the men interviewed, the other for women. One must read the text carefully along with the tables to get the necessary information. Even though all of the data presented in a bulletin refer to one survey, each table should stand on its own. More information in this case would help the reader.

Example 5
(Handling Complex Comparisons)

Original

TABLE 3. State Appropriations for Research and for Research and Extension Combined, in 14 States Spending Less Than \$48000 Per Annum On Research In 1925-30, As Percent of U.S. Total of State Appropriations, 1925-30 and 1953-57

Revision

Table 3. RELATIVE GROWTH IN STATE APPROPRIATIONS
FOR RESEARCH AND EXTENSION
14 Selected States, 1925-30 and 1953-57

Comment

It is difficult to revise the title of this table unless one studies the accompanying text. Even then one is not completely sure of the author's intent. Some of the detail given in the original title is repeated in the text. The method of comparison or technique of analysis, unless simple, should be explained somewhere other than in the title. An effort to explain the purpose of the table is as important here as in any other table.

Example 6
(Relationship Statistics)

Original

Table 2. Effect of Output Prices, Environmentally Related Yield Fluctuations, Farm Resources, Program Participation, Staff Characteristics and Program Characteristics on Farm Sales Revenue Increases of Participants on Small Farm Programs, Southern Region of the United States, 1977.

Revision

Table 2. REGRESSION COEFFICIENTS: VARIABLES AFFECTING FARM SALES
Small Farm Programs, Southern Region, United States, 1977

Comment

The original title is taken from a table published in the AJAE, May 1980. Most table titles in major journals are short and direct because they are reviewed by a number of people. This one must have escaped such scrutiny. Trying to explain a relationship or the components of a model in a table title is usually a mistake. Help your reader by giving the central idea in the title. Use the text for explanations.

A good title is worth some effort. Potential readers or users of tables deserve to know what was done, where the data came from and why it was assembled as it was. A good practice is to read your title aloud to someone else. Often that will make you more aware if it is too long, too complex or confusing.

Captions

The title provides general information about the contents of a table. Captions indicate what will be presented in the column below. It is here that detail is required in a brief form. The column headings usually tell what is included in the table, how it is measured, the unit of measurement and the time period involved.

Specific Suggestions

1. Abbreviations -- Whenever possible, avoid abbreviations. Write out words like bushels, pounds and percent. An exception is usually made with dollars. The dollar sign, if used at the left of the first item in each column of figures measured in dollars, is more convenient and easier to understand than a column of numbers headed by the word, dollars. In general the unit of measurement should be placed as close to the numbers as possible.
2. Capitalization -- The first word in each caption should be capitalized, other words in lower case. Whatever form of capitalization used, it should be followed consistently within a table and throughout a report.
3. Method of measurement -- When both the method of measurement and the unit of measure must be indicated, the method of measurement must appear in the caption. The unit may be placed in the body of the table itself below the caption. For example, a table may be used to compare different measures of output for the United States. Gross national product might well be one caption. The unit of measure, billions of dollars, could appear just above the column of figures in the body of the table, or as an added phrase in the caption (Gross national product, billions).
4. Comparisons -- If a comparison is intended between two or more columns with a common characteristic, this should be indicated by the caption. For example:

<u>Yield of tomatoes per acre</u>		
Gem	Fireball	Rutgers

Body

The body of a table is its focal point. Here ideas are presented and evidence arrayed. The skill of an author is finally reflected in the way he assembles his facts and the ease with which another person can follow what he has done. Clarity of presentation and economy of time and space are fundamental things to attain in making decisions on arrangement, content and detail.

Specific Suggestions

1. Number of columns -- Keep the number of columns in a table to a minimum. A table with one or two columns plus stubs is easiest to read. One with three or four columns of numbers is more difficult to follow. If five or more columns are required an author should consider whether there is not a better way to present the same information. These kinds of tables are usually placed in an appendix or are used as references.
2. General shape -- If there are more columns than rows consider reversing the table. Can the row headings be turned into column headings or captions? In most cases they can. Tables which stretch across a page are hard to read. Consider typical reading habits. If a total is presented the numbers which make up the total are expected to be found above it.
3. Width -- The body of a table determines its overall form or shape. Any table that is too wide to fit across a regular 8 1/2 x 11 page should be reconsidered. Readers like to look at tables along with the rest of the text. Turning a document sideways to consider a set of numbers requires more effort than most readers are willing to exert.
4. Stubs and descriptive material -- The left hand side of a table is used to describe what is placed in each row. Comparisons are usually made across a table, hence the stubs indicate the item for which comparisons are made. Arrangement within the stubs provides emphasis. Minor items which make up totals are usually indented under major headings. The first word in each stub is usually capitalized.
5. Rounding numbers -- Most tables do not present the original data which others will use as references. Two, three or four significant digits will present as much information as is needed or desired. Relative size is easier to grasp when rounding is done for a reader. Detailed statistics usually belong in an appendix or another volume.

Some special problems arise in rounding numbers.

- (a) Round to a commonly used unit. If some fraction of a dollar is important, use two decimal places (cents) rather than one even though the units are rounded to tenths of a dollar (\$7.20, \$18.40, \$6.80, \$0.30). Even if the basic data were correct to the nearest cent, the rounded numbers may tell the story equally well or better.
 - (b) Adding three zeros after two or three digits to indicate thousands may be more effective than heading a column, thousands. Rounding to millions or billions is more common than rounding to thousands, hundreds or tens.
 - (c) Use a zero before the decimal if there is no significant digit on the left hand side of the decimal point. This insures that the decimal is not overlooked.
6. Totals and averages -- Totals and averages are placed below the numbers from which they were computed. Some argue that if the total is of primary concern it should be presented first and the data from which it is computed be presented later. Most people expect a total or average after they see the numbers from which it was developed. Totals or averages should be set off from other numbers by skipping a line to draw attention to the change.
7. Omissions -- Lack of information for one or more items in a column of figures should be explained using a footnote. (Some authors use "NA" to indicate that the data were not included because they were not applicable.)
- The word, none, or a "0" indicates that the author filled the space consciously. The use of a dash may be interpreted in a variety of ways and is not recommended unless explained,
8. Estimates and sources of data -- If one or more numbers in a table is obtained from a different source, calculated in a different manner or estimated, attention should be drawn to this fact by using parentheses or a footnote. Parentheses around a number imply some kind of calculation or estimate. Standard errors or t ratios are frequently presented using parentheses directly below a coefficient.

9. Spacing -- Tables that have more than seven or eight rows of numbers benefit from leaving a blank line after every fourth, fifth or sixth line.

Space helps to emphasize particular numbers or lines. A row of totals is emphasized by skipping a line after listing the original numbers. In a frequency distribution a change in the interval used is signaled by skipping a line.
10. Lines -- Vertical lines should be avoided. They should only be used when an important division is required in a multi-column table. Reserve vertical lines for REFERENCE tables. Horizontal lines should be kept to a minimum. Three are standard: one after the title, another below the captions, and a third to separate the body of the table from footnotes and source notes or the text material which follows.
11. Punctuation -- Commas are used when four or more digits are presented on the left hand side of a decimal point. Dollar signs are usually placed in the first row of a column, one space to the left of the longest number. Colons are commonly used after major headings in the stubs and captions although this is not mandatory. Parentheses provide a warning that a number or word is different or unusual. Underlining should be used for emphasis.

Source Note

The source of basic data should always be acknowledged unless the information was collected by the author. This acknowledgment comes at the end of the table below the footnotes if there are any. The title of a general publication or the name of the agency collecting data is sufficient for general sources. Greater detail is needed when the data come from something other than a standard reference.

Designation of the source should stand out. Since every table should stand by itself a source should be repeated even though it was listed on a previous table. Whenever possible quote the original rather than a secondary source. Abbreviations are acceptable if they are commonly used. For example, the following is an acceptable source note:

SOURCE: U. S. Department of Commerce

or

SOURCE: U. S. Bureau of the Census,
Current Population Reports.

Specific Suggestions

1. Location -- The source note should be clearly separated from footnotes. Skip a line and start the statement at the left margin of the table.
2. Form -- The word, SOURCE, either full capitals or underlined should precede the statement. A phrase rather than a sentence is sufficient. The less familiar the source the more detailed should be the citation.
3. Lack of citation -- Remember that a table without a source note implies that the author collected the basic data.

Footnotes

Footnotes are used to explain numbers or phrases in a table which are unusual and which cannot be explained within the framework of the table itself. Avoid footnotes whenever possible. They detract from the general appearance of a table. If the numbers in a table come from a variety of sources, footnotes will be required. When used they should be concise and limited to one line if possible.

Specific Suggestions

1. Location -- Footnotes should be placed immediately below the last line of the table. They should be indented a few spaces from the edge of the table and prepared in sentence form.
2. Designation -- Letters rather than numbers should be used to designate footnotes in tables. Lower case letters are not likely to be confused with numbers in the body of the table and stand out sharply. Asterisks may be used if one or perhaps two footnotes are required. When three or more footnotes are required, letters should be used instead of asterisks. They should be used in alphabetical order and hence require less space than doubling and tripling of symbols.
3. Order -- Footnotes are listed in order starting with the title, followed by the captions, stubs, and then numbers in the body of the table.

Examples of Table Revisions

Some tables, presented as they appeared in their original publications, have been selected to illustrate a number of the foregoing suggestions. Both the original table and a revision are presented. Anyone, including this author, is capable of preparing a poor table. Hence the following tables should be considered as demonstration materials. They were not selected with any intent of discrediting the work of the several authors.

Example 1
(Rounding Numbers)

Original (From AJAE 62(1980):214),

Table 2. Present Values of Public Sector Project Costs at Stated Discount Rates

Source of Cost	Present Values in Year t_0 at Discount Rate	
	5%	10%
	----- \$ -----	
Interest subsidy ^a	17,016.41	107,672.97
Grant monies ^b	669,849.58	553,305.95
Total public sector cost	686,865.99	660,978.92

^a The accounting model is $\sum_i (Ap_i - Ar_i)/(1 + p)^i$.

^b The accounting model is $\sum_i G_i/(1 + p)^i$.

Revision

Table 2. PRESENT VALUES OF PUBLIC SECTOR PROJECT COSTS
Kentucky Marketing Cooperative, 1969-

Source of cost	Discount rates	
	5%	10%
	present value in year t_0	
Interest subsidy	\$ 17,020	\$107,670
Grant monies	<u>669,850</u>	<u>553,310</u>
Total public sector cost	\$686,870	\$660,980

Comment

Calculators and computers carry out numerical operations to many decimal places. An analyst must put numbers in perspective both for himself and the reader. Most of the time the numbers will have meaning in relative terms. Three or four significant digits will suffice.

In the revision the words, present value in year t_0 , were moved as close to the numbers as possible. Units of measure are easily lost in the captions.

The two footnotes were dropped in the table revision because the formulas were standard formulations. In a journal article it is safest to include them, but they could well appear in the text if necessary.

Original

(From ESPR3, Ohio State University, April 1980, p. 11).

Table 4. Number of Farms with Milk Cows and Distribution of Farms by Size of Dairy Herd, Selected Census Years, 1940-1974*

	<u>1940</u>	<u>1950</u>	<u>1959</u>	<u>1969</u>	<u>1974</u>
Number of Farms with Milk Cows	4,663,431	3,648,253	1,791,729	568,052	403,624
Number of Milk Cows per Farm					
1-19 Cows	4,538,117	3,498,564	1,572,035	362,467	224,191
Percent of all farms with milk cows	97.3 pct	95.0 pct	85.3 pct	63.8 pct	55.5 pct
20-49 Cows	115,226	166,248	230,187	157,309	118,703
Percent of all farms with milk cows	2.5 pct	4.5 pct	12.5 pct	27.7 pct	29.4 pct
50 cows and more	10,088	16,815	41,157	48,276	60,730
Percent of all farms with milk cows	0.2 pct	0.5 pct	2.2 pct	8.5 pct	15.1 pct

* Data not perfectly consistent within years due to classification problems.

Source: Census of Agriculture reports for the several time periods.

Example 2
(Format, Position on Page)

Revision

Table 4. FARMS WITH MILK COWS BY SIZE OF HERD
United States, Selected Census Years, 1940-74

Description	Census year				
	1940	1950	1959	1969	1974
	<u>number of farms</u>				
<u>Herd size:</u>					
1 - 19	4,538,000	3,465,000	1,572,000	363,000	224,000
20 - 49	115,000	166,000	230,000	157,000	119,000
50 or more	10,000	17,000	35,000	48,000	61,000
Total	4,663,000	3,648,000	1,837,000	568,000	404,000
	<u>percent of total farms</u>				
<u>Herd size:</u>					
1 - 19	97.3	95.0	85.3	63.8	55.5
20 - 49	2.5	4.5	12.5	27.7	29.4
50 or more	0.2	0.5	2.2	8.5	15.1
Total	100.0	100.0	100.0	100.0	100.0

SOURCE: U. S. Bureau of the Census, Census of Agriculture,

Comment

The original table is hard to read for a number of reasons. Its location on the page requires a reader to turn the report in order to study the title and table contents. Adding some horizontal lines helps the reader separate captions from the key numbers. Mixing percentages with the original data makes comparison difficult. One could argue that the percentages are unnecessary. If they are included it is easier to see the changes through time as suggested in the revision.

Some of the other proposed changes are more a matter of style or preference than requirements. Because the data came from the Census some would feel that the numbers should not be rounded. But if one is trying to show the nature of changes in these distributions over time, the rounding helps. Moreover the original data are always available and the author has already aggregated the herd size categories.

In 1950 and 1959, the data presented in the original table do not add to the total number of farms for those years. Returning to the census the discrepancies were found and the numbers for those years revised accordingly. A general rule for any author is to make sure one's numbers add up or are internally consistent. If there is a problem it should be corrected or identified as such.

Example 3
(Reversing Captions and Stubs)

Original (From Iowa State University Bulletin P-141, April 1978, p. 18).

Table 21. Farm business organization type by acres of cropland operated.

Farm business organization type reported by farm operator	Size of farm: Acres of cropland operated						Total
	1-74	75-149	150-299	300-499	≥ 500	None or no response	
	Number of farms reporting						
Single operator	91 (9.7) [94.8]	180 (19.2) [98.9]	308 (32.8) [90.1]	175 (18.6) [85.4]	64 (6.8) [64.0]	14 (1.5) [93.3]	832 (88.5)
Partnership (on some or all)	5 (0.5) [5.2]	2 (0.2) [1.1]	32 (3.4) [9.4]	26 (2.8) [12.7]	24 (2.6) [24.0]	1 (.1) [6.7]	90 (9.6)
Family corporation	--	--	1 (0.1) [0.3]	4 (0.4) [2.0]	11 (1.2) [11.0]	--	16 (1.7)
Manager (only)	--	--	1 (0.1) [0.3]	--	1 (0.1) [1.0]	--	2 (0.2)
Total	96 (10.2) [100.0]	182 (19.4) [100.0]	342 (36.4) [100.0]	205 (21.8) [100.0]	100 (10.6) [100.0]	15 (1.6) [100.0]	940 (100.0)

Example 3
(Reversing Captions and Stubs)

Revision

Table 21. FARM BUSINESS ORGANIZATION AND ACRES OF CROPLAND
940 Iowa Farms, 1976

Acres of cropland operated	Business organization				Total
	Single operator	Partnership	Family corporation	Manager	
	<u>number of farms</u>				
1 - 74	91	5	0	0	96
75 - 149	180	2	0	0	182
150 - 299	308	32	1	1	342
300 - 499	175	26	4	0	205
500 and over	64	24	11	1	100
No response	<u>14</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>15</u>
Total	832	90	16	2	940

Comment

It is usually easier to look at a frequency distribution when numbers are presented in a column next to the individual classes. In this case there are four different business organizations to consider. Partnerships and family corporations are used in the farms with larger crop averages. All the necessary information is included in the revision. One could leave out the last column in the table.

The authors of the original table sought to help readers throughout their bulletin by including percentages both for row totals and for column totals. This practice may be helpful to the analysts themselves. For most of us it is confusing and unnecessarily complicated. If specific percentages are important they can be discussed in the text or a separate table prepared.

Example 4
(Space, organization)

Original (From North Central Journal of Agricultural Economics 1(1979):10.)

Table 3. Impact of Energy Price Increases on Activity Levels, Net Returns,
and Energy Consumption on a Representative Iowa Farm Allowed to Rent Additional Land

Activity	Benchmark No EPI*	Solutions		
		Twofold EPI	Fivefold EPI	Tenfold EPI
Corn-Soybeans Low fertilization (acres)				67
Continuous Corn High fertilization (acres)	570	357		
Corn-Corn-Soybeans High fertilization (acres)			403	
Corn-Oats-Meadow-Meadow High fertilization (acres)	40	40	40	40
Corn-Corn-Oats-Meadow High fertilization (acres)				
Hog farrowings (litters)	100	100	100	100
Finishing market hogs (head)	525	616	700	700
Feeder calves fed excreta (head)		273	208	180
Feeder calves fed corn grain (head)	153	27	92	120
Feeder yearlings fed excreta (head)				
Cow/calf fed excreta (units)				
Methane digester operation level				68%
Methane digester income penalty	\$7,135	\$5,999	\$1,926	
Net returns	\$70,290	\$58,685	\$36,867	\$10,059
BTUs (10 ⁶)	4,779	3,098	2,370	1,230

*EPI = energy price increase.

Example 4
(Space, organization)

Revision

Table 3. IMPACT OF INCREASED ENERGY PRICES ON FARM ORGANIZATION
Representative Iowa Farm, Renting Allowed, 1976 Conditions

Activities	Energy price increases assumed			
	None	Twofold	Fivefold	Tenfold
<u>Optimal solutions</u>				
<u>Crops, acres*</u>				
Corn-soybeans				67
Continuous corn	570	357		
Corn-corn-soybeans			403	
<u>Livestock</u>				
Hog farrowings, litters	100	100	100	100
Finishing market hogs,				
herd	525	616	700	700
Feeder calves fed excreta		273	208	180
Feeder calves fed				
corn grain	153	27	92	120
<u>Other results</u>				
Methane digester operation				
level				68%
Methane digester income				
penalty	\$7,135	\$5,999	\$1,926	
Net returns	70,290	58,685	36,867	\$10,059
BTUs (10 ⁶)	4,779	3,098	2,370	1,230

*Corn-soybeans at low fertilization rates, all others high.

Comment

The original table reports a series of optimal solutions for an Iowa farm obtained by linear programming where energy prices are increased successively but other options held constant. Most readers interested in these results will have some knowledge of the technique of analysis. The need is to facilitate comparisons and help the reader observe important changes related to energy prices.

The key changes in the revision relate to the title, captions and body of the table. It is possible to have too much white space in a table. In the original table it is difficult to line up numbers with the appropriate descriptions. The original table includes three productive activities or options that did not appear in any final

solutions. In the revision these have been dropped. They could be mentioned in a footnote to the table for completeness. Alternatively they could be discussed in the text. So many alternatives are considered and then not included in optimal solutions that it is somewhat unusual to list some potential activities without any numbers to go with them.

If energy price increases are the central variable in the analysis then they should be given explicit treatment in the captions and emphasis in the title. Bringing the term, optimal solutions, down into the table draws attention to the numbers that follow. Some added headings in the descriptive material helps the reader in studying the results.

Example 5
(Vertical lines, Column Order)

Original (From Illinois Agr. Exp. Sta. Bul. AERR 163, July 1979, p. 8).

Table 3. Landlord's Net Rent Per Tillable Acre from 1973 Through 1978 on Grain and Livestock Farms 340-659 Acres in Size and Rented Under Crop-Share Leases, by Soil Productivity Levels ^a

Type of farm and soil-rating groups ^a	1978	1977	1976	1975	1974	1973
Grain farms:						
Soils 93-100. . . .	\$ 99	\$ 74	\$114	\$ 90	\$119	\$ 97
80-92	92	69	105	91	109	91
65-79	83	66	93	88	82	75
Under 65. . . .	45	46	55	42	62	49
Livestock farms:						
Soils 93-100. . . .	\$..	\$ 61 ^b	\$ 99	\$ 96	\$115	\$ 98
80-92	86	61 ^b	101	98	99	105
65-79	71	72 ^b	81	62	99	68
Under 65.	60 ^b	...	59	59	63

^aRecords for 1973-1975 were from all parts of Illinois. In 1976 to 1978 farmers with soils rated under 65 were from southern Illinois only while those rated 65-100 were from central and northern Illinois only.

^bThere were only 6 or less farms in each of these groups. Therefore, these averages are not reliable.

Example 5
(Vertical lines, Column Order)

Revision

Table 3. LANDLORD'S NET RENT PER TILLABLE ACRE
Grain and Livestock Farms, Illinois, 1973-78

Type of farm and soil rating groups	1973	1974	1975	1976	1977	1978
<u>Net rent per tillable acre</u>						
<u>Grain farms</u>						
Soils 93-100	\$97	\$119	\$90	\$114	\$74	\$99
80-92	91	109	91	105	69	92
65-79	75	82	88	88	93	83
Under 65	49	62	42	55	46	45
<u>Livestock farms</u>						
Soils 93-100	\$98	\$115	\$96	\$99	\$61 ^a	\$--
80-92	105	99	98	101	61 ^a	86
65-79	68	99	62	81	72 ^a	71
Under 65	63	49	49	--	60 ^a	--

^a Averages based on 6 or less farms.

Comment

The original table is complete and the data included are well documented. It is an above average table. Readers can make the comparisons easily and quickly.

There are two reasons for including a revision. One has to do with the order in which the columns of annual data are presented. Nearly all statistical references and the major sources of time series data present information for the most recent year in the right hand column of a table. That is conventional usage. To differ from that standard means there is a pressing reason. None seems evident here.

The vertical lines in the original table cause no important problems for a reader. They do create extra work and problems for a typist or a type setter. In this case, the columns stand out well enough in the revised table so that the vertical lines contribute little. In most cases this practice should be reserved for appendix tables or reference bulletins.

Special commendation should go to this author for rounding the net rent per tillable acre to the nearest dollar. Overall the bulletin and writing from which this table is taken is of a high standard.

Example 6
(Simplifying a Complex Table)

Original (From Maryland Agr. Exp. Sta. Bul. MP 927, October 1978, p. 22).

Table 1. Models of Annual Data

Independent Variable	Dependent Variables											
	Attendance per 1000 population				Deflated Pari-mutuel handle							
	Mile	Fair ^b	Harness		Mile	Fair	Harness		Mile	Fair	Harness	
	Coef.	S.E. ^a	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Days	2.96	.71	*	*	*	*	*	*	*	*	*	*
Time trend	-14.32	3.13	-2.69	.32	-29.03	6.12	.65 ^c	.16	-1.79	.45	.18	.04
Track closing	-45.04	26.23	*	*	-20.32	9.02	*	*	*	*	*	*
Attendance	*	*	*	*					133.61	13.70	81.19	8.78
Intercept	296.90		155.80		406.04				-23.40		-6.70	
R ²	.56		.75		.79				.89		.86	
F	9.47		34.79		10.35				87.98		73.71	
d.f.	22		24		10				23		23	
												12

^aS.E. = Standard error of regression coefficient

^bCoefficients for days and track closings were not significant (at 95% level) in a second model

*Variable not included in model

^cA quadratic term for trend was also included in this model

Example 6
(Simplifying a Complex Table)

Revision

Table 1. REGRESSION MODELS FOR ATTENDANCE AND BETTING
Horseracing, Maryland, annual data, 1946-71

Variables and results	Type of racing		
	Track	Fairgrounds	Harness
<u>Effect on attendance per 1,000</u> <u>population of:</u>			
Days raced annually	2.96 (0.71)		
Time trend	-14.32 (3.13)	-2.69 (0.32)	29.03 (6.12)
Quadratic time trend			0.65 (0.16)
Track closing	-45.04 (26.23)		-20.32 (0.02)
Intercept	296.9	155.8	406.0
R^2	0.56	0.75	0.79
F	9.47	34.8	10.4
Degrees of freedom	22	24	10
<u>Effect on deflated pari-mutuel</u> <u>handle of:</u>			
Time trend	-1.79 (0.45)	0.18 (0.04)	0.06 (0.04)
Attendance	133.6 (13.7)	81.2 (8.78)	36.6 (3.49)
Intercept	-23.4	-6.70	5.95
R^2	0.89	0.86	0.95
F	87.0	73.7	123.5
Degrees of freedom	23	23	12

Comment

It is not easy to present statistical results in a direct, easily understood manner. Commonly an author tries to put more into one table than is necessary. Whenever there are more than 5 or 6 columns of numbers in a table, it is time to think about other ways to present the information.

There are a number of things that deserve review in the original table. The title does not help the reader visualize what is to follow. The key dependent variables and the item of central interest, horse racing, as well as the time span covered are missing. Shifting the table around on the page encourages more careful scrutiny of the data. By considering the two different analyses one after the other a substantial number of the *'s can be eliminated. Leaving the spaces blank is equally effective.

The problem of too many classifications in the captions or column headings is demonstrated in the original table. Four different lines of headings will usually lead to confusion.

The issue of significant digits appears in the original table as well. It is nice for uniformity to carry out all the numbers to two decimal places. But in some cases that implies five significant digits. In others it only allows one (0.04). For regression coefficients, two or three significant digits are probably adequate. Presenting them should be given priority over a uniform number of decimal places.

In the revision, abbreviations have largely been avoided. Most of the footnotes have been dropped. The comment about a second model in footnote b should be included in the text if at all. One could argue that an explanation of the standard errors in parentheses under the regression coefficients is necessary. A footnote could be used for this although the procedure followed in the revised table is quite widely used.

Example 7
(The Simple Table)

Original

Table 4. TIME SPENT BY LENGTH OF WAITING LINE
 AT THE PARCEL PICKUP STATION DURING THE LAST OF THE WEEK,
 FOUR SELECTED STORES, NEW YORK STATE, 1959

Length of Waiting Line	Minutes Per Hour
1	8.3
2	7.5
3	5.0
4-6	3.7
Over 6	3.0

Example 7
(The Simple Table)

Revision

Table 4. DELAY FOR PARCEL PICKUP
Weekends, Four Stores,
New York, 1959

Number of cars waiting	Percent of time
0	54
1	14
2	13
3	8
4-6	6
Over 6	5
Total	100

Comments

Even simple tables can be confusing. The original is hard to understand. It is spread across the whole page when it might well be integrated on half a page with the text. Reading the original text would help one figure out what the table is supposed to tell. Adding one line and changing the first caption makes the basic story clearer and more complete. One might conclude a variety of things from the original table, simple in appearance though it be. In this case substitution of "percent of time" for "minutes per hour" helps explain what did occur.

CHARTS

A good chart helps one see the essence of an idea. Charts make statistics come to life. They put ideas into perspective. They are the pictures the mind retains long after the numbers on which they were based are forgotten. Very often a few, well designed charts will make the central points in ways that words or tables could never do.

There are many different kinds of charts used to present numerical statements. We see them in newspapers and magazines and on television nearly every day. They are a kind of standardized art form. Most of us, with thought and care, can help people understand what we have to say by using them. The most important types are:

- (1) Graphs
- (2) Bar charts
- (3) Pie charts
- (4) Maps
- (5) Flow charts and diagrams

Good charts are sometimes made more exciting by the use of cartoons and pictures. These add to the fun and readers' attention. But they are not required. Emphasis is to be placed on developing

ideas supported with numerical data in the form of charts. If someone with graphic skills is available to liven up the chart so much the better. But concept and control of what is presented should remain with the author.

Some General Suggestions

Charts like tables need to be labeled. They should stand on their own and provide enough information so a reader can find the basic data from which they were constructed. Different kinds of charts require different procedures, but all charts need numbers, titles, units of measurement, source notes and data references.

1. For most publications, with the exceptions of newspapers and news magazines, charts should be numbered. It helps in references and discussion in the text. Whether they are called charts, figures or diagrams, stick with one such designation and number them consecutively.

2. A short descriptive title that tells what you want the reader to see is preferred. If the chart itself does not tell where the data are from and the time span covered it should be a part of the title. In most cases the title should appear above the chart along with the number. That provides space below for data and data sources as well as room for the label on a horizontal axis when there is one.

3. Units of measurement must be clearly indicated. Abbreviations are acceptable if they are widely known. Write out descriptions in full for lines, bars or axes of a graph or sections of a pie chart. If there isn't room to write out the description think about what you are doing.

4. Make sure the reader can find the source of the data from which the chart is made. If no source is listed, it implies that the author collected the original data. Most charts are constructed from someone else's numbers. Give that source appropriate credit. Source notes like those suggested in the section on tables are appropriate.

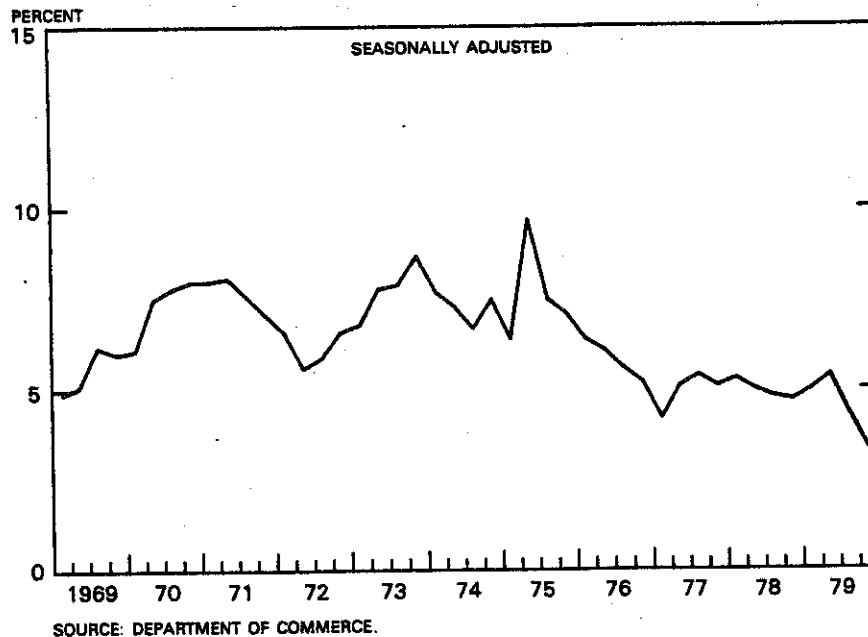
Graphs

Everyone has made a graph. They are the most commonly used charts and help readers visualize trends, changes through time and simple relationships. Examples of some well designed graphs have been chosen to illustrate some important points. Brief comments accompany each.

Example 1
(Single Line Graph)

Chart 1

Personal Saving Rate



FROM: Economic Report of the President, 1980, p. 30.

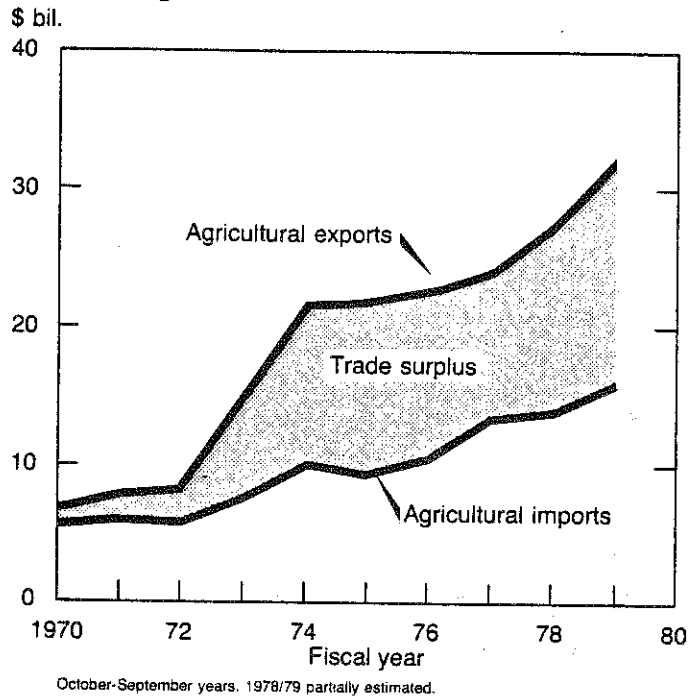
Comment

One line on a chart has many advantages. There is no question about what is of central importance. The horizontal and vertical axes of the diagram are clearly labeled. The title is short and to the point. It is clear that quarterly data were used and supplied by the Department of Commerce. The recent down turn in the savings rate is established against enough history to provide perspective. The vertical scale is easy to follow. The line is nicely centered in the space available. It is a winner.

Example 2
(Two or More Lines)

Chart 169

U.S. Agricultural Trade Balance



FROM: USDA Agricultural Handbook No. 561, p. 75.

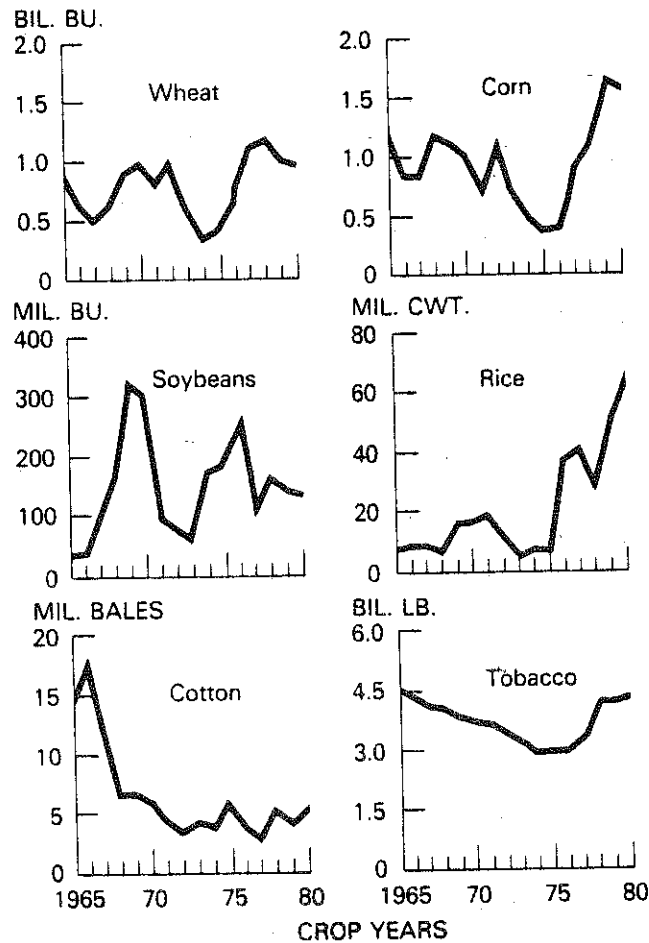
Comment

Two lines on a graph are easy to read if they are related in a logical manner and use the same scales. The lines must be labeled clearly. This excellent chart describes the trade surplus in agricultural products as well as the trends in exports and imports. A square chart where the vertical space is roughly equal to the horizontal distance has many advantages. Shading the area between exports and imports is an effective way to highlight the size of the trade surplus.

Example 3
(A Set of Related Single Line Charts)

Chart 219

Stocks of Major Farm Commodities



Crop years beginning: Wheat July 1, 1960-64, June 1, 1965 to date; cotton and rice, August 1; soybeans, September 1; corn and other tobacco, October 1. 1980 forecast.

FROM: USDA Agricultural Handbook No. 561, p. 101.

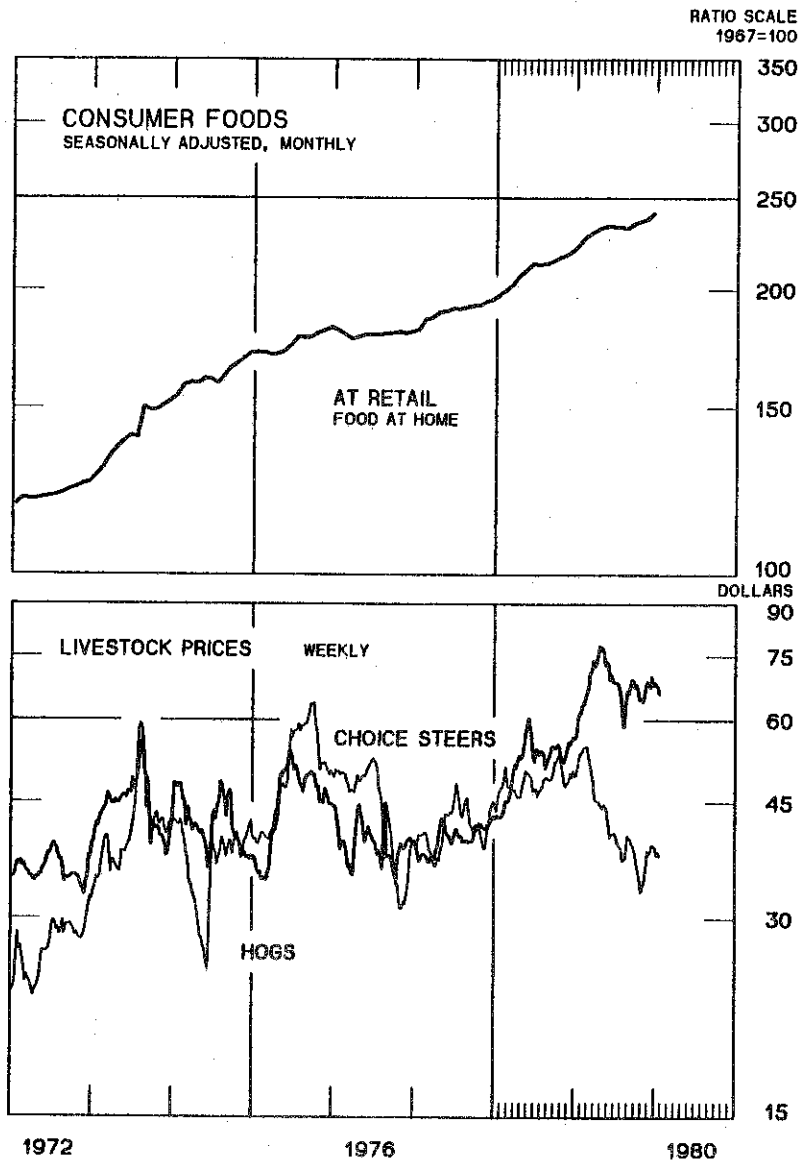
Comment

A series of individual, single line graphs which have common characteristics is more effective than trying to put all of the same lines on one or two larger charts. The

trends are different. The individual diagrams show the variability from year to year for specific crops. Comparisons can be made more easily than if the lines are closer together. This approach has many advantages to a reader interested in only one or two of the specific commodities.

Example 4
(Ratio Scales)

FOOD PRICES



FROM: Federal Reserve Chart Book, February 1980,
p. 21.

Comment

Ratio scales or semilogarithmic charts help analysts and readers observe whether or not constant percentage changes occur over time. This kind of graph is quite widely used by economists and engineers. Care must be taken to call attention to the vertical scale. The procedure used in the Federal Reserve Chart Book is generally good. The kinds of data used for the charts are prominently identified within the charts. The ratio scale is marked on the right hand side rather than the left. This is done to facilitate reading the most recent data from the graph. The horizontal scale is marked in monthly intervals for the most recent years.

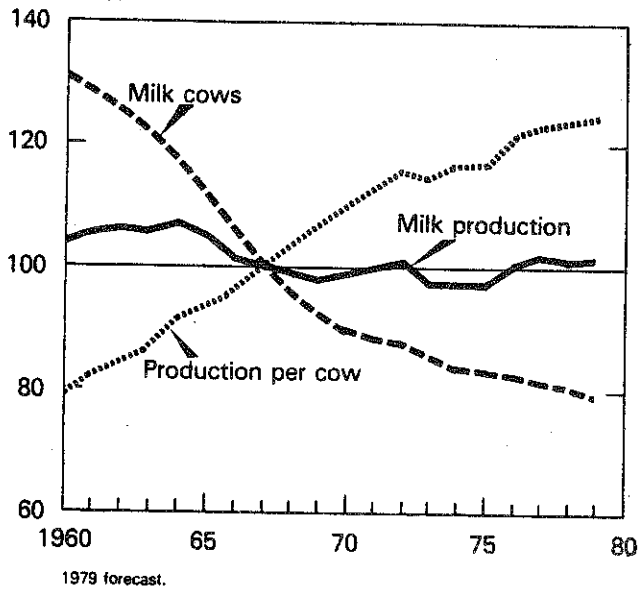
It is much easier to follow the chart on consumer foods than the one on livestock prices. Even though only prices for hogs and steers are presented it is difficult to be sure which line is which. It is also difficult to see the weekly detail. Perhaps there is an effort to present more information in the lower chart than can be handled effectively.

Example 5
(Three lines, different units)

Chart 204

**Milk Production, Number of Cows,
And Milk Per Cow**

% of 1967



1979 forecast.

From: USDA, Agricultural Handbook No. 561, p. 93.

Comment

If one wants to show how contrasting trends bring about a specific result, this chart is quite effective. The authors wisely put all of the information in percentage terms. Number of cows, production per cow and total milk production require three different quantity scales. It is a rare situation indeed when you can justify more than one scale on a chart! With time series data this is an ideal way to make a point. Milk production has remained remarkably stable even though cow numbers have dropped because yields have increased proportionately.

In the original publication the numerical data were listed below the chart and a second diagram included on the same page. If these data were presented in an article the table would have been numbered and organized somewhat differently.

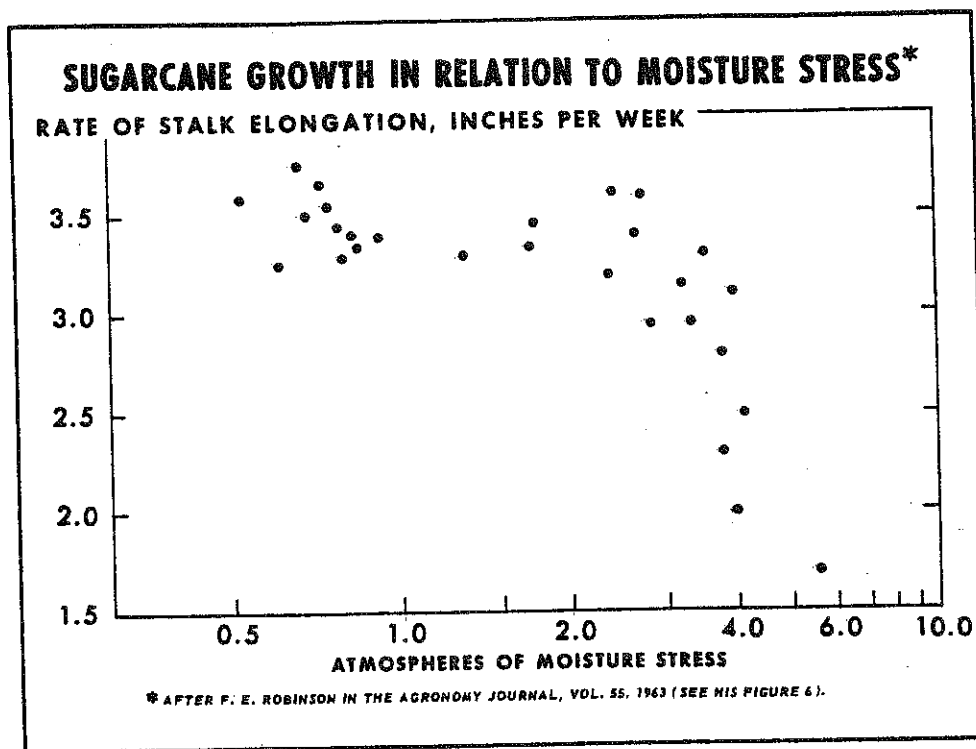
Milk Production, Number of Cows, and Milk per Cow

	1976	1977	1978	1979 ¹
Milk production:				
Billion pounds	120.3	122.7	121.9	122.2
Percentage of 1967	101.3	103.3	102.7	102.9
Milk cows on farms: ²				
Million	11.1	11.0	10.8	10.7
Percentage of 1967	82.4	81.8	80.1	79.9
Milk production per cow:				
Pounds	10,879	11,181	11,240	11,385
Percentage of 1967	122.9	126.3	127.0	128.6

¹ Forecast. ² Average number on farms during the year, excluding heifers not yet fresh.

Computed from data published in *Milk Production, Disposition, and Income* (ESCS).

Example 6
(Scatter Diagram)



FROM: Agricultural Economics Research 22:1, January 1970, p. 14.

Comment

One of the most effective ways to analyze cross section or time series data for relationships is with a scatter diagram. A chart like this one allows each reader to get an impression of the nature and extent of the variability over the range of observations made. It is an excellent diagram.

The use of a square diagram is encouraged. It is helpful to have the scales repeated on the right hand side of the diagram. The units of measurement are clearly indicated. Note that a logarithmic scale is used for the horizontal axis. The title explains the relationship studied. In this case the data are more interesting than a line of average relationship fitted to them.

Example 7
(Relationship Comparisons)

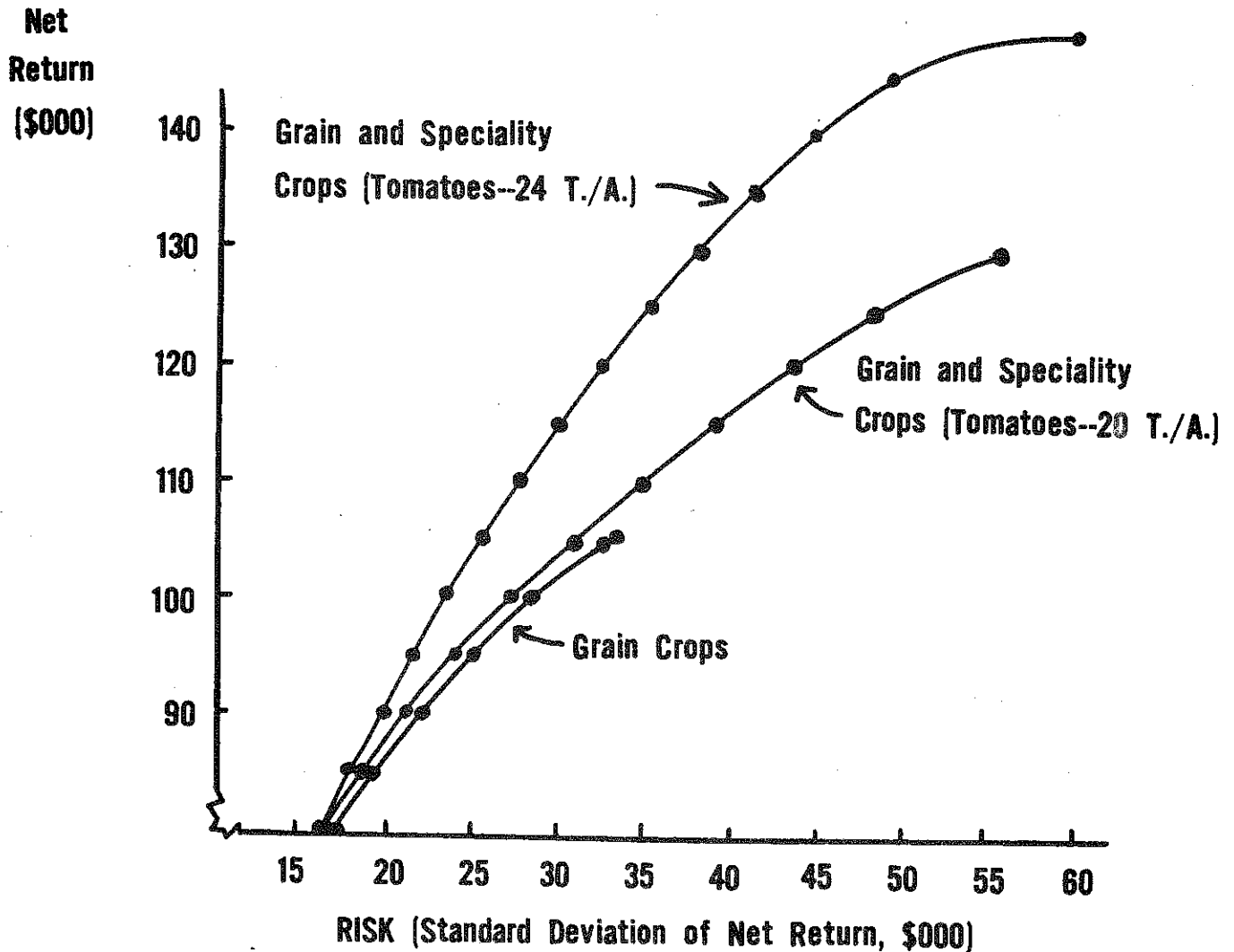


Figure 1. Efficiency Frontiers

FROM: North Central Journal of Agricultural Economics 1 (1979):18.

Comment

A graph can often provide perspective on a set of relationships that is impossible in a standard table. In this example a set of efficiency frontiers derived from a linear programming analysis are presented. The scales are clearly identified. The data on the curves are calculated values.

If the authors had finished off the diagram with lines at the top and on the right hand side it would be improved. The scale for net return should be expanded. Moving the figure number and title to the top of the chart would give it more prominence. A little more information in the title would be helpful as well.

Example 8
(Too many lines)

Chart 34

Energy Prices Paid by Farmers

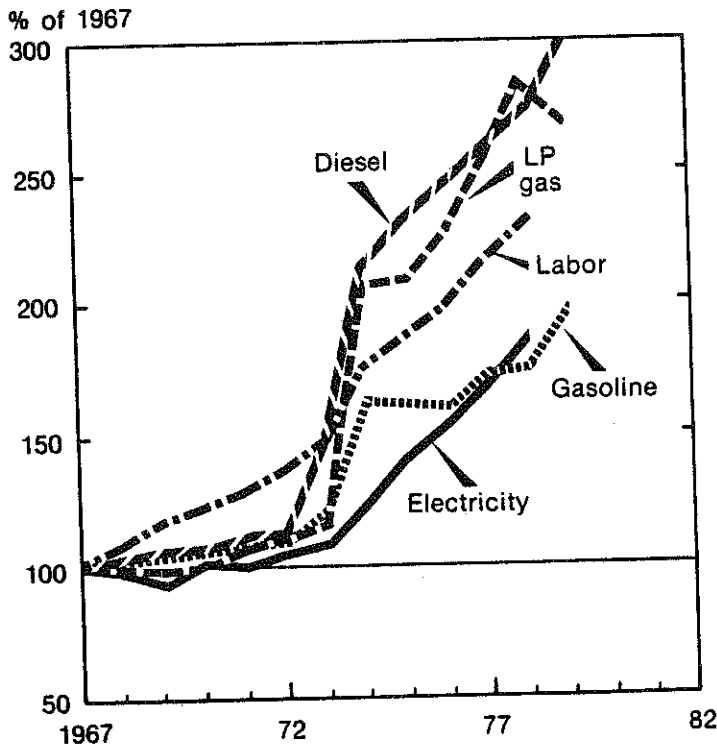
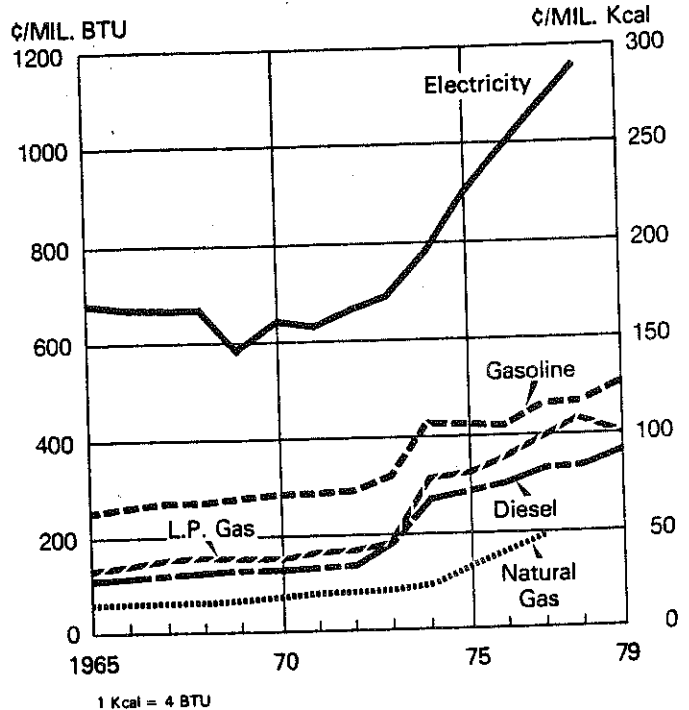


Chart 35

Energy Prices Per BTU Paid by Farmers



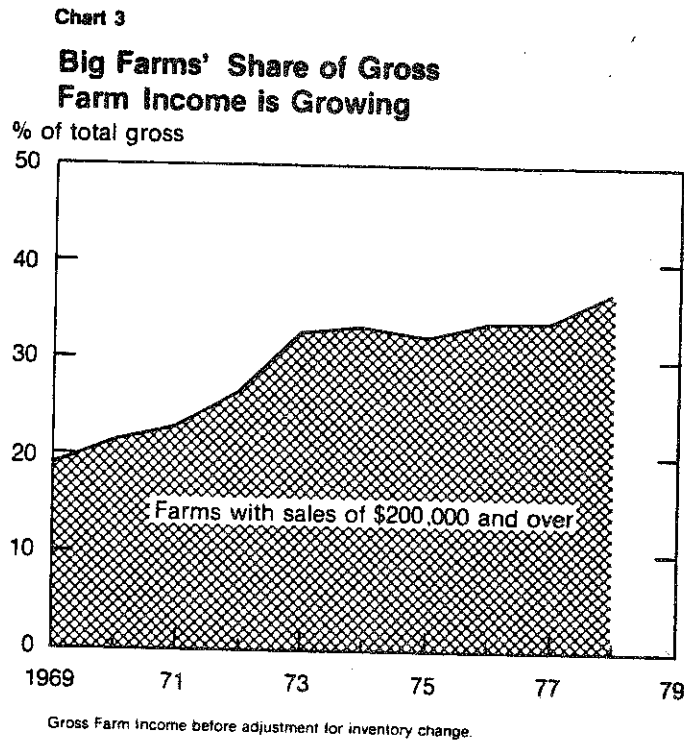
FROM: USDA, Agricultural Handbook No. 561, p. 21.

Comment

In most cases three lines on a chart are a maximum. One begins to have trouble telling which line is which if they intersect or move closely together. If one must put as many as 5 lines on one chart then one can see differences and make comparisons more clearly on Chart 35 than Chart 34.

In Chart 34 there is the added problem of using percentages which are all 100 or greater. If percentages are to be presented for time series data try to get the index of 100 somewhere in the middle of the numbers. The different energy prices would have been easier to examine if a year like 1973 had been chosen as the base instead of 1967. Whenever possible it is helpful to chart percentages within a range between 50 and 200.

Example 9
(Prices, Percentages, and Improper Comparisons)

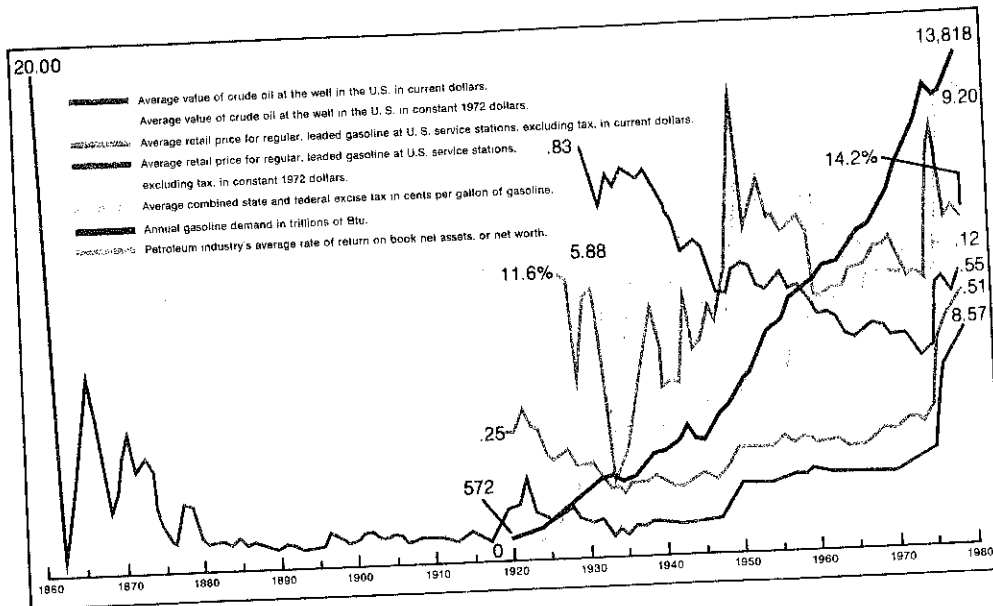


FROM: USDA, Agricultural Handbook No. 561, p. 6.

Comment

This is a straightforward chart. The title is convincing. It is also a misuse of statistics. Between 1969 and 1979 producer prices doubled. The Producer Price Index for farm products went from 109 in 1969 to 241 in 1979 (1967=100). A farm selling \$200,000 of farm products in 1979 was roughly equivalent to one selling \$100,000 of sales in 1969. An invalid comparison is made in Chart 3. When prices are changing rapidly, aggregates should be put on common base if possible. In 1969 farms with sales of \$100,000 or more made up 29.2 percent of the national total. In 1978 farms with \$200,000 or more of gross farm sales made up 36.8 percent of the total. These are roughly comparable statistics but not easily put into a chart.

Example 10
(What not to do)



FROM: EXXON, USA, Second Quarter, 1979.

Comment

The major corporations of America produce some of the best charts and graphs available, often in color and with high standards of quality. They also have produced some disasters. The chart reproduced above is exactly the same size as the original in the color magazine prepared by the Public Affairs Department of Exxon. It is a good example of what not to do.

There are seven lines in the chart. All of the scales are different and seemingly unrelated. The type is so small it is hard to read. The original lines, even in color, were hard to follow. The items considered are a mixture of quantities, prices, values and rates of return. There is no title. After some study it is not clear what the author intended that we see.

Even if your graphs aren't as professional as those prepared by the Federal Reserve Board or the USDA you can stick to one or two lines per graph, clear labels, valid comparisons and a clear statement of purpose in your title.

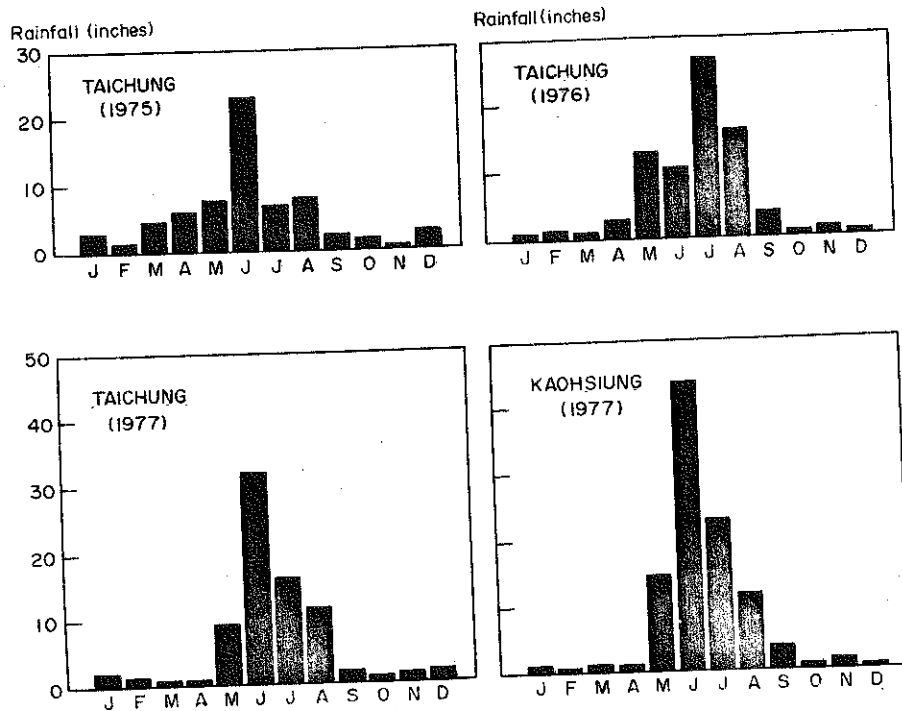
Bar Charts

Bar charts are the most widely used means of presenting relative rankings of numerical data other than tables. They are surprisingly flexible. In most cases they help one grasp the size of relative differences. Moreover they can be constructed with very modest drafting materials.

In most cases bar charts are used to supplement more detailed numerical data in one or more tables. An author can use a bar chart to emphasize one or more key points. The decision as to whether to use horizontal or vertical bars is a matter of personal preference. Vertical bars are somewhat more commonly used. A few general comments on making bar charts follow:

- (1) Be sure there is a properly labeled scale to provide reference, either vertical or horizontal.
- (2) Dividing a bar into components is acceptable; 3 or 4 parts is about all most people can comprehend if a series is presented.
- (3) Use consistent spaces or intervals between bars except where an important change in time periods or categories occurs.
- (4) Aim for a chart that is square or near square as possible.
- (5) A clear title and chart number is just as important for a bar chart as for a table.

Example 1
(Frequency distributions)



2. Distribution of total monthly rainfall. Taichung and Kaohsiung, Taiwan, 1975 and 1977.

FROM: IRRI, Farm Level Constraints to High Rice Yields in Asia: 1974-77, p. 354.

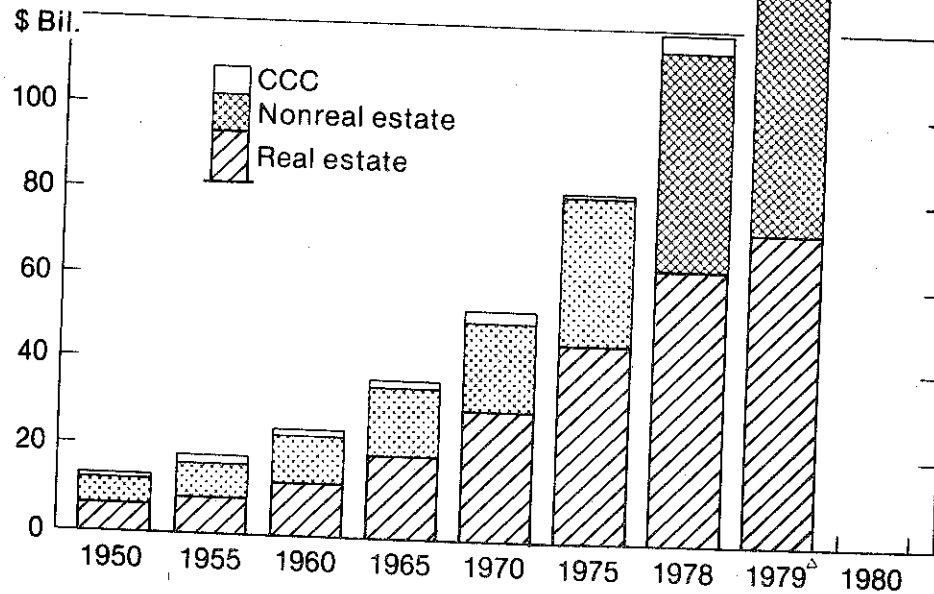
Comment

In this bar chart four frequency distributions are presented. A scale is clearly identified. Variation among three years at one location is visualized. The rainy periods are easily identified. Each diagram is self contained and comparisons facilitated. The title would be easier to identify if it was in larger or bold face type and placed above the diagram.

Example 2
(Components of a total)

Figure 5

Farm Debt Outstanding*



*Farm loans outstanding January 1.

^Δ Preliminary.

USDA

Neg. ESCS 5734-80 (1)

FROM: USDA, Agricultural Information Bulletin 430, p. 18.

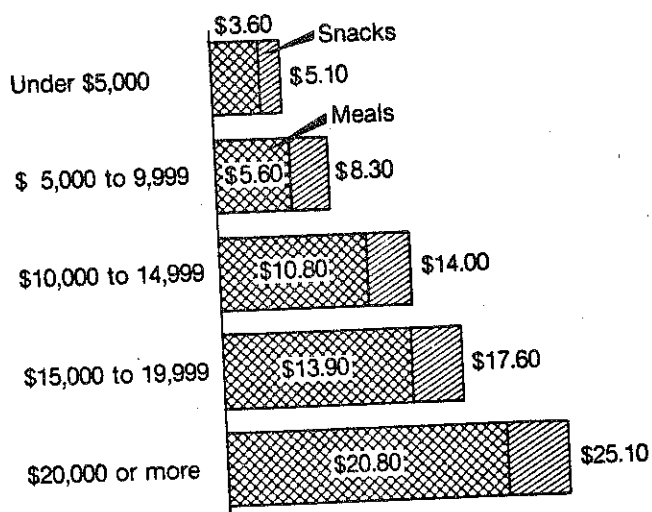
Comment

The components of farm debt are divided into three categories in this chart. It is traditional to place the largest item on the bottom and the smallest percentage on the top of the most recent bar on the chart. This order should prevail on each bar even though the importance (percentage) of items may vary for individual bars. Sometimes the proportions or the actual values are indicated for each of the sections within the individual bars. In this case a larger separation might have been made between 1975 and 1978 to indicate the change in years. Overall it is very well presented.

Example 3
(Comparisons without scales)

Chart 109

**Food Away from Home,
Expense Per Week by Income**



FROM: USDA, Agricultural Handbook No. 561, p. 54.

Comment

All of the basic data can sometimes be presented in a bar chart if the classifications used are relatively simple. This chart presents results from a nationwide consumption survey made in 1977-78. It is based on data from 3500 households. This additional information about the chart was presented on the same page. The year involved could have been included in the title.

When the two components of food expenditure away from home are directly identified and the general proportions are clear, it is not necessary to add a general scale as well. The point of reference is already clear from the way in which the individual bars are constructed.

It is useful to put actual numbers inside a bar or close to it as has been done in this case. If the total and the largest item is given the reader can easily calculate the other value. This kind of chart can be surrounded by text or explanation and be a natural part of a page.

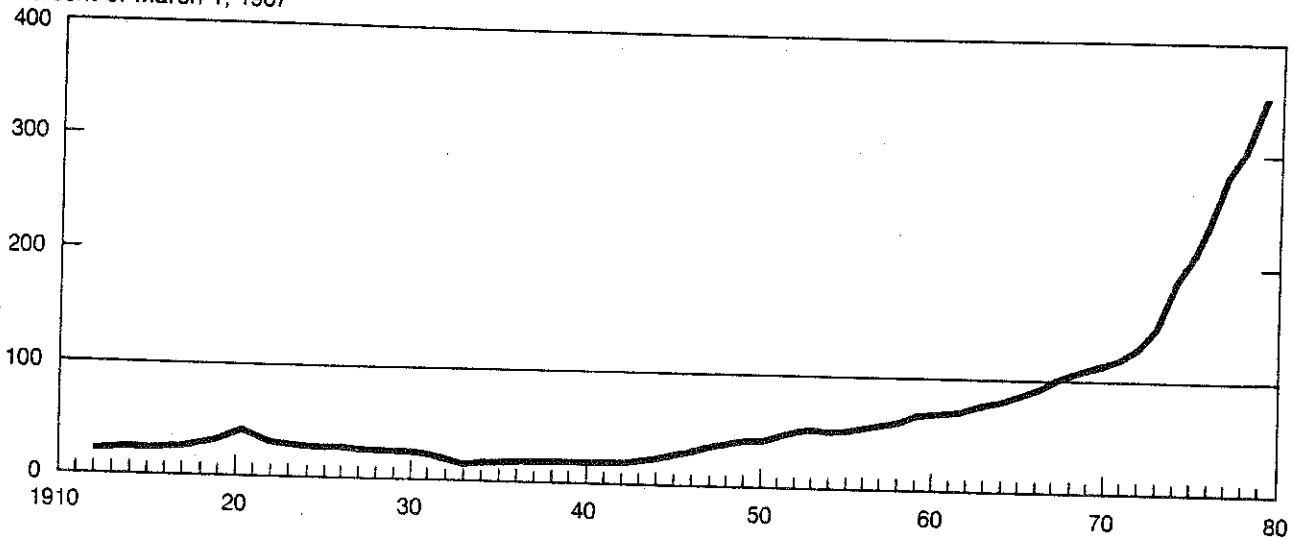
Example 4
(Percentage changes over time)

Chart 23

Change in Farm Real Estate Values

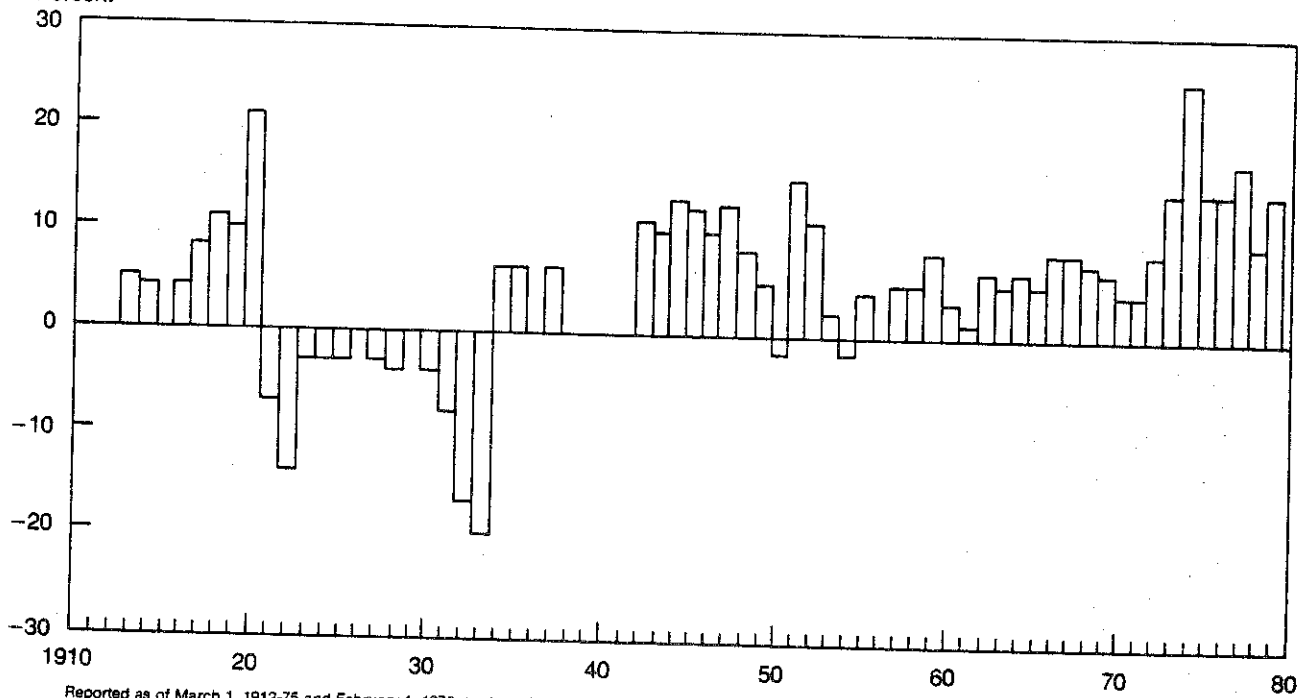
Change in Value per Acre

Percent of March 1, 1967



Change in Value From Previous Year

Percent



Reported as of March 1, 1912-75 and February 1, 1976, to date. Excludes Alaska and Hawaii. Data unavailable prior to 1912.

FROM: USDA, Agricultural Handbook No. 561, p. 15.

Comment

Percentages are hard to interpret once they depart very far away from 100. Decreases from 100 are limited to 100 points. Increases can go on forever. In many respects a decrease of 50 points from a base of 100 is equivalent in relative magnitude to an increase of 100 points on the same base.

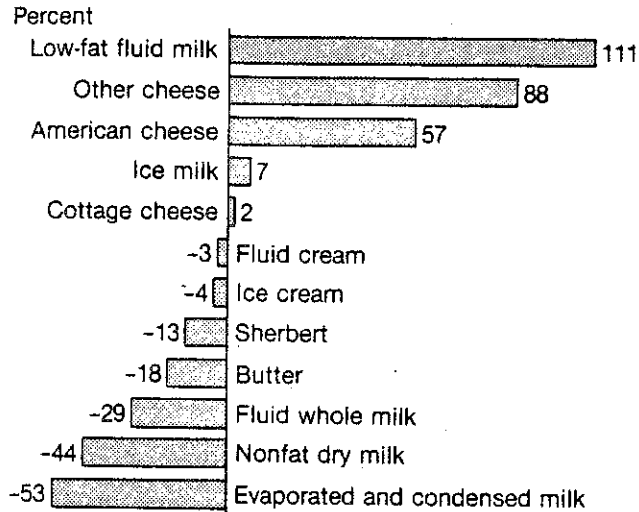
When one wants to make comparisons over a substantial number of years like 1912 to 1979 it is difficult to get perspective on relative changes. The combination of a line graph and bar chart as presented in this example is most effective.

The percentage change in value from the previous year is an excellent way to remove most of the interpretation problem inherent in index numbers and percentages. This USDA chart is quite ingenious and helps one see both the general trend and puts yearly changes into perspective. This kind of chart combines a great deal of information in a relatively small space and makes a few central points clearly.

Example 5
(Positive and negative changes)

Chart 208

**Changes in per Capita Dairy
Product Sales, 1968-78**



FROM: USDA, Agricultural Handbook No. 561, p. 95.

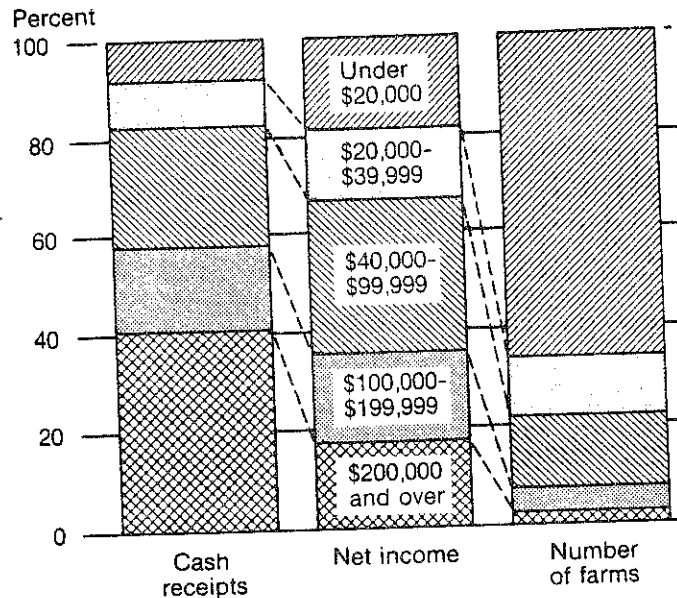
Comment

A bar chart is effective in contrasting positive and negative changes. Either horizontal or vertical bars can be used for this kind of presentation. The lack of a scale in this case is compensated for by listing the individual percentage changes next to each bar. A chart like this one draws attention both to the major changes and the products which have had stable consumption patterns. A table presenting the original numerical data can be combined with this kind of chart to provide quantitative information on per capita use in both time periods.

Example 6
(Complex comparisons)

Chart 5

**Cash Receipts, Net Income, and Farms
By Sales Classes**



1978 data. Net income before adjustment for inventory change.

FROM: USDA, Agricultural Handbook No. 561, p. 7.

Comment

Most USDA charts are of a very high standard, easy to understand and worthy of commendation. But a few try to tell a combination of things simultaneously and can be confusing. In combination with two tables and some text it is easier to understand this chart but there remain some problems. There are five different size classes and three different concepts to relate. The eye and mind have problems in making the relevant comparisons.

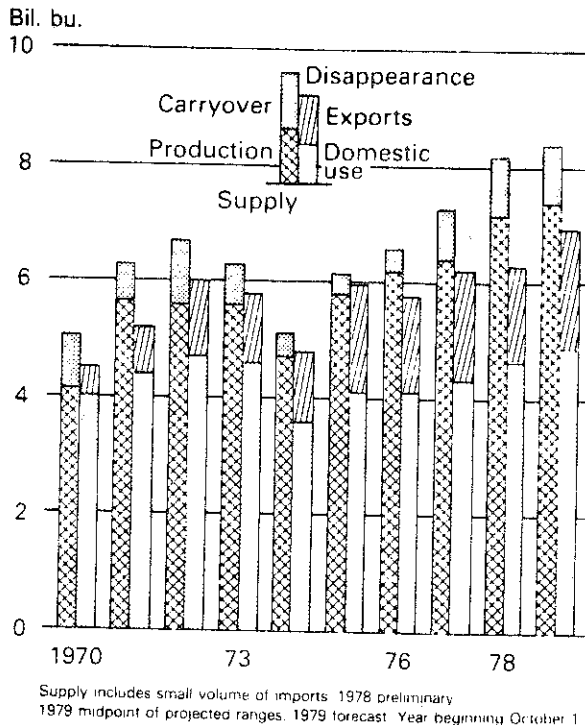
A vertical bar divided into five parts using percent of total is an effective device. The left hand bar, cash receipts is a traditional presentation. If only one of the other two bars were present one could follow the cross comparisons reasonably well. Adding the third bar creates difficulty particularly when the proportions for the different shaded areas are reversed. In this particular case if the net income category had been removed, the stark contrast would have been highlighted and more easily followed.

As a general rule it pays to use more charts and make your individual points clearly rather than trying to make a set of comparisons simultaneously that may be more complex than most readers can grasp.

Example 7
(Bar chart inappropriate)

Chart 241

Corn Supply and Disappearance



Comment

FROM: USDA, Agricultural Handbook No. 561, p. 112.

Bar charts should help a reader get perspective on the relative size of different things. Sometimes bar charts are more confusing than the original table. The one prepared for corn supply and disappearance is such an example. The concept to be considered is a balance sheet where all sources of supply are related to all the different kinds of uses. Stocks or carryover from one year to the next make up the differences. Ending inventory for one year is beginning inventory for the next.

There are a number of problems in understanding this chart. One is that there are four different categories for corn. The one for "domestic use" is the same color or shade as the white background. It is hard for a reader to tell which is domestic use and which is blank space to separate years. As a general rule the space between bars should be a different width from the bars themselves. In this case it is hard to tell which is the data for a given year and which is the space between years.

Equally important in presenting a balance sheet is the need to show that all sources of supply = all uses including carryover. The chart should have demonstrated that carryover at the end of the year was the balancing mechanism or beginning inventory for the next year. This does not appear to be the case in 1978 and 1979 which adds to the difficulty in understanding this complex bar chart.

Sometimes a simple table is a better alternative than a graph or chart because it can tell what you want to convey to the reader.

Pie Charts

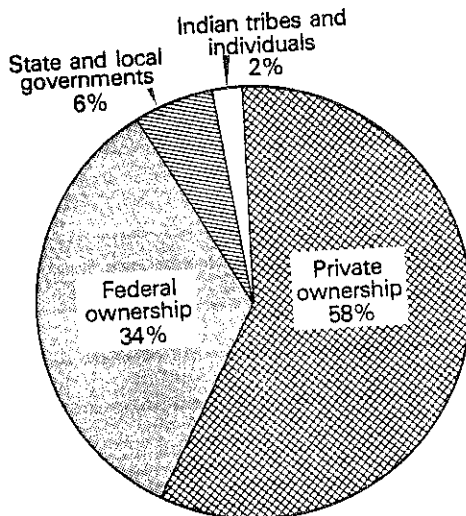
Dividing a pie into pieces is a common American experience. Splitting a circle into parts is a good way to show proportions as long as the pieces are large enough so the reader can see them. Pie charts add variety to a publication and are particularly effective in showing how changes in proportion have occurred through time. The circles or pies should be large enough so the reader has no difficulty in getting perspective on the proportions.

Example 1

(Form and the number of pies)

Chart 46

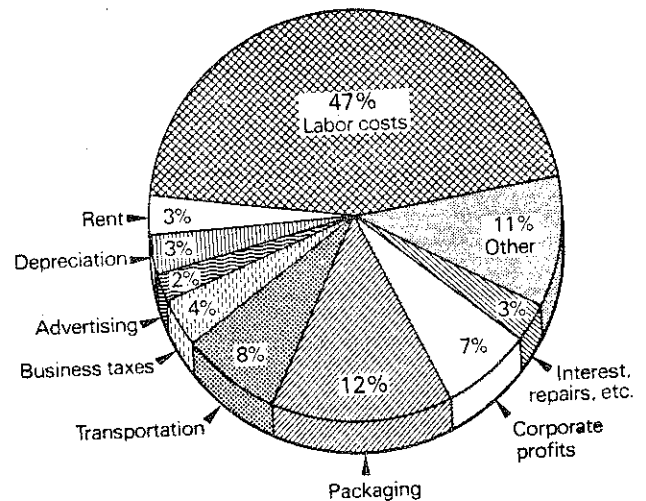
Land Ownership in the United States



1974 data.

Chart 106

What Makes Up the Farm-Food Marketing Bill



Transportation is intercity rail and truck. Corporate profits are before taxes. Other includes utilities, fuel, promotion, local hired transportation, insurance, etc. 1978 preliminary.

FROM: USDA, Agricultural Handbook, No. 561, pp. 27 & 53.

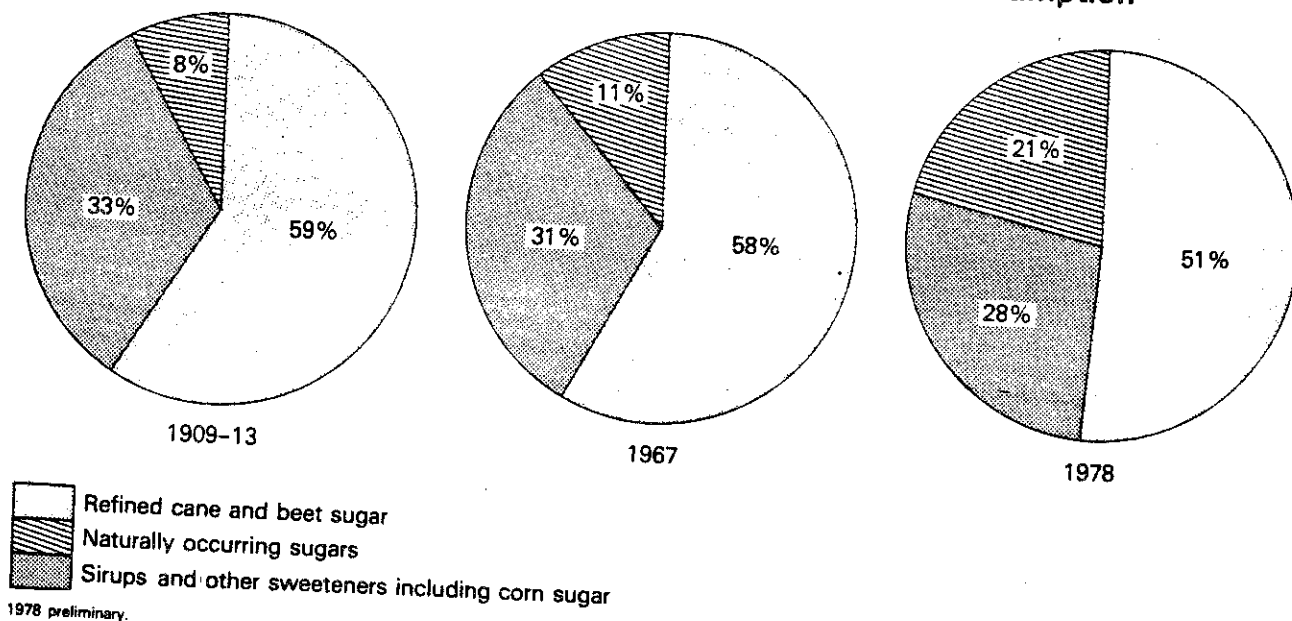
Comment

Both of these charts are quite easy to read and understand. The proportions are clearly indicated and related to the appropriate description. The chart on the left with 4 divisions is the easier one to read and construct. In most cases the extra effort entailed in providing a three dimensional effect as shown in the chart on the right is not necessary and may distort the picture. Don't try to go beyond whole percentage points in a pie chart. If greater detail is necessary use a table.

Example 2
(Comparisons over time)

Chart 130

Sources of Caloric Sweeteners, Civilian Consumption



FROM: USDA, Agricultural Handbook, No. 561, p. 60.

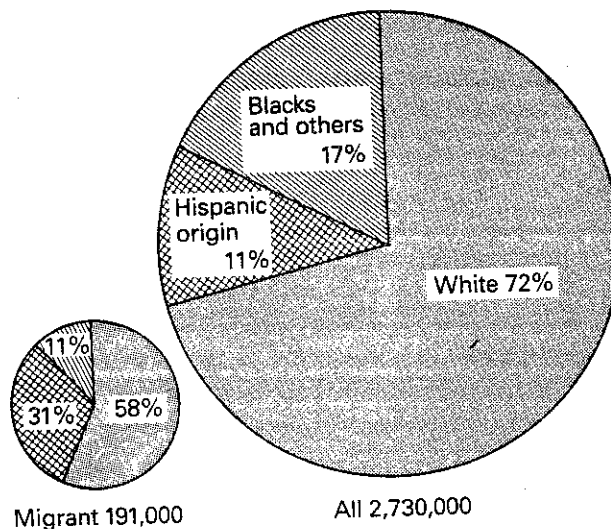
Comment

Three circles of the same size divided into three pieces shows change through time effectively. This chart is easy to understand and easy to remember. The three categories could have been identified within the pies but the procedure used is quite acceptable.

Example 3
(Pie charts of different sizes)

Chart 76

**Racial and Ethnic Background
Of Hired Farmworkers**



1977 data. Source: Hired Farm Working Force Survey of 1977.

FROM: USDA, Agricultural Handbook, No. 561, p. 40.

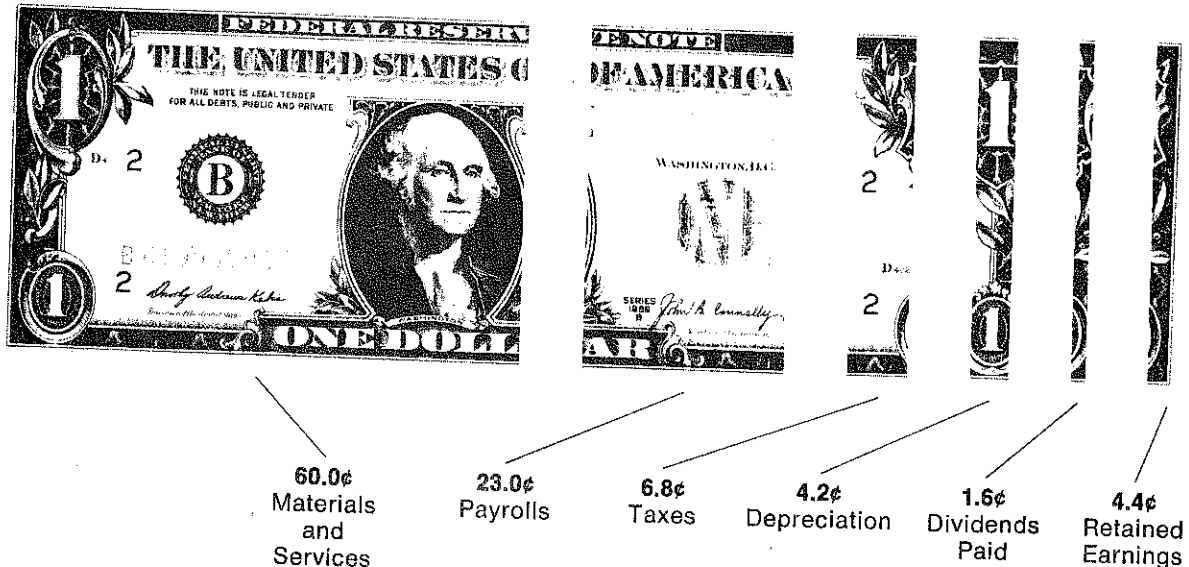
Comment

Two or more pies of different sizes can draw attention to relative differences. The general effect is helpful in getting perspective as shown in this example. Two comparisons are possible.

It is often difficult to get the two pies or circles in correct proportion to each other and even if you get them right the reader generally has trouble relating the area of a small circle to the area of a larger one. In this case they are roughly proportional. When this approach is used the proportions of the circles should be considered carefully and made to be nearly as correct as possible.

Example 4
(Dividing up the dollar)

Where the Sales Dollar Went in 1977



FROM: AIRCO, Inc., 1977, Annual Report, Form 10-K, p. 33.

Comment

A variation in the pie chart is to divide some other familiar item. The annual report of a corporation often provides some excellent charts. Cutting up an American dollar has the same effect as splitting a pie and helped to keep reader interest in a potentially dull report.

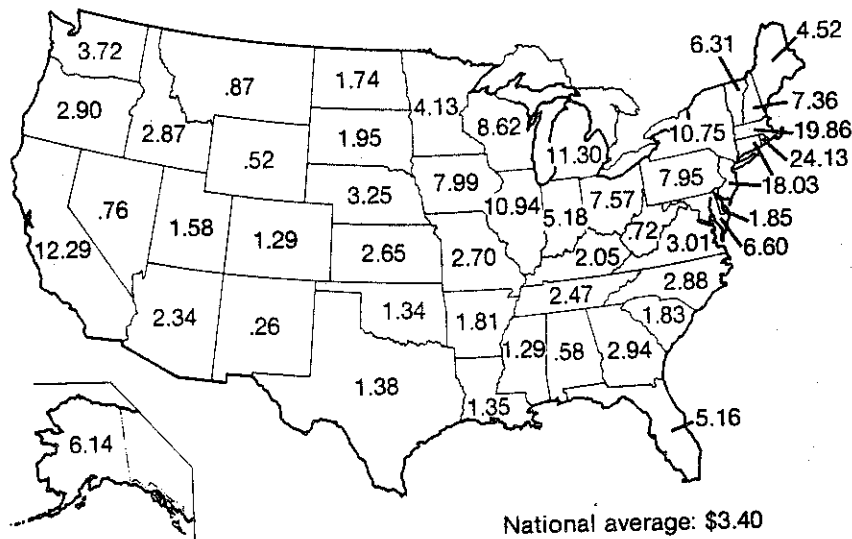
Maps

One of the most effective ways of showing information on a geographical basis is to use an outline map. This requires access to maps and materials to shade or insert numbers. A map can convey many things at a glance which is almost impossible in a table. Two excellent examples from the USDA point out the kinds of things which are possible.

Example 1
(Numerical data)

Chart 22

Farm Real Estate Taxes per Acre, 1977



Data is preliminary.

FROM: USDA, Agricultural Handbook, No. 561, p. 14.

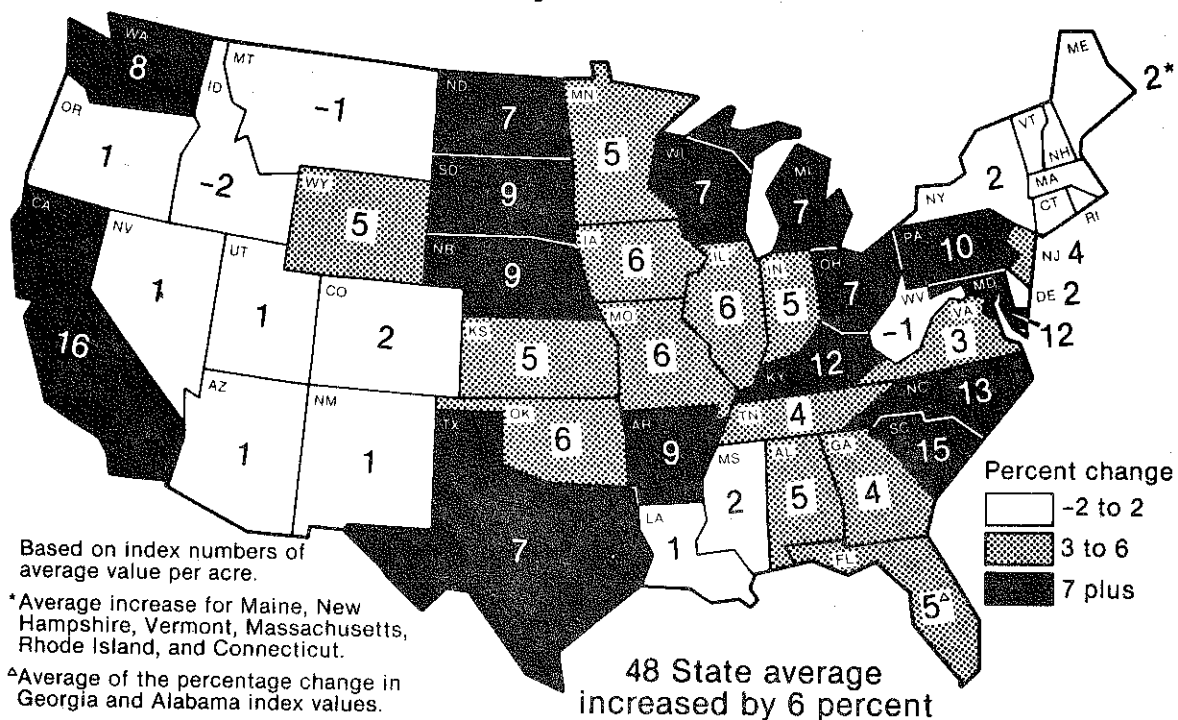
Comment

This map provides a picture of average real estate taxes for each of the states in 1977. A table presenting this information cannot allow one to see all the regional comparisons as easily or effectively. One can see the substantial differences from state to state and by region. Reasons for the observed differences and any other comments can be discussed in written materials provided with the chart. This is an excellent example of how to use a map to convey a large amount of information in a relatively small space.

Example 2
(Shaded maps)

Figure 4

**Percentage Change in Average Value
of Farm Real Estate per Acre
November 1978-February 1979**



FROM: USDA, Agricultural Information Bulletin No. 430, p. 10.

Comment

Most readers expect the shading on a map to indicate that light or no color means small or very little and dark means large or more. Dot maps are white where there are no observations and dark where there is heavy concentration. Don't confuse a reader by making up a different system.

This map conforms to the general rule. The smallest increases or decreases in value are not shaded. The larger increases are indicated in black. Actual percentage changes are included for each state. Only three categories were established which is good. Once one gets to five or more different categories the problem of differentiating between shades or colors is much more likely. A simple, clearly presented map is one of the most effective charts one can use.

Flow Charts and Diagrams

Just as an outline helps a writer organize his thoughts, a flow diagram can help a reader see how ideas or variables relate to each other. Economists have learned that flow charts help them organize their own thinking. In turn this is a good way to present some ideas.

Even though some relationships are very complex it is most helpful to see the central ideas before one is overwhelmed with the details. A flow chart should insure that the central variables and directions of flow are easily identified. A very busy chart is not likely to help the reader or the analyst himself.

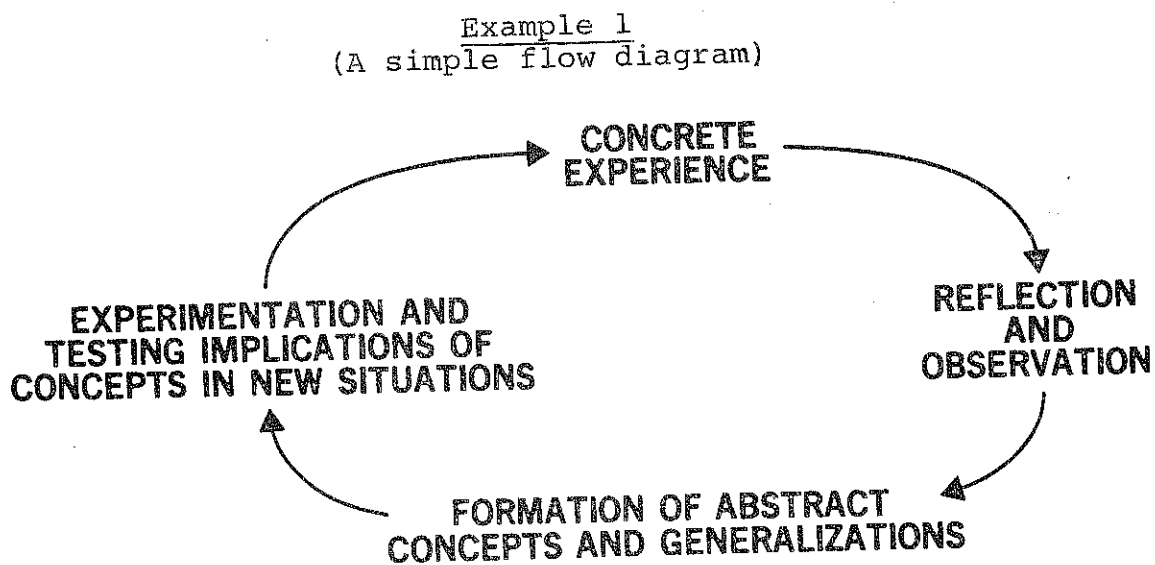


Figure 1. The experiential learning model

FROM: Boehlje, M. D. and Vernon R. Eidman, AJAE, December 1978, p. 988.

Comment

This simple diagram with its circular flow helps draw attention in an article to a central idea. It is easy to grasp and easy to read. More flow diagrams should evaluate this style and clarity of presentation.

Example 2
(A complex flow diagram)

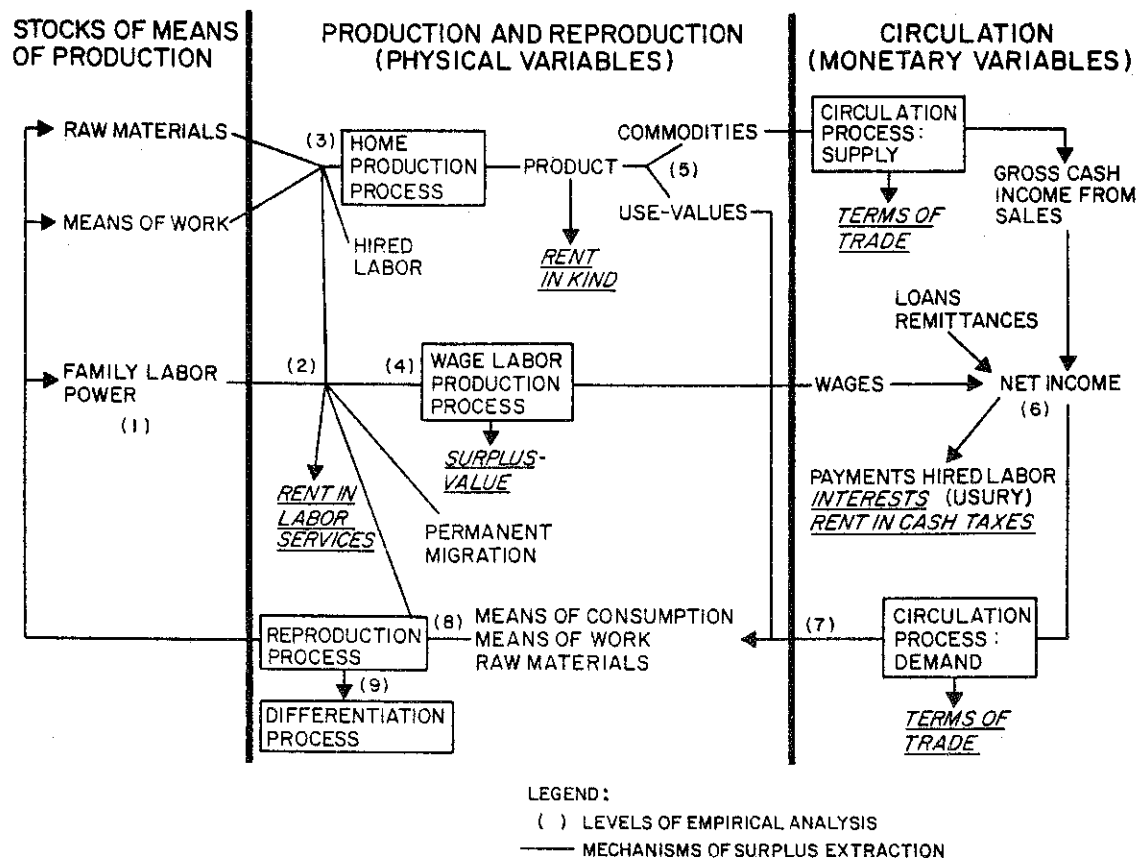


Figure 1. Organization of the peasant household

FROM: Deere, C. D. and Alain de Janvry, AJAE, November 1979, p. 603.

Comment

A set of complex relationships can be made more understandable with a flow diagram. The objective of the flow diagram should be to help the reader see the key variables and the nature of the postulated relationships. Simplifications are necessary. The diagram should show the base outline, not all the details.

This flow diagram uses short descriptive phrases, a few boxes, some lines and arrows and key dividing lines. One's attention is drawn to the three major divisions and the flows or connections among them. It is an effective way to highlight the ideas presented in the text. It is an integral part of the article and the analysis which follows. Even though the real world is more complex, the diagram helps the reader to follow the author's argument.

Example 3
(How much in one diagram)

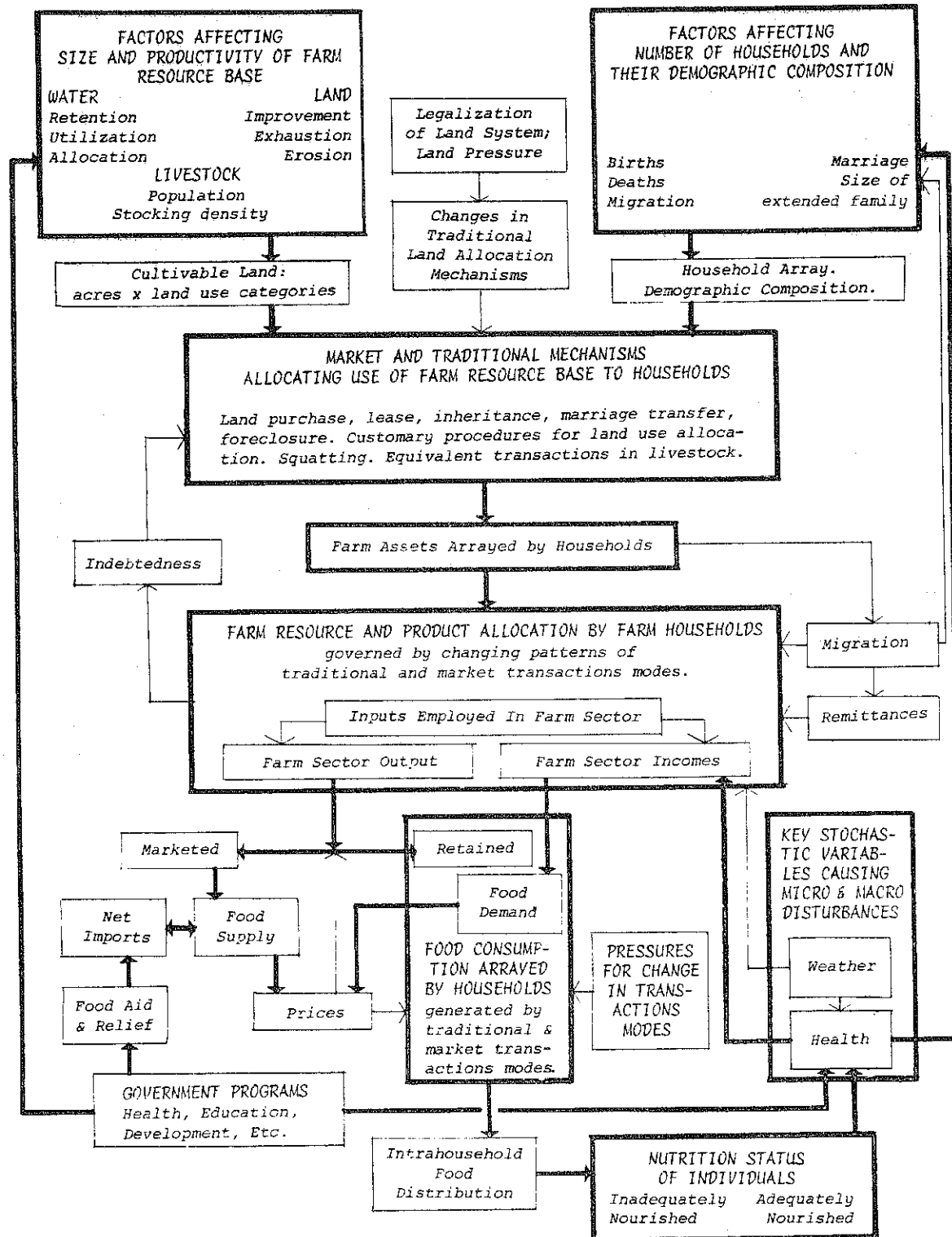


Figure 1. System governing nutrition status in Machakos District, Kenya

Comment

How much information can be put in one chart? What portion of it can be understood? The answers to these questions differ depending on the audience and the skill and ingenuity of the chart maker. One way to demonstrate complexity in an organization chart is to have a multitude of boxes with lines going in all directions. In large organizations that probably is a good description of reality. But that may not help understanding at any level.

The chart presented here is neat and tidy. If one works at it, one can follow the flows. But there are too many words and phrases. The need for all the information is not clear to this reader. Some of the details could have gone in the text or could have been omitted. If nutritional status is the central focus it should have had a central place instead of a small box in the corner.

A flow diagram or organization chart can be a great way for an analyst to think through a complex problem. It can be as big or complex as desired to establish the elements of the process considered. But that kind of chart is not something to be published except in a technical paper for others interested in technical detail. In most cases a very complex diagram can be broken into some component parts. If these parts are important they may well deserve separate treatment.

An analogy to graphs can be made for flow diagrams. When there are three lines on a chart, adding any more should be considered with care. When there are three or four major divisions in a flow diagram, think carefully about the number of interactions you want to add to maintain clarity and reader understanding.

Judging Your Final Product

Readers tend to be more aware of tables and charts that are hard to read than those which are clear and easy to understand. Carefully prepared materials may go unappreciated. But this helps a reader focus on the ideas behind the chart or table and not on the diagram itself. Making good charts is not a science. But careful work will make a difference. Clarity, simplicity, and order are the fundamental rules of the game.

After constructing a set of tables and charts, a quick review of a set of questions like these may suggest a few more improvements.

- (1) Is the purpose of each table and chart clear?
- (2) Is there a title for each that tells the reader what, where and when?
- (3) Where will each table and chart be placed in relation to the explanatory text?
- (4) Are all the numbers, lines and information really necessary?
- (5) Does each table fit across the page and if not, why not?
- (6) Is the source of the information clearly stated if it is not original with you?
- (7) Have you used a variety of ways to present numerical data? Would a chart work in place of one or more of the tables?
- (8) Will each table and chart stand by itself and be understandable?

Good tables and charts provide their own rewards. They lead to understanding. An ordinary person can figure out what you are saying with a good chart or table but it takes an unusual person to develop them.

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