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MAKING TABLES AND CHARTS

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B. F. Stanton
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A third edition, largely based on materials presented in A.E. Ext. 80-26, is provided to help individuals present quantitative information in the form of tables and charts. A good table or chart can tell a story economically and clearly. The world of personal computers has made this possibility much easier. The author must still make the key decisions. There is both art and science involved. Effort on the author's part will make readers happy. The careful work of Linda Morehouse to present these materials clearly is gratefully acknowledged. Comments and suggestions from our colleagues in agricultural economics are reflected throughout the publication.

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July 1987

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EXPRESSING IDEAS WITH TABLES AND CHARTS

INTRODUCTION

They say a picture is worth a 1000 words. The picture should be in focus. It helps if it is 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 cannot compete with a color picture from National Geographic. But they can get your attention; make a point; capture an idea in visual form. Interest rates are falling at an increasing rate. Words cannot 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 is 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 is easy to see that making a table or chart is not science. There is a lot of ART and EXPERIENCE involved. Most readers can find the central point of a good chart. If a table is poorly organized and cluttered with data, readers will likely 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 some major points to consider and demonstrate differences between effective efforts and those which fall short. Putting together a table or a chart which makes a point will provide both you and others satisfaction. It will save a reader time. It can make a difference in your final report.

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 in each column and row.

The source of the data, if it is 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, straight-forward, and very well organized. 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 by location. If one is looking for good examples of a range of ways to use charts successfully, USDA'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 grasp easily.

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, straight-forward 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 the ideas and approaches rather than specific rules. We can always find ways to improve our illustrations and supporting evidence. This is the basic objective of this bulletin.

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 U.S. 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 Agricultural Statistics Board, National Agricultural Statistics Service, USDA. 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/		
	1985	1986	1985	1986	1985	1986	1986 AS % OF 1985
	THOUSANDS		POUNDS		MILLION POUNDS		PERCENT
ALA	49	44	11,163	12,023	547	529	97
ALAS	1.6	2.2	13,875	14,318	22.2	31.5	142
ARIZ	86	86	15,674	15,907	1,348	1,368	101
ARK	80	68	10,600	11,103	848	755	89
CALIF	1,004	1,013	16,701	17,014	16,768	17,235	103
COLO	78	80	14,167	14,850	1,105	1,188	108
CONN	47	43	13,191	13,953	620	600	97
DEL	10.3	10.2	14,282	14,412	147.1	147.0	100
FLA	173	179	11,780	12,028	2,038	2,153	106
GA	117	109	11,111	11,560	1,300	1,260	97
HAW	11.3	11.5	12,566	13,565	142.0	156.0	110
IDAHO	170	166	14,241	14,422	2,421	2,394	99
ILL	227	221	11,987	12,674	2,721	2,801	103
IND	202	202	11,955	12,158	2,415	2,456	102
IOWA	352	335	11,528	11,579	4,058	3,879	96
KANS	113	111	11,372	11,721	1,285	1,301	101
KY	231	227	9,619	10,251	2,222	2,327	105
LA	96	93	9,490	9,538	911	887	97
MAINE	55	51	12,236	12,608	673	643	96
MD	123	124	13,211	13,226	1,625	1,640	101
MASS	47	43	12,660	13,047	595	561	94
MICH	394	379	14,132	14,259	5,568	5,404	97
MINN	915	891	11,847	11,912	10,840	10,614	98
MISS	87	82	10,069	10,195	876	836	95
MO	232	227	12,371	12,907	2,870	2,930	102
MONT	28	27	12,464	12,481	349	337	97
NEBR	109	108	12,294	12,500	1,340	1,350	101
NEV	18.8	19.0	14,149	14,421	266.0	274.0	103
N H	29	28	12,552	13,250	364	371	102
N J	38	36	12,816	13,389	487	482	99
N MEX	67	66	16,090	16,545	1,078	1,092	101
N Y	948	947	12,374	12,401	11,731	11,744	100
N C	128	121	13,656	14,008	1,748	1,695	97
N DAK	101	97	11,089	11,072	1,120	1,074	96
OHIO	388	383	12,552	12,888	4,870	4,936	101
OKLA	110	111	10,755	10,721	1,183	1,190	101
OREG	100	99	14,380	14,859	1,438	1,471	102
PA	740	734	13,491	13,831	9,983	10,152	102
R I	3.5	3.2	12,571	13,125	44.0	42.0	95
S C	48	47	12,167	12,021	584	565	97
S DAK	162	156	10,994	11,045	1,781	1,723	97
TENN	210	207	10,643	10,729	2,235	2,221	99
TEX	319	323	12,439	12,659	3,968	4,089	103
UTAH	83	79	13,675	14,620	1,135	1,155	102
VT	183	181	13,169	13,575	2,410	2,457	102
VA	164	155	12,817	13,523	2,102	2,096	100
WASH	222	212	16,892	17,745	3,750	3,762	100
W VA	34	33	11,235	11,364	382	375	98
WIS	1,876	1,862	13,166	13,534	24,700	25,200	102
WYO	11.6	10.8	11,552	12,130	134.0	131.0	98
U S 3/	11,016	10,839	12,994	13,293	143,147	144,080	101

1/ AVERAGE NUMBER DURING YEAR, EXCLUDING HEIFERS NOT YET FRESH.
2/ EXCLUDES MILK SUCKED BY CALVES.
3/ WILL NOT ADD DUE TO ROUNDING.

Source: Agricultural Statistics Board, NASS, USDA, Milk Production, February 1987, p. 5.

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 1986 in terms of milk cow numbers were:

Wisconsin	1,862,000
California	1,013,000
New York	947,000
Minnesota	891,000
Pennsylvania	734,000

These states had 50.3 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, 1986

State	Cow numbers	Percent of total
Wisconsin	1,862,000	17.2
California	1,013,000	9.3
New York	947,000	8.7
Minnesota	891,000	8.2
Pennsylvania	734,000	6.8
Ohio	383,000	3.5
Michigan	379,000	3.5
Iowa	335,000	3.1
Texas	323,000	3.0
Missouri	227,000	2.1
40 other states	3,745,000	34.6
United States	10,839,000	100.0

Source: Agricultural Statistics Board, NASS, USDA, Milk Production, February 1987.

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 a little more than half of the cows. The second group of five states 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 1986. 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, 1986

State	Milk cows	Milk production
	thousands	million pounds
Wisconsin	1,862	25,200
California	1,013	17,235
New York	947	11,744
Minnesota	891	10,614
Pennsylvania	734	10,152
Michigan	379	5,404
Ohio	383	4,936
Texas	323	4,089
Iowa	335	3,879
Missouri	227	2,930
40 other states	3,745	47,897
United States	10,839	144,080

Source: Agricultural Statistics Board, NASS, USDA, Milk Production, February 1987.

In Table 3, the positions of Michigan and Ohio and those for Texas and Iowa in the order of states are 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 at a level of 144 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 25.2 and 17.2, respectively or at the most 25.20 and 17.24. 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 is sufficient.

Table 4. DAIRY COWS, YIELDS, AND PRODUCTION
Leading States, 1986

State	Milk cows	Average production per cow	Total production
			billion pounds
Wisconsin	1,862,000	13,500	25.2
California	1,013,000	17,000	17.2
New York	947,000	12,400	11.7
Minnesota	891,000	11,900	10.6
Pennsylvania	734,000	13,800	10.2
Michigan	379,000	14,300	5.4
Ohio	383,000	12,900	4.9
Iowa	323,000	12,700	4.1
Texas	335,000	11,600	3.9
Missouri	227,000	12,900	2.9
40 other states	3,745,000	12,800	47.9
United States	10,839,000	13,300	144.1

Source: Agricultural Statistics Board, NASS, USDA, Milk Production, February 1980.

One final table has been constructed from the original data on page 4. All three characteristics for the ten 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.

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 may be turned off by the resulting complexity. 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 from where the basic materials were taken 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. NUMBER OF FARMS BY VALUE OF PRODUCTS SOLD New York, 1982 — TITLE

Value of agricultural products sold (STUBS)	Number of farms	Total value of sales (millions) (BODY)
Less than $2,500	10,479	$ 9.5
$ 2,500 - 4,999	4,421	15.7
5,000 - 9,999	4,339	30.7
10,000 - 19,999	3,563	50.3
20,000 - 29,999	2,041	50.2
30,000 - 39,999	1,655	57.6
40,000 - 59,999	3,148	156.4
60,000 - 79,999	2,779	193.3
80,000 - 99,999	2,386	213.6
100,000 - 199,999	4,991	682.6
200,000 - 499,999	1,975	567.9
$500,000 or more	398	391.7
Abnormal farms*	32	7.4
Total	42,207	$2,426.9

CAPTIONS

*Farms operated by public institutions or government bodies. — FOOTNOTE

Source: U.S. Bureau of the Census, Census of Agriculture. — SOURCE NOTE

Table Construction

The first and most important task in making a table is to decide what it is the reader should learn from 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 does not 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 to 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 authors 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 uses 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 USDA 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 four lines when two 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 $48,000 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 revised 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 columns 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:

Yield of tomatoes per acre		
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 for reference.

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. Short 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 8½ x 11 inch 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 in a report are not designed to present the details of an original data set. In most cases, two to 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 are computed. Some argue that if the total is of primary concern, it should be presented first and the data from which it is computed, presented later. Most people expect a total or average after they see the numbers from which it is 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 (1) obtained from a different source, (2) calculated in a different manner, or (3) estimated, attention should be drawn to this fact by using parentheses or a footnote. Parentheses around a number imply some kind of calculation or forecast. Standard errors or t-ratios are frequently presented using parentheses directly below a coefficient as well.

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" should be in full capitals or underlined and 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 as phrases or short statements.

2. Designation -- Letters or asterisks rather than numbers should be used to designate footnotes. 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.

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 the 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 $\sum_t (Ap_t - Ar_t)/(1 + p)^t$.

[b] The accounting model is $\sum_t G_t/(1 + p)^t$.

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	669,850	553,310
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 within 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.

Example 2
(Format, Position on Page)

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*

	1940	1950	1959	1969	1974
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.

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
	number of farms				
Herd size:					
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
	percent of total farms				
Herd size:					
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 numerical data. 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						
	1-74	75-149	150-299	300-499	≥ 500	None or no response	Total
	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				
	Single operator	Partnership	Family corporation	Manager	Total
	number of farms				
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	14	1	0	0	15
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 occur on farms with larger crop acreages. 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, Volume 1, No. 1, January 1979, p. 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	Solutions			
	Benchmark No EPI*	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
	optimal solutions			
Crops, acres*				
Corn-soybeans				67
Continuous corn	570	357		
Corn-corn-soybeans			403	
Livestock				
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
Other results				
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 are 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.

If energy price increases are the central variable considered 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 understanding 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

[a]Records 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.

[b]There 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
	net rent per tillable acre					
Grain farms						
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
Livestock farms						
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 a good table. Readers can make comparisons easily and quickly.

There are two reasons for suggesting 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

ndependent Variable	Dependent Variables											
	Attendance per 1000 population						Deflated Pari-mutuel handle					
	Mile		Fair[b]		Harness		Mile		Fair		Harness	
	Coef.	S.E.[a]	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ays	2.96	.71	*	*	*	*	*	*	*	*	*	*
ime trend	-14.32	3.13	-2.69	.32	-29.03	6.12	-1.79	.45	.18	.04	.06	.04
					.65[c]	.16						
ack closing	-45.04	26.23	*	*	-20.32	9.02	*	*	*	*	*	*
tendance	*	*	*	*			133.61	13.70	81.19	8.78	36.62	3.49
ntercept	296.90		155.80		406.04		-23.40		-6.70		5.95	
2	.56		.75		.79		.89		.86		.95	
	9.47		34.79		10.35		87.98		73.71		123.50	
f.	22		24		10		23		23		12	

[a]S.E. = Standard error of regression coefficient

[b]Coefficients for days and track closings were not significant (at 95% level) in a second model

*Variable not included in model

[c]A 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
Effect on attendance per 1,000 population of:			
Days raced annually	2.96		
	(0.71)		
Time trend	-14.32	-2.69	29.03
	(3.13)	(0.32)	(6.12)
Quadratic time trend			0.65
			(0.16)
Track closing	-45.04		-20.32
	(26.23)		(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
Effect on deflated pari-mutuel handle of:			
Time trend	-1.79	0.18	0.06
	(0.45)	(0.04)	(0.04)
Attendance	133.6	81.2	36.6
	(13.7)	(8.78)	(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, horseracing, 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 separately, 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). In most cases, two or three significant digits are probably adequate. Presenting significant results 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 might 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 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 a basic relationship or make a comparison. 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 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 create reader interest. But they are not required. Emphasis here is 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. If a data source is not provided, you imply that you collected the original data. 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 exception of newspapers and news magazines, charts should be numbered. The numbers help in making references and discussing central points 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 the data source 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.

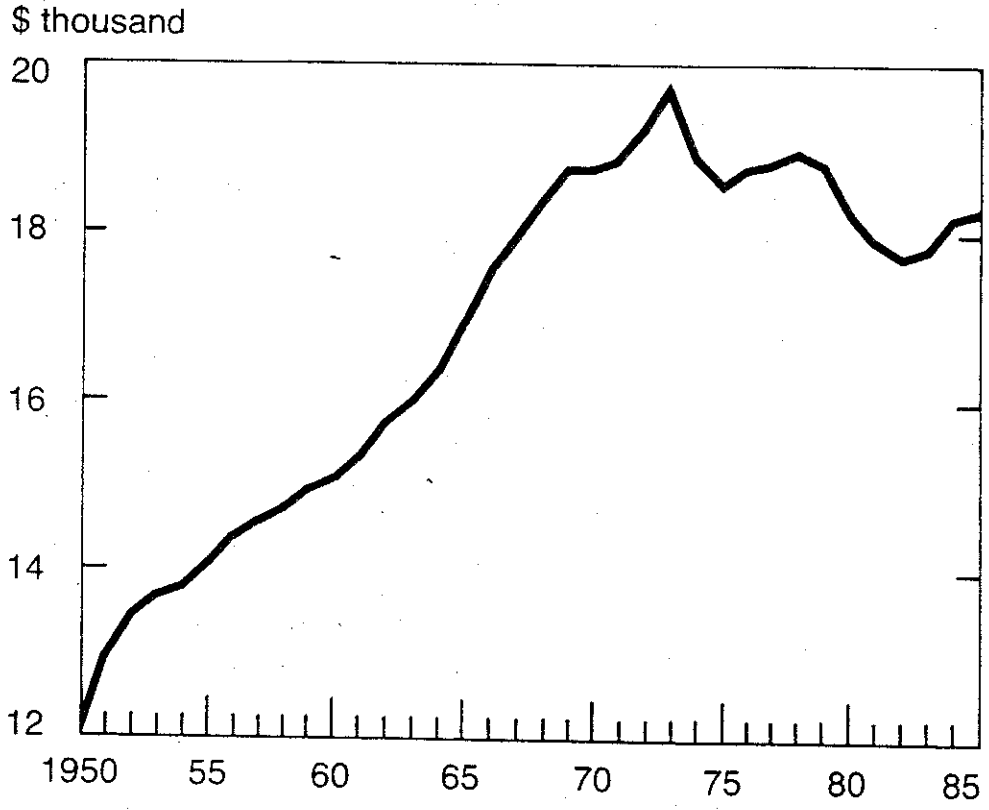
GRAPHS

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 168

Real Wage and Salary Income per Civilian Employee



Sources: Bureau of Economic Analysis and Bureau of Labor Statistics.

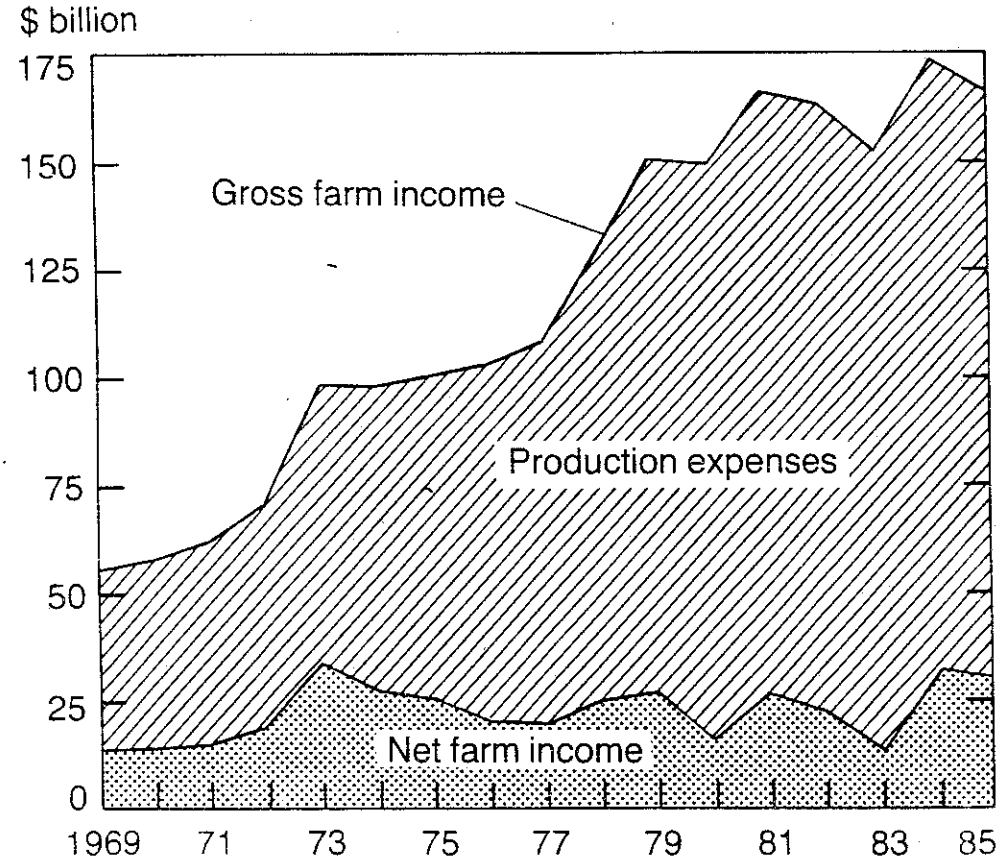
Comment

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 annual data were used and obtained from two U.S. government agencies. The central point is clear. Real wage and salary income per employee in the U.S. increased steadily from 1950 to 1973. Since that time it has declined in more years than it has increased. The vertical scale is clearly identified. The line uses much of the available space drawing attention to the annual changes from the earlier trend.

Example 2
(Two or More Lines)

Chart 10

Net Farm income



Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 8.

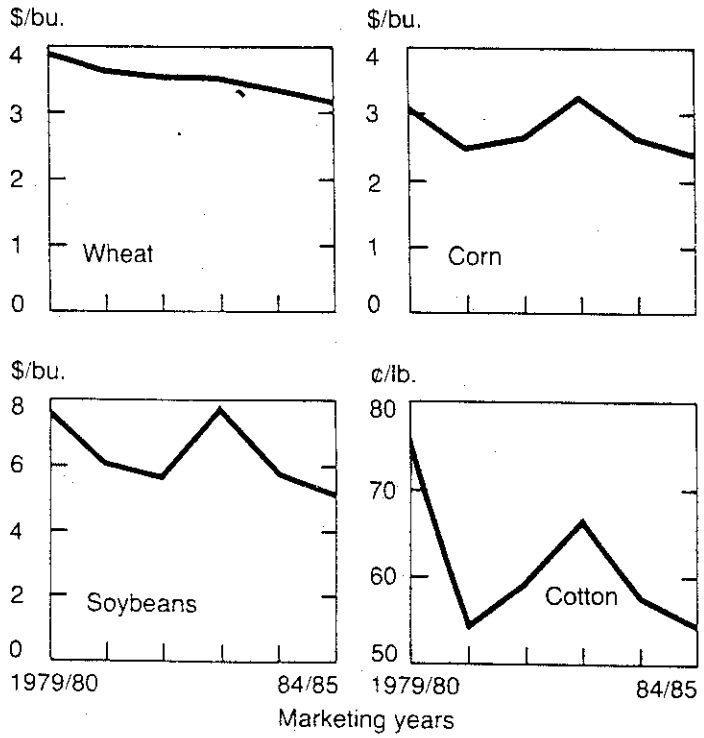
Comment

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 increases in gross farm income in the United States and its two components: production expenses and net farm income. A square chart where the horizontal space is roughly equal to the vertical space has many advantages. The two different areas of shading help to make the relationships clear.

Example 3
(A Set of Related Single Line Charts)

Chart 38

Prices Received by Farmers for Major Commodities

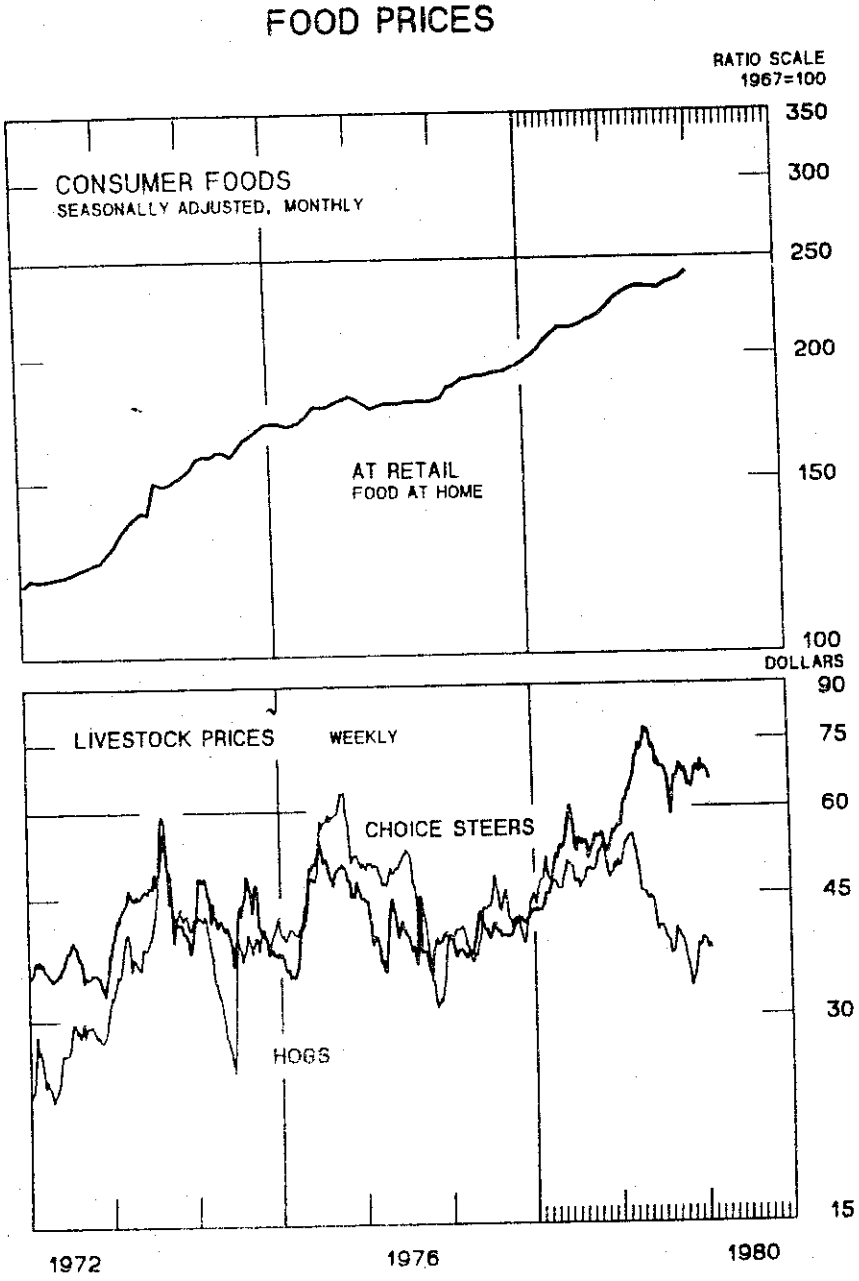


Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 16.

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)



Source: 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

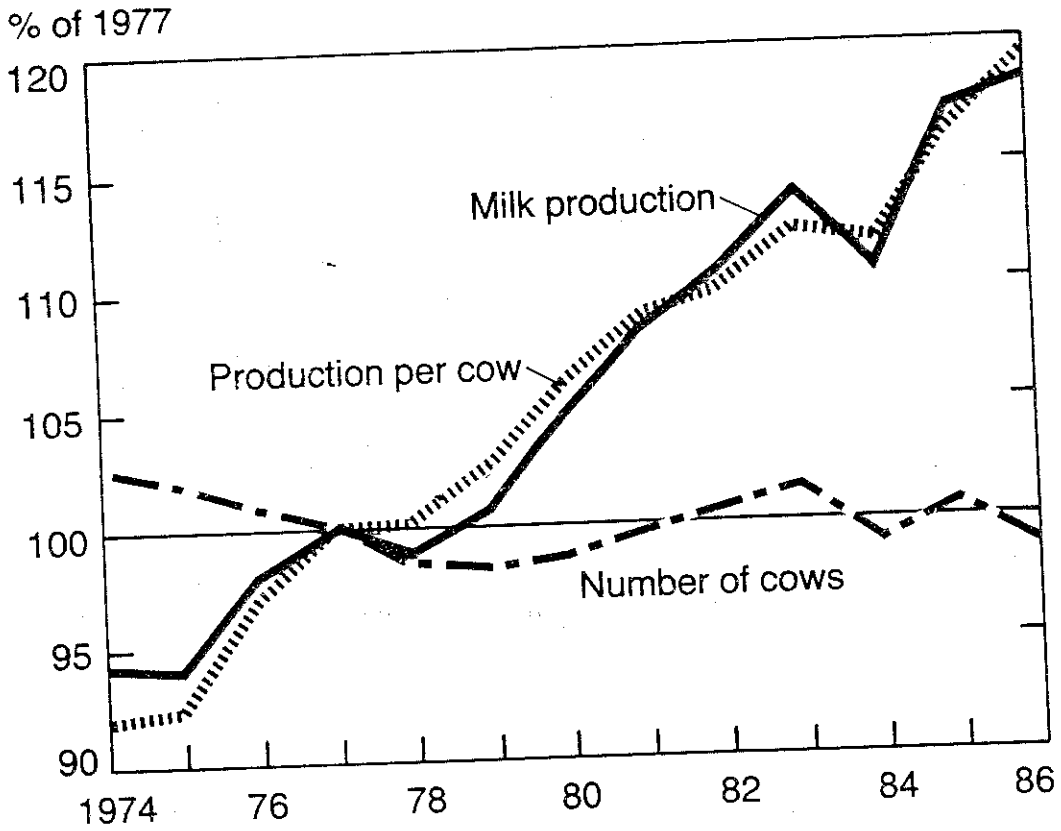
widely used by economists and engineers. Care must be taken to call attention to the vertical scale. The procedure used in the Federal Reserve Chart Book is generally good. The kinds of data used for the charts are prominently identified within the charts. The ratio scale is marked on the right hand 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 231

Milk Production, Number of Cows, and Milk per Cow



1986 forecast.

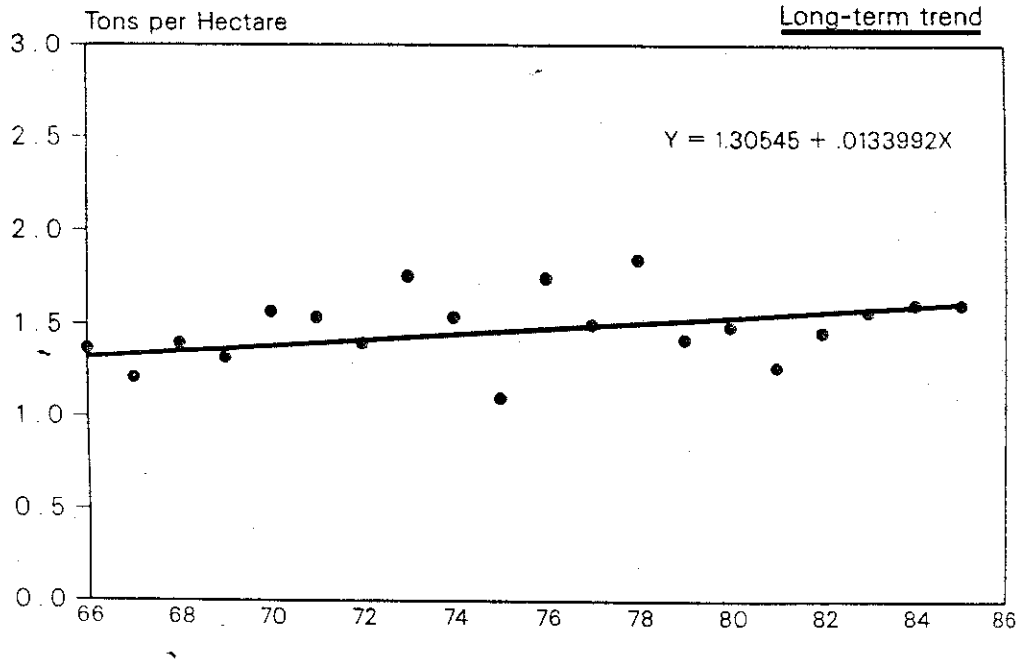
Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 97.

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. The number of cows has remained remarkably stable while production per cow and total output have increased together.

Example 6
(Scatter Diagram)

Figure 28. Trend in Soviet Grain Yields in Metric Tons per Hectare, 1965-86.



Source: U.S. Department of Agriculture, Foreign Agricultural Service, *Foreign Agriculture Circular, Grains* (Washington, D.C.), FG 25-76, October 7, 1976; FG 4-83, February 15, 1983; FG 7-85, May 1985; SG 5-86, May 1986.

Source: World Food Institute, World Food Trade and U.S. Agriculture, 1960-1985, p. 28.

Comment:

One of the most effective ways to analyze cross section or time series data for relationships is with the aid of 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.

A rectangular or nearly square chart is preferred. Scales on both the right and left hand side of the diagram are helpful. The units of measurement should be clearly indicated as was the case here. The title explains the relationship studied. In this case, the individual observations are of more interest than the line of average relationship.

Example 7
(Relationship Comparisons)

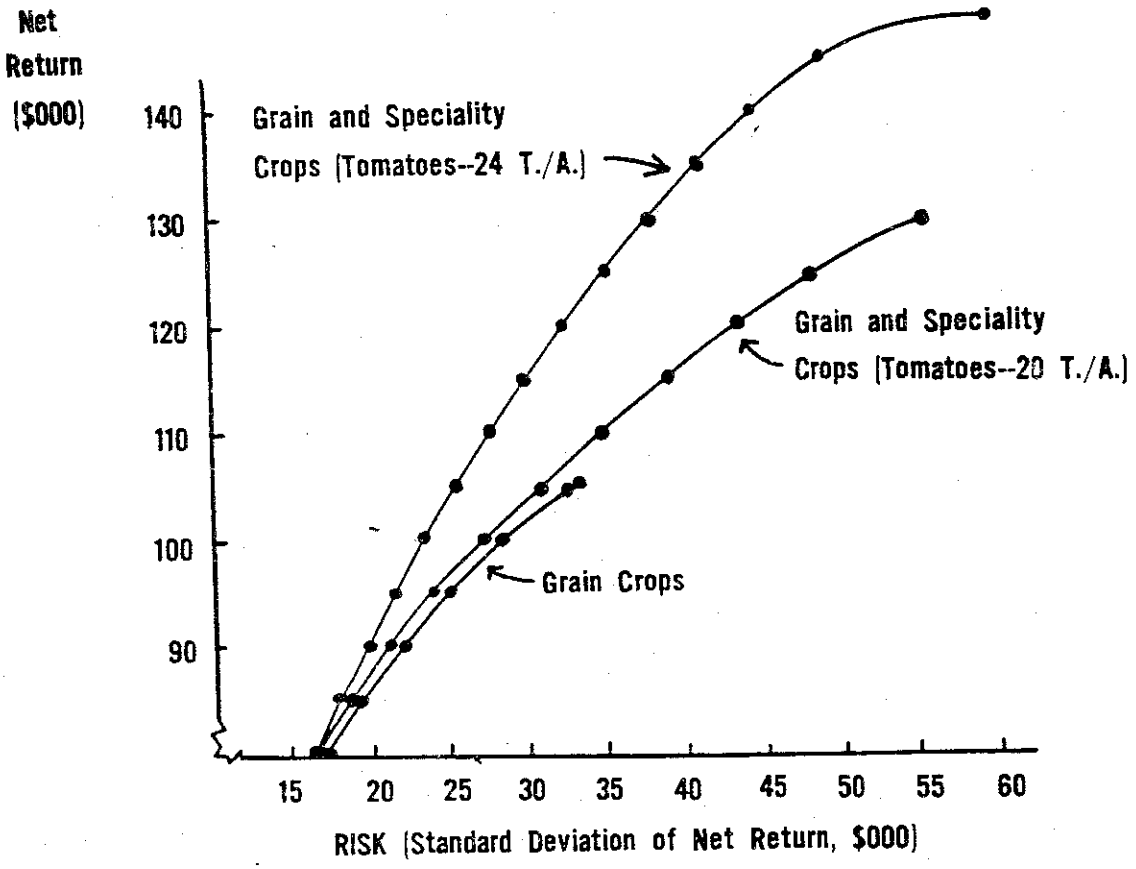


Figure 1. Efficiency Frontiers

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

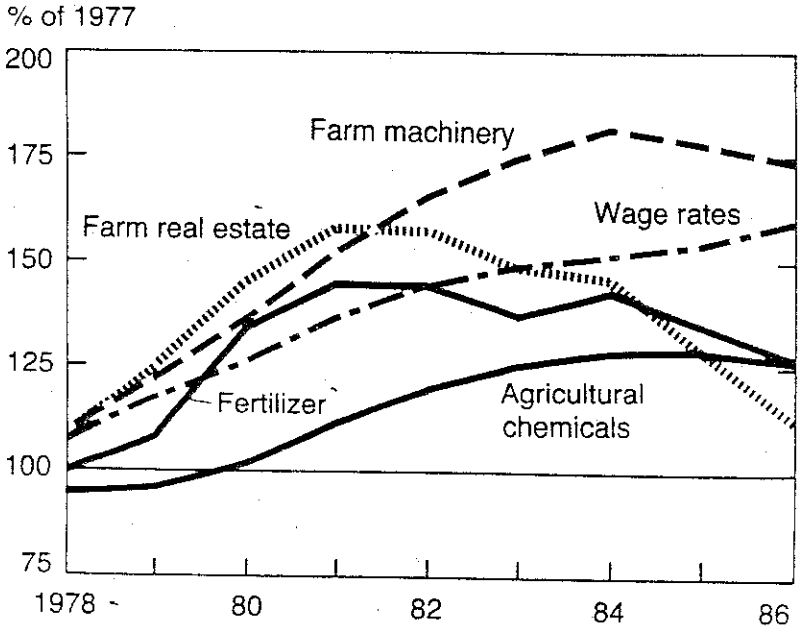
Comment

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 41

Prices of Selected Farm Inputs



1985 preliminary, 1986 projected. Farm machinery includes tractors and self-propelled machinery.

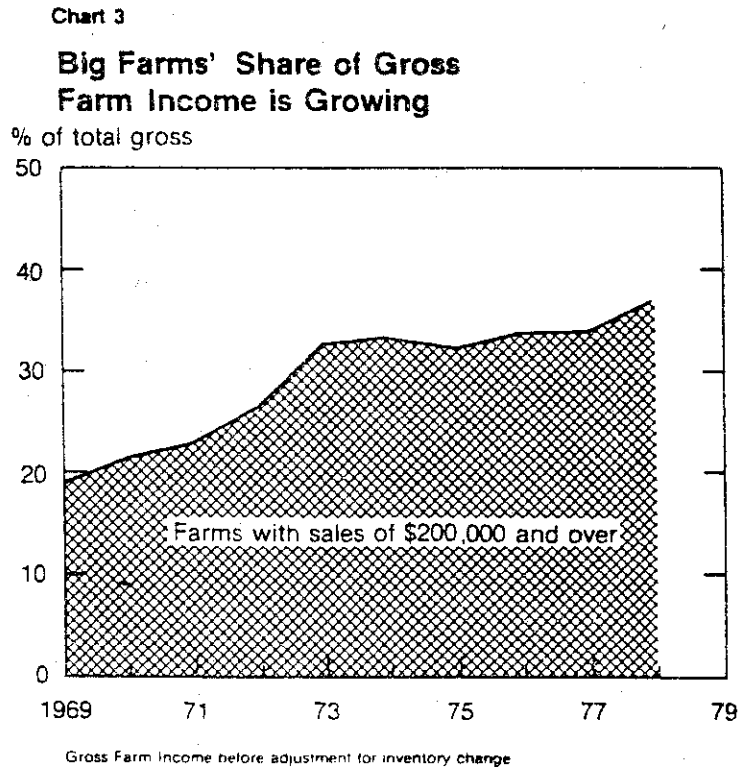
Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 17.

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 five lines on one chart, care should be taken to make the lines different enough so they can be identified.

In Chart 41, there is the added problem of using percentages which are mostly 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. Whenever possible, it is helpful to chart percentages within a range between 50 and 200.

Example 9
(Prices, Percentages, and Improper Comparisons)



Source: 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. When prices are changing rapidly, aggregates should be put on a 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)

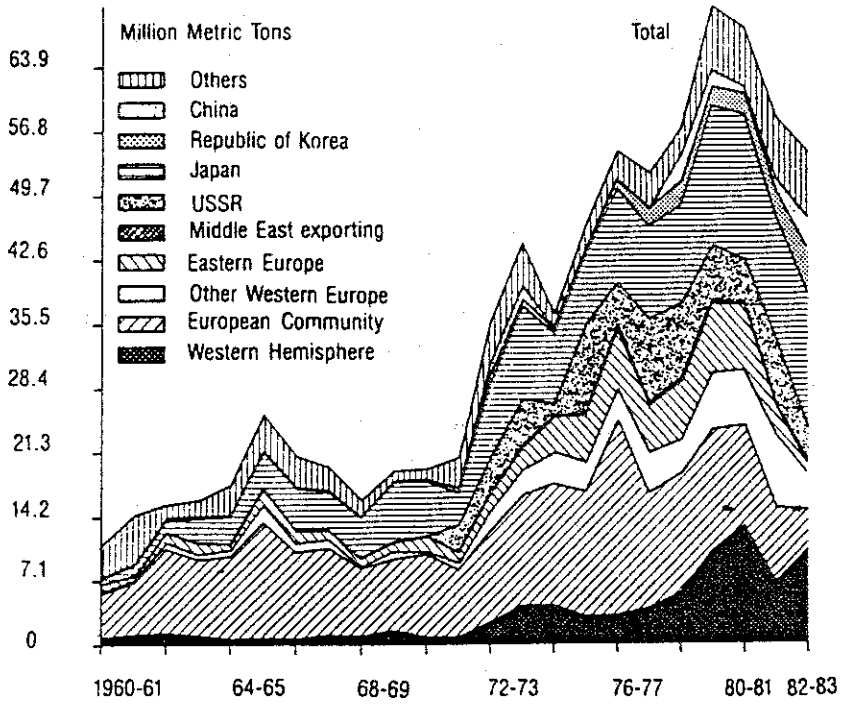


Figure 16. U.S. Coarse Grain Exports by Destination, October-September, 1960-61 to 1982-83.
Note: 1982-83 exports are projected using the October 1982-March 1983 percentage change from a year earlier.
Sources: U.S. Department of Agriculture, Agricultural Marketing Service, *Grain and Feed Market News* (Independence, Missouri), various issues and *Grain Market News* (Independence, Missouri), various issues.

Source: World Food Institute, World Food Trade and U.S. Agriculture, 1960-83.

Comment

This chart was probably prepared with the assistance of one of the software packages now available to convert data from spread sheets into graphs or charts. The computer effectively made a diagram that had equal horizontal and vertical distance, which is commendable. But the decisions about the scales on the left were a disaster. One can guess that the scale consists of ten equal units based on the largest value divided by ten. If one does not make conscious decisions about the scales wanted, the software package will do it for you with this kind of result.

This is also a good illustration of too many lines on one chart. It is almost impossible to know where the proportions are increasing and decreasing when there are ten divisions to consider. A maximum of four lines is the usual rule of thumb. One would have to work hard to see that Japan was the largest buyer in 1982-83. This is an example of the need for scales on the right hand side of the diagram where reader interest is highest, not on the left. Make the software package work to present what you want to show, not the converse.

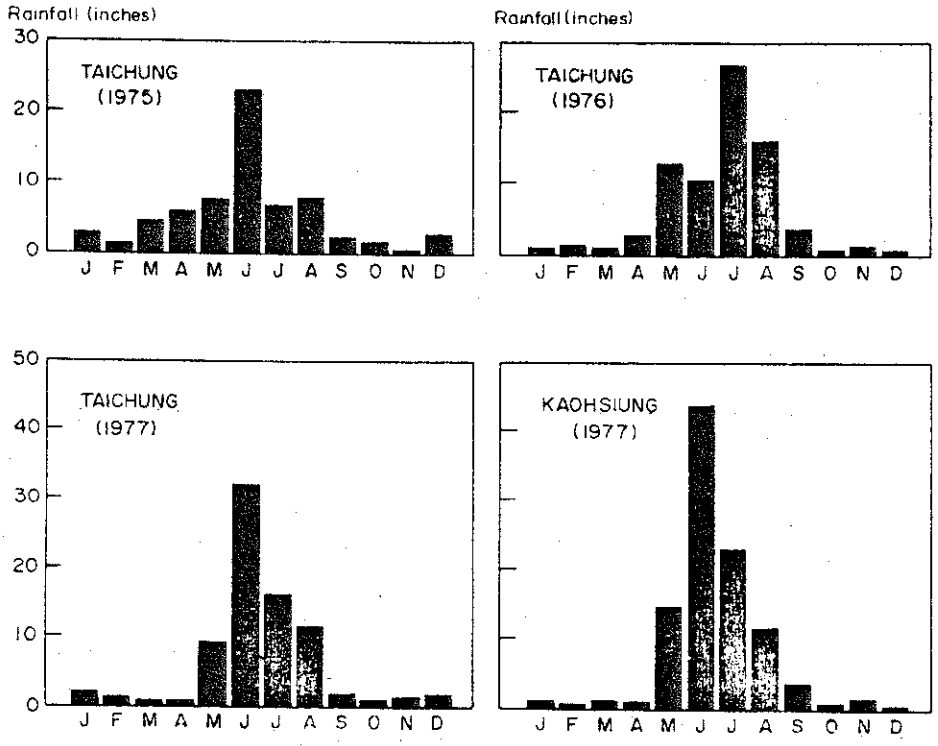
BAR CHARTS

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 using the programs provided in most spread sheets available for use in personal computers.

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 as nearly square as possible.
5. A clear title and chart number is just as important for a bar chart as for a table.
6. Provide the actual numbers or values either at the end of each bar or inside the bar itself.

Example 1
(Frequency Distributions)



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

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

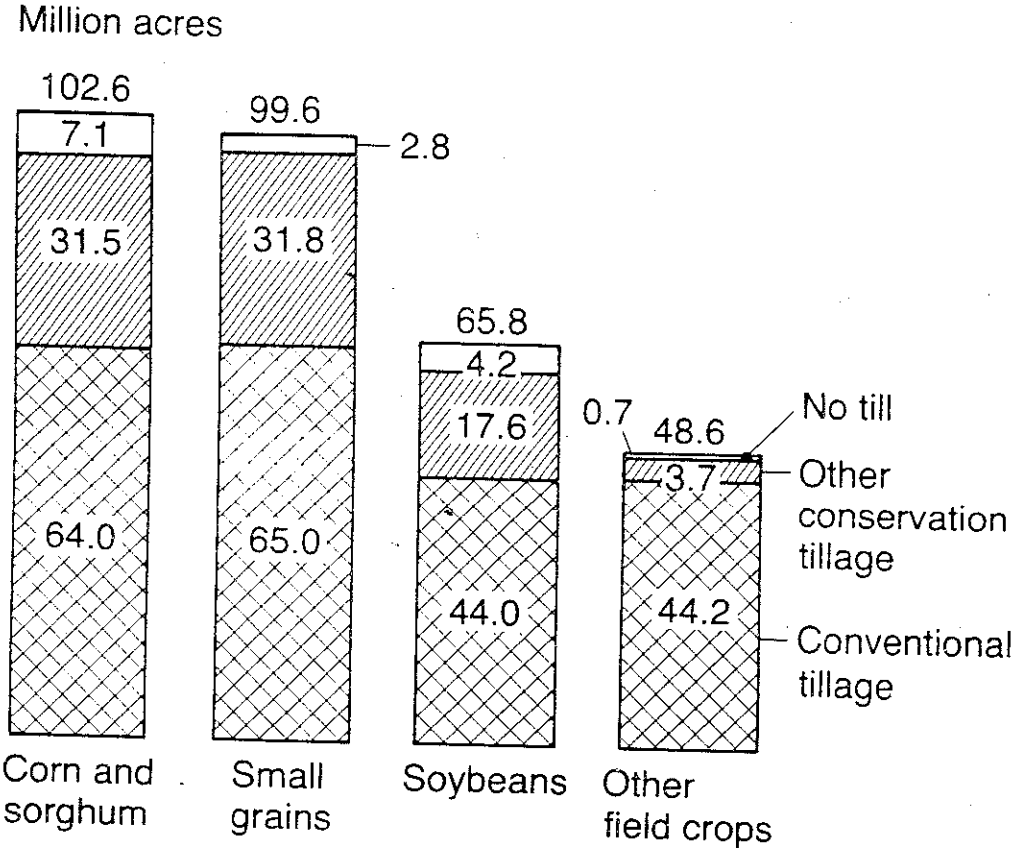
Comment

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

Example 2
(Components of a Total)

Chart 76

Tillage Methods Used on Major Crops



1985 data. Source: Conservation Tillage Information Center.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 30.

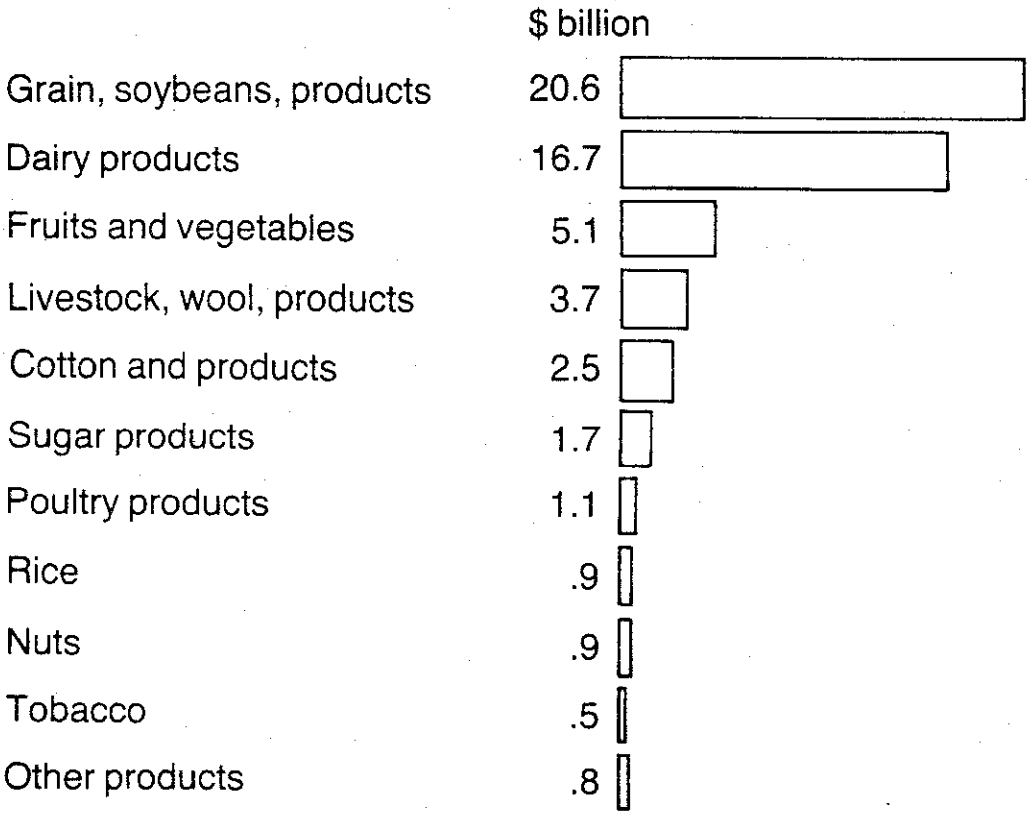
Comment

Tillage methods for each crop 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. The proportions or the actual values are indicated for each of the sections within the individual bars. The chart would appear more finished if it had a border around it. It does present important information in an attractive and easy to read manner.

Example 3
(Comparisons Without Scales)

Chart 91

Farm Products Marketed by Farmer Cooperatives



1984 data. Total net marketing business = $54.6 billion. Total may not add due to rounding. Other products include dry beans and peas.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 34.

Comment

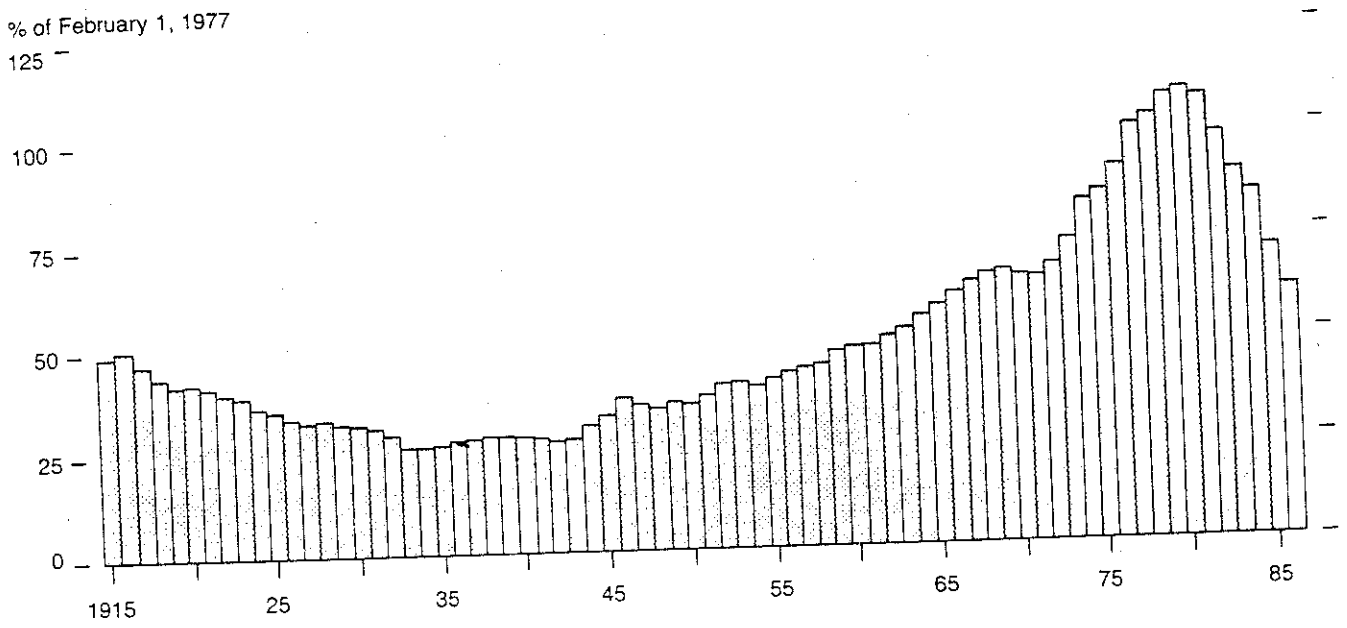
All of the basic data can sometimes be presented in a bar chart if the classifications used are relatively simple. This chart tells the relative importance of different farm products marketed by farmer cooperatives in 1984. Some additional information about the data are presented on the same page below data and the bars. The year involved could have been included in the title. It is very much like a simple table.

It is useful to put actual numbers inside a bar or close to it as has been done in this case. This kind of chart can be surrounded by text or explanation and be a natural part of a page, providing a change of pace for interested readers.

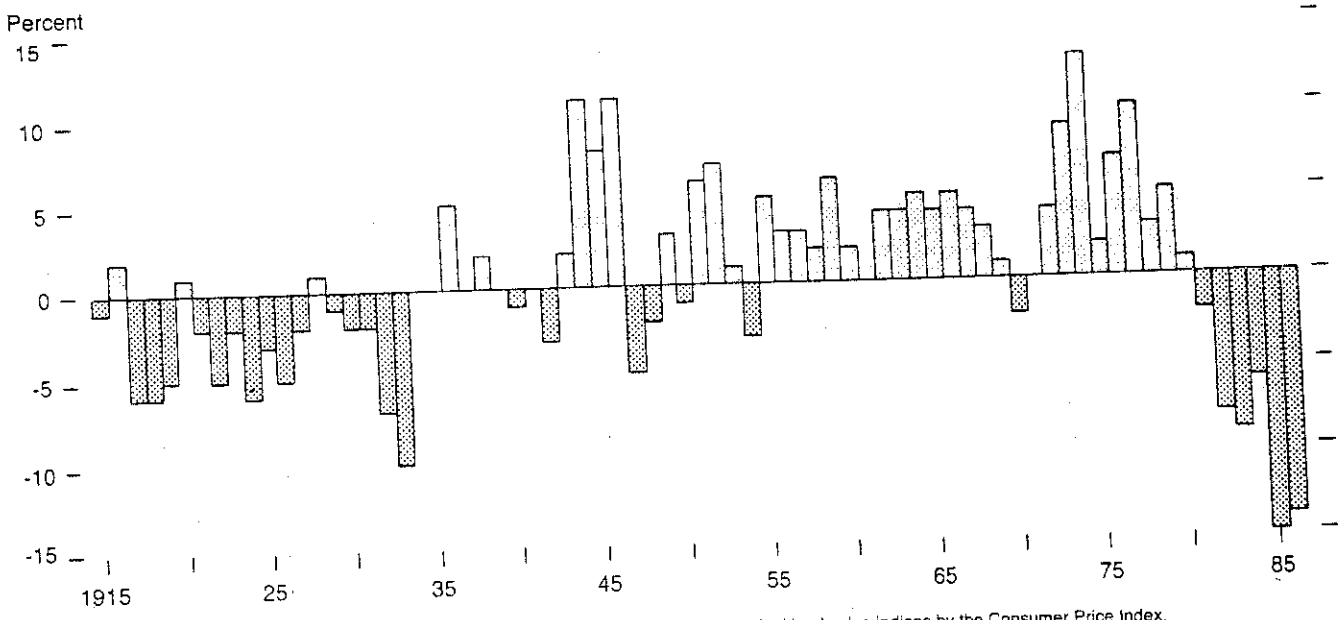
Example 4
(Percentage Changes Over Time)

Chart 56

Index of Real Value per Acre of U.S. Farmland



Change in Real Value per Acre from Previous Year



Excludes Alaska and Hawaii. The indices of real farmland value computed by dividing the nominal land value indices by the Consumer Price Index.

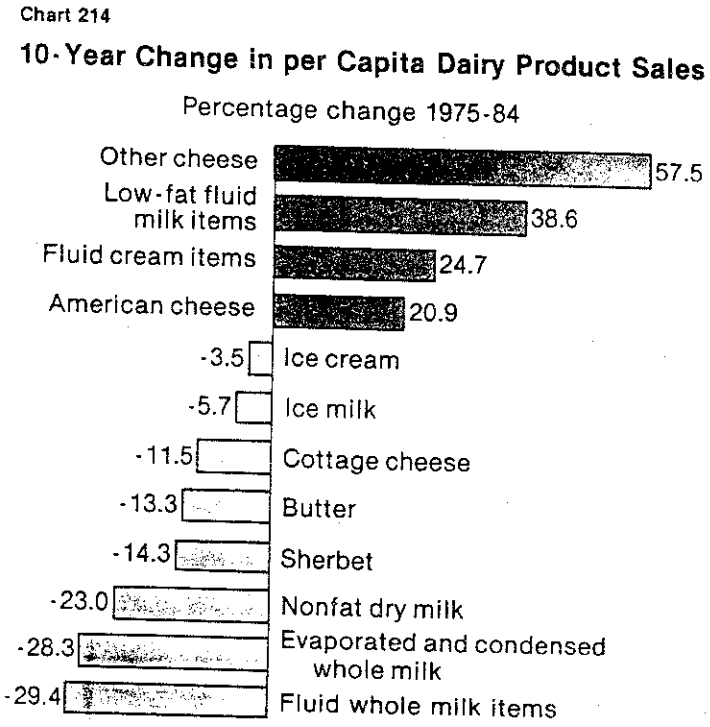
Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 24.

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 1915 to 1985, it is difficult to get perspective on relative changes. The combination of actual index numbers on a 1977 base and then the individual percentage changes from the previous year is most effective. This helps to remove most of the interpretation problem inherent in index numbers and percentages. This particular USDA chart is quite ingenious and helps one see both the general trend and puts yearly changes into perspective. It combines a great deal of historical information in a relatively small space and makes some major points readily visible, especially the changes in the most recent years..

Example 5
(Positive and Negative Changes)



Source: USDA, 1985 Agricultural Chartbook, No. 652, p. 74.

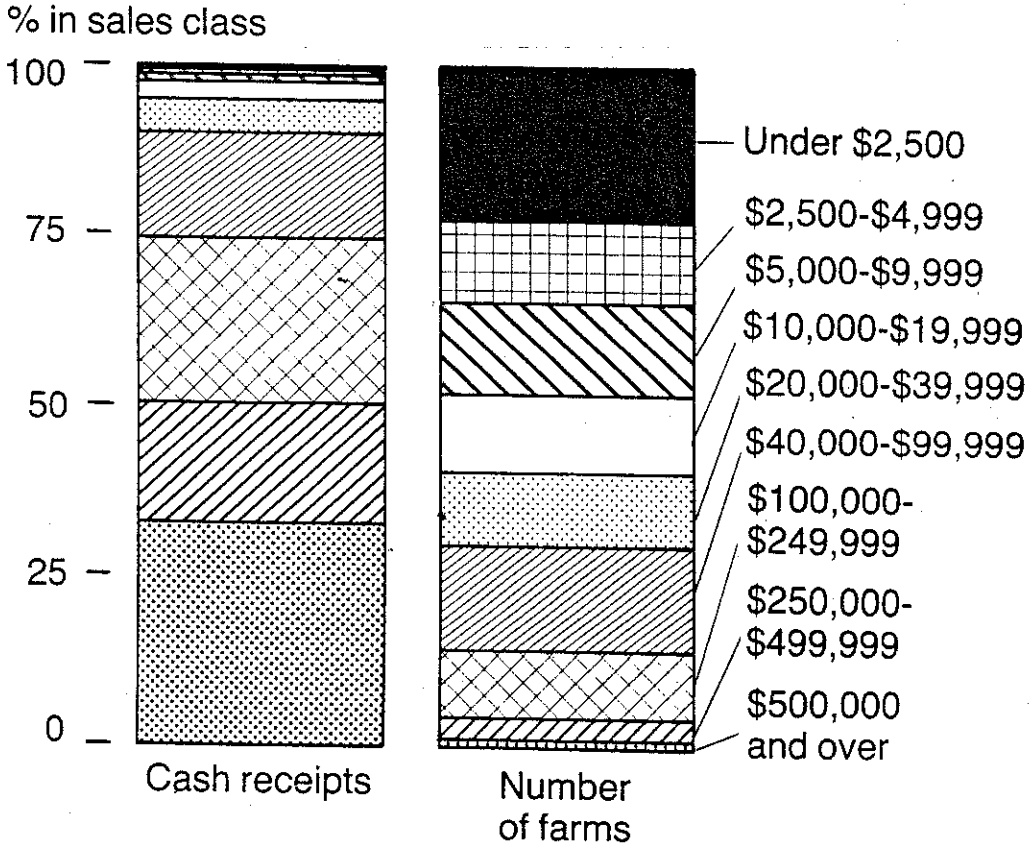
Comment

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 18

Cash Receipts and Farms by Sales Class



1984 data. Cash receipts from farm marketings including net CCC loans.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 10.

Comment

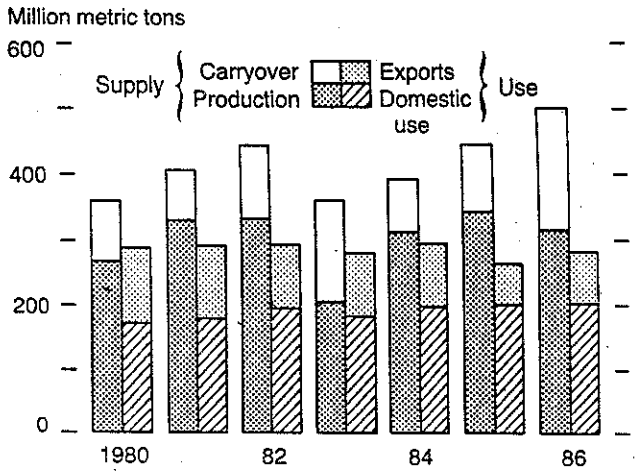
Most USDA charts are of a very high standard, easy to understand and worthy of commendation. But a few try to tell a combination of things simultaneously and can be confusing. In combination with the basic data and some text, it is easier to understand this chart but there remain some problems. There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

A vertical bar divided into fewer parts using percent of total is an effective device. The left hand bar, cash receipts, is a traditional presentation. But the effort to divide the small farms into five classes makes it difficult to see the cross comparisons. This is one case where a simple table would have been more effective than the bar chart.

Example 7
(Is the Bar Chart Inappropriate?)

Chart 201

Total Grain Supply and Use



1985 preliminary; 1986 projected. Supply includes imports. Year beginning September 1 for corn and sorghum; June 1 for oats, barley, wheat, and rye; and August 1 for rice.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 105.

Comment

Bar charts should help a reader get perspective on the relative size of different things. Sometimes bar charts are more confusing than a table with numbers. The one prepared for total grain supply and use 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 grain each year. If numbers had been included, it might have helped to explain total supply and total use.

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. Sometimes a table will tell the story you wish to make most effectively.

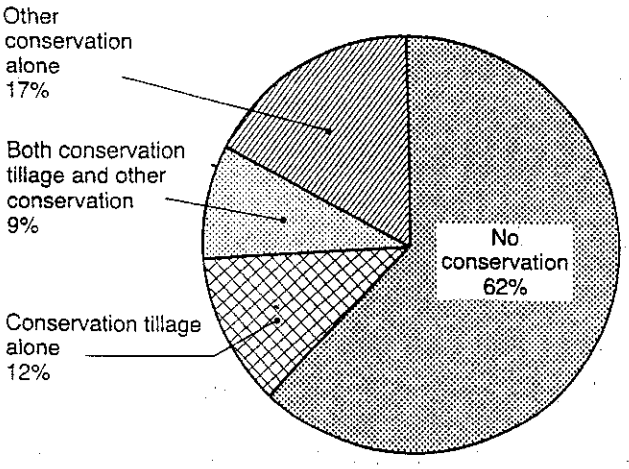
PIE CHARTS

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 Pieces)

Chart 74

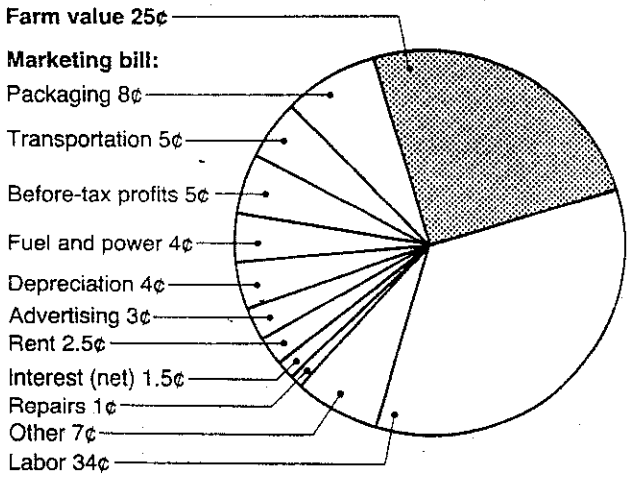
Percentage of Farms Practicing Soil Conservation



1983 data. Includes only farms with cropland. Source: Farm Production Expenditure Survey.

Chart 147

What a Dollar Spent on Food Paid for in 1985



1985 preliminary. Other costs include property taxes and insurance, accounting and professional services, promotion, bad debts, and miscellaneous items.

Source: USDA, 1986 Agricultural Chartbook, No. 663, pp. 29 and 54.

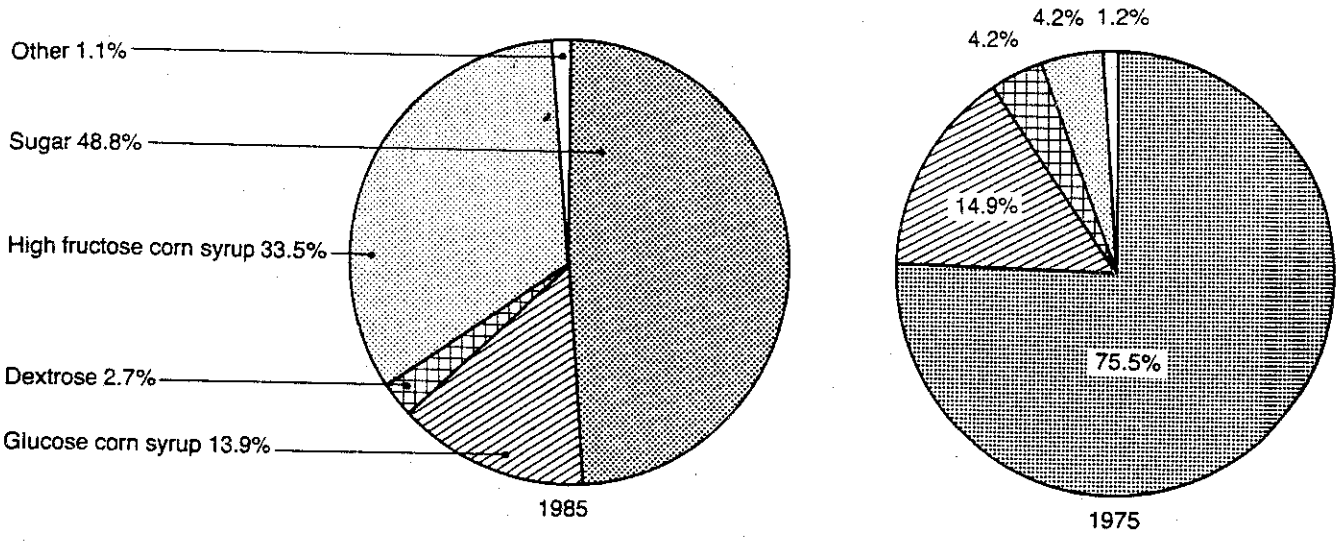
Comment

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 four divisions is the easier one to read and construct. The one on the right has 12 pieces and has almost become a table because some of the pieces are so small. Slicing up a dollar bill would be another approach to presenting the same material.

Example 2
(Comparisons Over Time)

Chart 294

Per Capita Consumption of Caloric Sweeteners



Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 114.

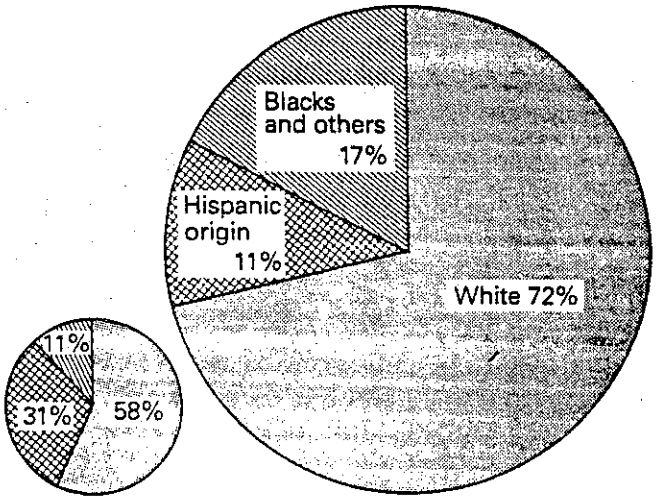
Comment

Two circles of the same size divided into five pieces shows change over a ten year span effectively. This chart is easy to understand and easy to remember. The five categories are clearly identified with percentages in the more recent year. Commonly, the most recent year is placed on the right, not the left.

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.

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

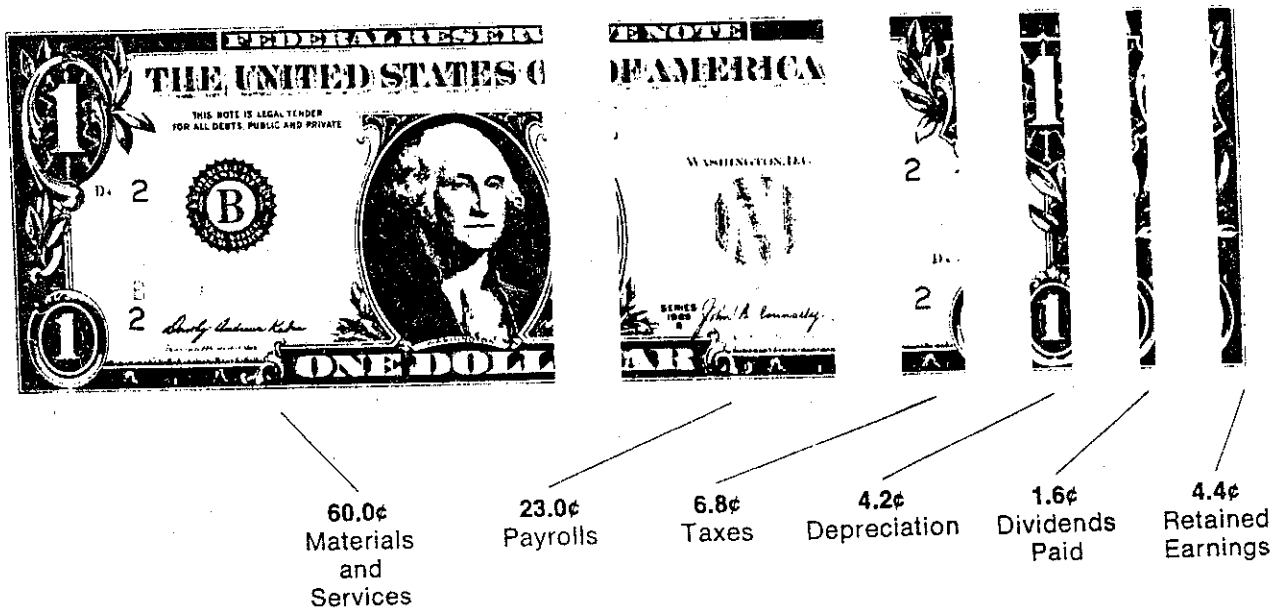
Comment

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



Source: 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

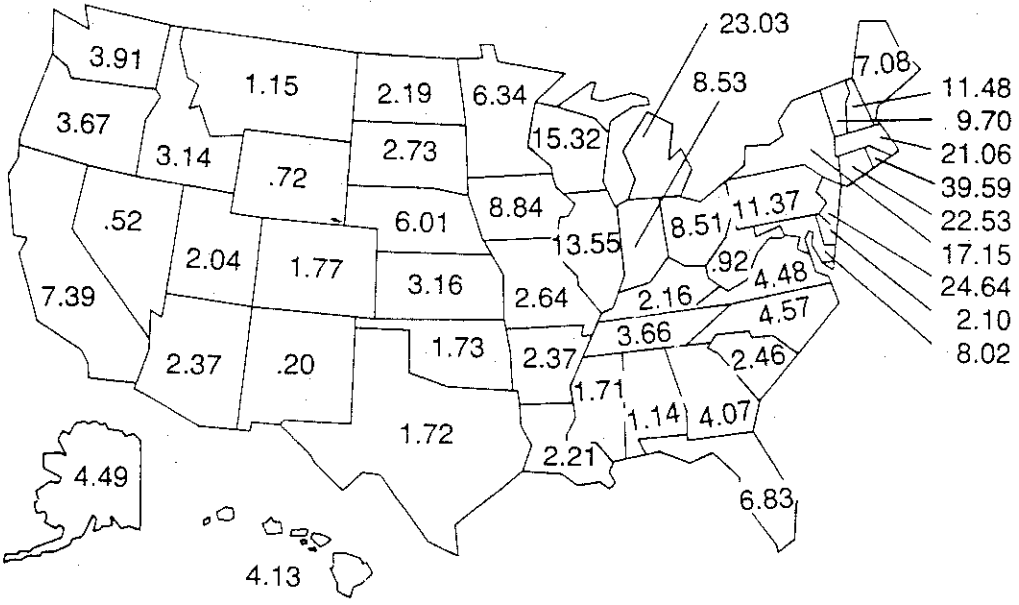
One of the most effective ways of showing information on a geographical basis is to use an outline map. This requires access to maps and materials to shade or insert numbers. A map can convey many things at a glance which is almost impossible in a table. Two excellent examples from the USDA point out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

Example 1
(Numerical Data)

Chart 35

Farm Real Estate Taxes per Acre

Dollars



Average, 50 States: $4.32

1983 revised.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 15.

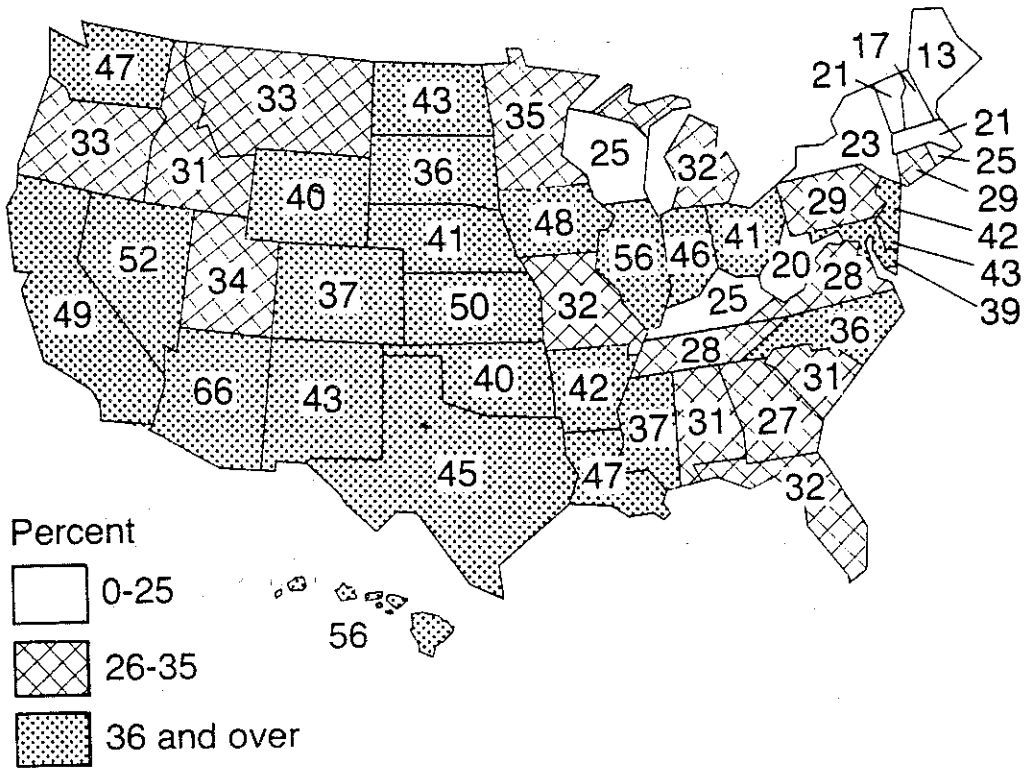
Comment

This map provides a picture of average real estate taxes for each of the states in 1983. 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 map. 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)

Chart 59

Percentage of Farmland Leased from Others



1982 data.

Source: USDA, 1986 Agricultural Chartbook, No. 663, p. 25.

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. There are three categories of percentages. The states with 25 percent or less of farmland leased are unshaded. Those with 36 percent or more have the darkest coloring. The actual percentages are included in each case. Trying to shade with more than four different categories becomes difficult. In most cases, four is the maximum number one can see easily.

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.

Example 1
(A Simple Flow Diagram)

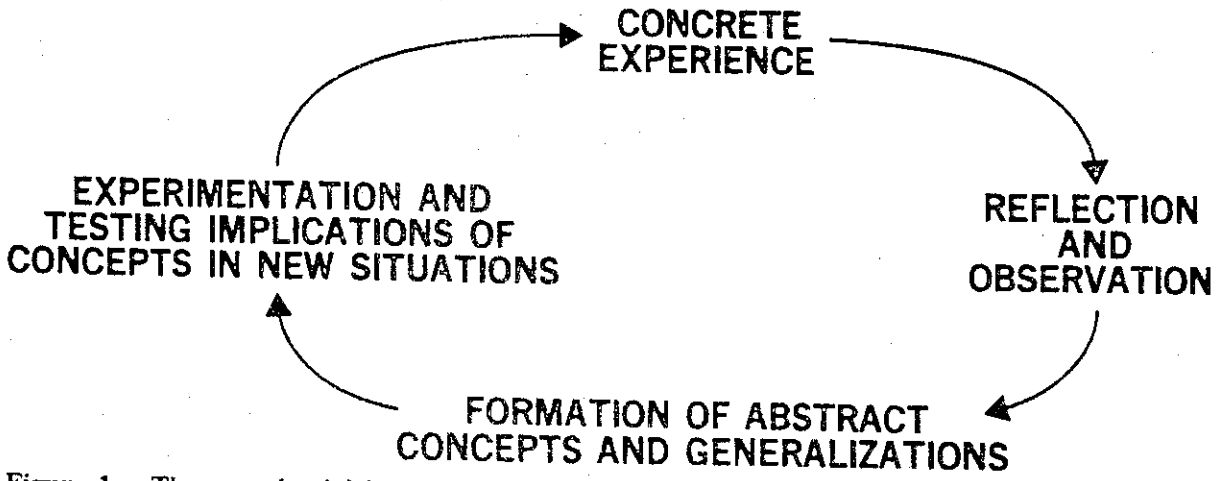


Figure 1. The experiential learning model

Source: 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 emulate this style and clarity of presentation.

Example 2
(A Complex Flow Diagram)

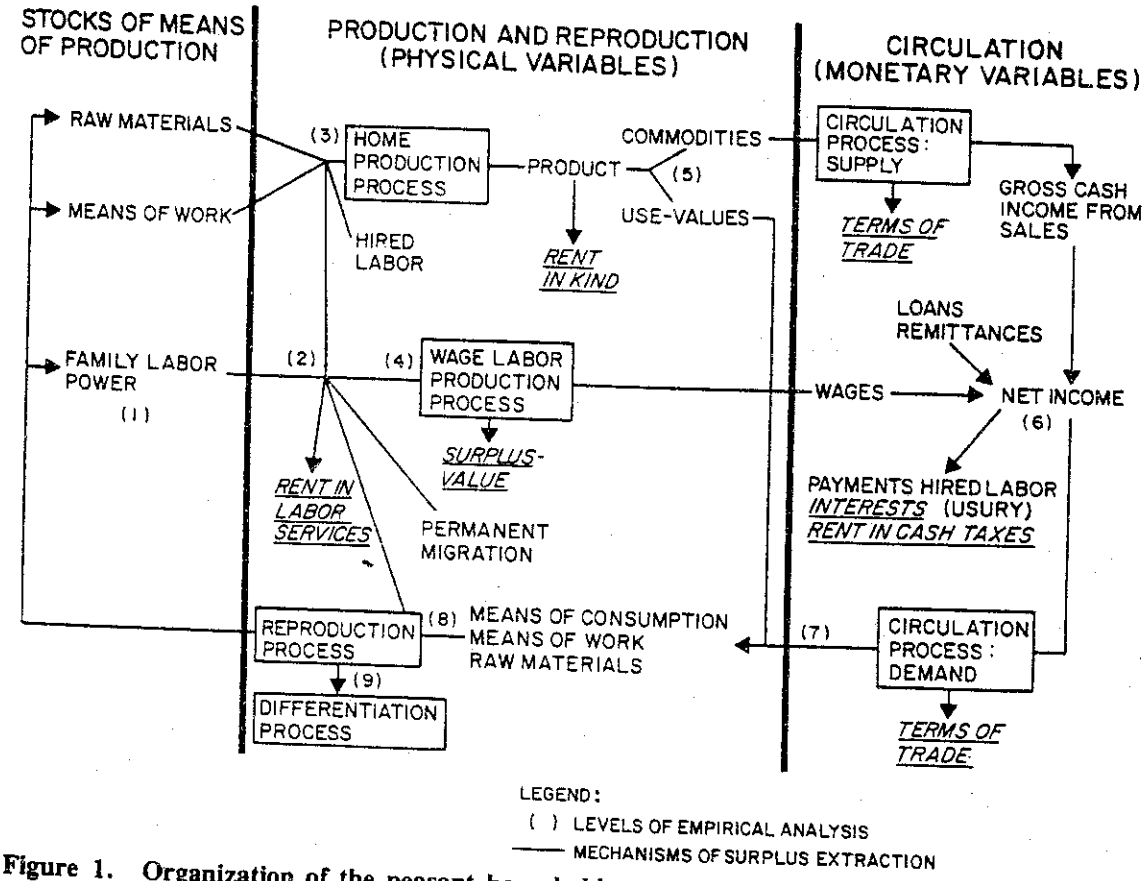


Figure 1. Organization of the peasant household

Source: 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)

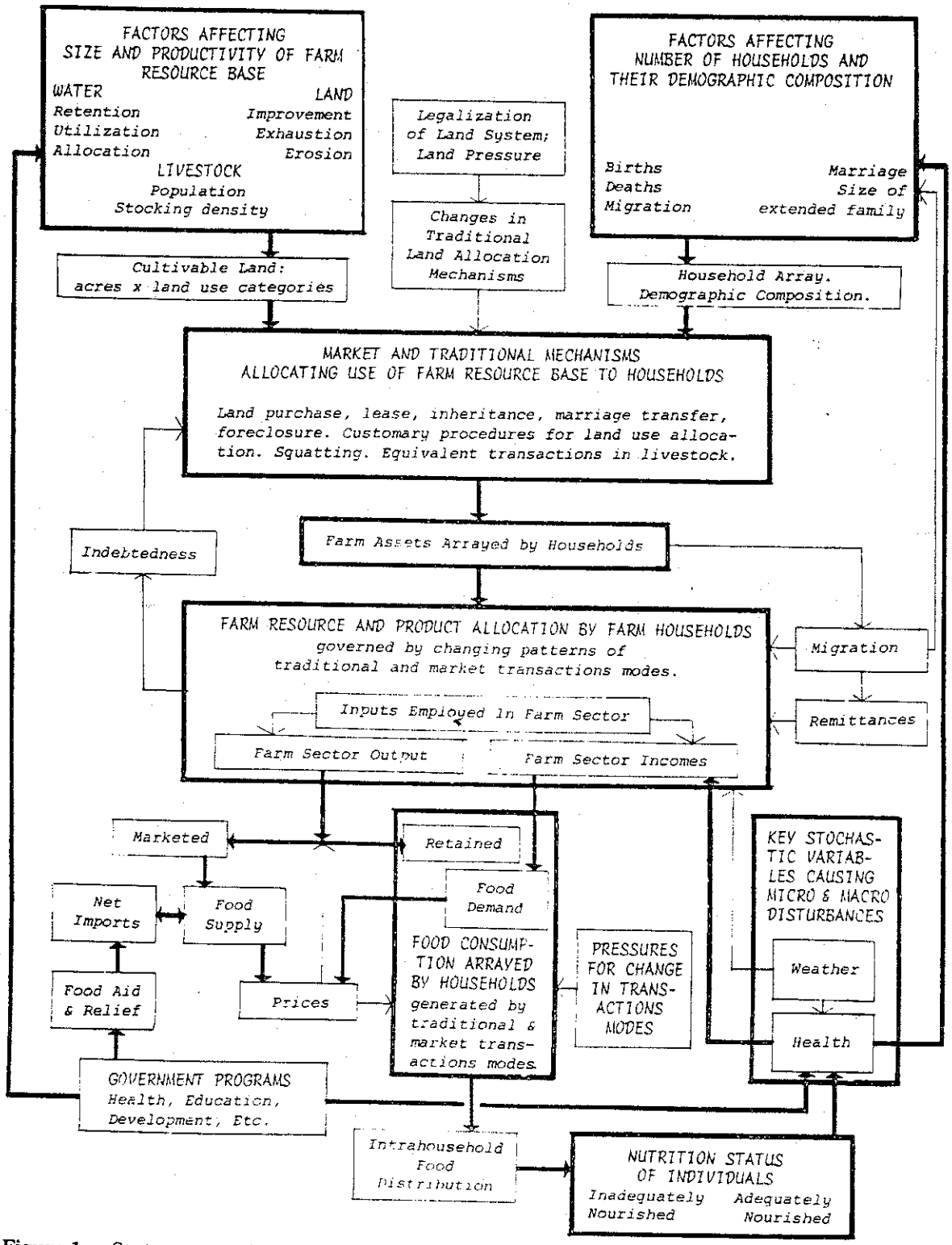


Figure 1. System governing nutrition status in Machakos District, Kenya

Source: Joy, Leonard. AJAE, December 1979, p. 980.

Comment

How much information can be put into 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 every 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 the following may suggest a few more improvements.

1. Is there a clear central focus for each table and chart?
2. Does the title for each tell the reader what, where and when?
3. How is the table or chart integrated into the text?
4. Are all the numbers, lines and information really necessary?
5. Does each table fit across the page?
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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