APPLICATION OF SAMPLING SURVEY IN ESTIMATING AGRICULTURAL STATISTICS OF THAILAND

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CONTENTS

CHAPTER I

INTRODUCTION

A. The Importance of Agricultural Statistics in Thailand

The use of statistics in agriculture represents one of the ways in which statistics have come to play an important role in our daily lives. Zarkovich summed up this development in the following paragraph:

> ...today statistics have penetrated every phase of life. In contrast to remote periods of history, our age may truly be said to be a statistical one. Hardly any branch of science is without its application of statistical methods. In some fields statistics has become a basic tool for research. Side by side with this, the increasing role of the modern state in various aspects of social life would be unimaginable without statistics. This is why governments and other public authorities and even private interests are encouraging the extension of statistical activity. Whatever planning is attempted for whatever purpose, statistical data are sought as a basis.[1]

While good statistics can be useful, as Zarkovich points out, not all statistics are good. They must be prepared and used carefully if their net contribution to human welfare is to be both positive and substantial. The current study will consider an important dimension of the use of statistics in Thailand's development.

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[1] S. S. Zarkovich, Sampling Methods and Censuses, (Rome, Italy: FAO, 1965), p. 59.

Thailand is an essentially agricultural country. Agriculture provides direct employment to 81 percent[2] of the nation's population. Approximately one third[3] of the Gross Domestic Product originates in the agricultural sector, including agricultural crops, livestock, fisheries and forestry. Substantially more income is earned in the marketing and processing of agricultural commodities. The major exports of Thailand continue to be primary agricultural products such as rice, rubber, teak, corn, kenaf, cassava, oil seeds, and other upland crops. These account for 90 percent[4] of total foreign exchange earnings.

Since Thailand has a prosperous agrarian economy,[5] and agriculture continues to be the main economic activitity despite the growing importance of other sectors of the economy,[6] agricultural statistics are a very important input for decision-making purposes. This applies to all levels of the economy from the farmer to the national political leadership.

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[2] Somnuk Sriplung, Potentials in the Economic Development of Thailand Agriculture, (Bangkok, Thailand: Ministry of Agriculture, 1968), p. 1.

[3] Thailand, The National Economic Development Board, The Second National Economic and Social Development Plan (1967-1971), (Bangkok, Thailand: 1968), p. 83.

[4] Ibid.

[5] Harvey H. Smith, and others, Area Handbook for Thailand, (Washington, D.C.: U.S. Government Printing Office, September, 1968), p. 309.

[6] Ibid, p. 311.

Farmers need data on crop and livestock production for use as a guide in deciding when to sell their farm products, what is a fair price, and whether there are shortages or surpluses. They also need information on market prices of the crops and livestock they want to sell as a guide in deciding when and where to sell.

Processors and traders can use price and quantity data in business decisions oriented toward profit maximization. Consumers likewise can make better purchase decisions based on good supply information. Economists in government, universities, business, and other institutions need agricultural statistics in their research, analysis and policy making for the various segments of the economy. Their research into production, marketing and distribution economies benefits both farmers and other individuals in related sectors of the economy.

The importance of agricultural statistics, as a branch of statistics, is well illustrated in the following quotation:

> The importance of the statistical approach to the solution of practical problems has gradually come to be realized during recent times. The progress in this direction is explained by several developments. Fundamentally, the tremendous growth of population, large-scale production, and trade that followed the Industrial Revolution has required the production and use of a vast volume of statistics in every sphere of social activity. Statistical knowledge has increased in quantity, quality, and frequency. The expanding needs of government have accelerated this growth. As a result, fact-finding has become an integral part of economic progress.[7]

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[7]William A. Spurr, and Charles P. Bonini, Statistical Analysis for Business Decisions, (Homewood, Illinois: Richard D. Irwin, Inc., 1967), p. 3.

> ...The whole world now seems to hold that statistics can be useful in understanding, assessing, and controlling the operations of society.[8]

Because of their importance to the country, the agricultural data have been collected and estimated by various offices of the Thai Government for many years. Many of these data, however, are out-of-date and inaccurate. Many government action programs for national development have failed because of the lack of accurate agricultural statistics. Moreover, agricultural marketing and international trade contract have frequently been upset by the out-of-date and inaccurate agricultural statistics. Undoubtedly, this contributes to the poor performance of the Thai economy. Therefore, the inaccurate and out-of-date agricultural statistics may be considered as a primary problem to be solved for successful economic and social development plans in Thailand. All possible ways to provide better agricultural statistics should be taken into consideration.

B. Objectives of the Study

In order to solve the problem of unreliable agricultural statistics in Thailand, this study attempted to design an appropriate method that would furnish better agricultural data subject to the limited resources available. The major purposes of this study may be stated as follows:

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[8]Solomon Fabricant, "Factors in the Accumulation of Social Statistics," Journal of the American Statistical Association, Vol. 47, (Washington, D.C.: American Statistical Association, June, 1952), p. 259.

1. To discuss the existing methods and procedures in collecting agricultural statistics in Thailand.

2. To propose revisions in these methods and procedures in order to make them more modern and accurate and thereby to produce better agricultural statistics for Thailand.

CHAPTER II

CURRENT METHODS AND PROCEDURES OF COLLECTING AGRICULTURAL STATISTICS IN THAILAND

A. Institutions and Persons Involved

The agricultural statistical work of Thailand is carried on largely in the Ministry of Agriculture. The Ministry has a number of branches or Departments namely, Rice, Agriculture (for other crops except rice), Livestock, Fisheries, Forestry, Agricultural Extension, and the Office of the Under-Secretary of State. Each department has a number of divisions and sub-divisions including provincial administration.[9] Under the provincial administration are the changwad (provincial) and amphur (district) officers.

Each department under the Ministry of Agriculture, except the Office of the Under-Secretary of State, collects agricultural statistics for its own specialty through the provincial officers. The primary data are collected by phuyaiban (head of village). The data are then reported in turn via the kamnan (head of commune), amphur officer, and changwad officer to the department involved. The data are finally passed on to the Division of Agricultural Economics in the Office of the Under-Secretary of State. This division

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[9] For the provincial administration, Thailand is divided into 71 changwad (provinces). Each changwad is successively subdivided into amphur (districts), tambon (communes), and muban (villages) of which the muban is the smallest administrative unit.

is responsible for all government agricultural statistical work except the agricultural census.

At the Division, the data are tabulated and missing data are estimated. Finally they are published in the report "Agricultural Statistics of Thailand." This publication is a comprehensive volume giving, among other things, information on crops (area planted, area damaged, area harvested, production, value, index numbers of production, etc.), livestock, fisheries, forestry, exports and imports of agricultural products, irrigation projects, rainfall, etc.

Several other government offices are also involved in collecting agricultural statistics on regular basis. Some of the more important are: the National Statistical Office which conducts the agricultural census; the Ministry of Interior, which is responsible for cattle registration; the Ministry of Economic Affairs which collects prices of agricultural products; and the Ministry of Finance which records the statistics on export of agricultural products by weight and free on board value. Other additional statistics sometimes are collected in special surveys by some of the offices mentioned above and other institutions such as Kasetsart University, the National Economic Development Board, etc.

B. Annual Crop Reporting

In Thailand, the crop reporting is conducted annually by the Departments of Rice and Agriculture in the Ministry of Agriculture. The Department of Rice is responsible for

collecting only rice statistics while the Department of Agriculture collects data on other crops. Both of these departments have their own provincial and district officers in each province and district where their respective crops are grown. These local officers usually do crop extension as their main work. The crop reporting is a minor part of their total activities.

As mentioned previously, the phuyaiban collects primary crop data for his muban. He does this on separate forms for the rice crop and for all remaining crops. There are three main rice schedules. The first consists of a two-visit survey in which the phuyaiban is expected to visit all rice cultivators in the muban. Two visits are necessary to determine the size of early (April to June) and late (July to September) rice plantings. The second schedule deals with damage to the rice crop. Four damage reports are made during May to December on a village basis. The third schedule consists of two harvest reports (early and late) again for each cultivator basis. Thus, the phuyaiban must make eight reports per year for the rice crop. The rice reports also contain information on cattle and buffaloes working on rice fields. In addition to rice, there are three schedules on other upland crops, three on vegetable crops, and two on fruit crops each year. All the reports on these other crops, eight in total, are made on a village basis.

C. Sources of Livestock Information

"Agricultural Statistics of Thailand, 1967", a report published in 1970 by the Division of Agricultural Economics, Ministry of Agriculture, indicates that there are three major sources of livestock statistics in Thailand. They are:

1. The Department of Livestock, Ministry of Agriculture, is responsible for annual collection of data on number of hogs in the country.

2. The Department of Public Administration, Ministry of Interior, collects annual data on the number of other livestock and poultry.

At the primary level, the phuyaiban makes separate annual reports on hog numbers and other livestock and poultry numbers for his area. Then the two reports are passed on to the kamnan, to the amphur officer, and to the changwad veterinarian. After that, the report of hog numbers goes to the Department of Livestock, while the report for other livestock and poultry is passed on to the Department of Public Administration. The livestock statistics collected by these two departments are only the number of living animals. They are collected once a year only. The data cover elephants, horses, buffaloes, cattle, sheep, goats, hogs, and poultry. None of these animals are reported on an age basis.

3. The Bangkok Municipal Slaughterhouse keeps daily records for the numbers of cattle, buffaloes, and hogs slaughtered at its plant. This data also includes information about diseases of animals slaughtered.

D. Agricultural Census

The Agricultural Census, one of the major sources for agricultural statistics, is conducted in Thailand approximately every ten years by the National Statistical Office under the Office of the Prime Minister. The first agricultural census of Thailand was taken in 1950. The information published from this census included Thailand's total land area and the areas in each of the following classifications: forest land, swamp land, farm holdings, areas planted of crops, and other land uses. This information was also presented for the country as a whole and for each region[10] and changwad.

The second agricultural census of Thailand was carried out in 1963. This census in general conformed to the 1960 World Agricultural Census Program which was sponsored by the Food and Agriculture Organization of the United Nations. The 1963 Agricultural Census gathered and tabulated statistical data relating characteristics of the holding and holder, land utilization, number and area of farms, areas and production of crops, livestock numbers, agricultural power and machinery, soil tillage, farm population, etc. Data were presented by provinces as well as on a regional basis. All census returns were compiled manually but tabulated on an electronic computer. It is expected that the 1973 Agricultural Census of Thailand will be conducted following the 1970 Population Census.

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[10]Thailand may be divided into four geographical regions as the Northern Region, the Central Region, the Northeastern Region, and the Southern Region.

E. Other Sources

Other sources of agricultural statistics in Thailand are the offices that usually collect current agricultural data involved in their own work, including some special survey projects. These sources are:

1. Department of Fishery: Fisheries statistics in Thailand are collected annually by the changwad fishery officers. Information for both marine and inland fisheries is collected on the tonnage and value of commercial fish, the number of boats and equipment registered for fishing, the number and area of fish ponds, both for government and private ownership. The information from the provinces is passed on to the Department of Fisheries, Ministry of Agriculture.

2. Department of Forestry: There are forest offices in most of the provinces in Thailand. The changwad and amphur forestry officers also have extra work in collecting statistics for production of teak trees and yang trees (under licenses), timber, firewood, charcoal, bamboo and other forest products. The provincial figures are then passed on to the Department of Forestry, Ministry of Agriculture.

3. Department of Information, Ministry of Economic Affairs: The statistics on prices of agricultural products regularly are collected by the Department of Information, Ministry of Economics. They collect daily wholesale prices of agricultural products at the wholesale markets in Bangkok. There are also the changwad economic officers collecting monthly provincial wholesale prices of agricultural products. Then, the changwad economic officers pass on the price report

to the Department of Information. This department publishes and issues the daily newspaper "Commercial News" presenting general marketing news, including wholesale prices of agricultural products.

4. Department of Customs, Ministry of Finance: The records of agricultural products exported from Thailand are the responsibility of the Department of Customs, Ministry of Finance. The statistics for agricultural products exported are published monthly and yearly. The figures cover weight and free on board value of agricultural commodities exported.

5. Survey for Special Purpose: There are some surveys conducted for a special purpose dealing with agriculture. Surveys are conducted by private institutions, Kasetsart University, foreign institutions, etc. Each survey collects and estimates only a few kinds of data for special purposes only. Some examples of the surveys for special purposes are: (1) Crop Production Survey which is carried on annually by the National Statistical Office, the purpose being to estimate the yield of rice, kenaf, and corn, (2) Rice Inventory Survey which is conducted every quarter of the year by the National Statistical Office, the objective being to estimate the amount of rice in possession of millers, traders, storages, farmers at particular point of time, (3) the Farm Management Extension Program conducted in some provinces in the Central Region and the Northeastern Region by the Division of Agricultural Economics. The objectives of this program are to study the farmer's economic condition and to introduce modern farm management

techniques. The program also provides some agricultural data such as farm income, farm expense, farm credit, yield of some crops, etc. There are many other surveys for special purposes dealing with agriculture which provide other kinds of agricultural statistics.

F. Inaccuracy of Data

The agricultural statistics of Thailand are technically unsatisfactory in that they are based entirely on subjective estimates from the sources and are accordingly probably biased as to level and as to changes from year to year. The annual crops and livestock reports seem to be the major source of the present agricultural statistics in Thailand. The accuracy of agricultural data, hence, depends mostly upon the methods and procedures in making reports for crops and livestock.

The problem of inaccuracy of agricultural statistics was mentioned in a study on crop reporting in 1967:

> The primary agency for collection of data on crop area and production is that of Kamnans (heads of communes, consisting of about 8 to 10 villages) and phuyaibans (village headmen). The figures supplied by kamnans and phuyaibans are known to be unreliable. This was revealed first in 1957 when a pilot investigation was conducted on objective lines by the Ministry of Agriculture with the help of F.A.O. Agricultural Statistician. The recent surveys of the National Statistical Office on objective lines have also furnished estimates of area and production of crops, differing from those supplied by kamnans and phuyaibans. Further the figures of area and production of crops as obtained from the Agricultural Census, 1963 of all agricultural holdings, employing the agency of school teachers as enumerators, did not always agree with those furnished by kamnans and phuyaibans. So it has been difficult, in all cases, to accept for planning purposes, the figures of area and

> production of crops, obtained through the agency of kamnans and phuyaibans. Therefore, there is a general disbelief in the ability of kamnan and phuyaiban to furnish reliable agricultural statistics. [11]

Unfortunately, Thawani's report contains no information about specific kinds of errors, their sizes or their frequency.

The primary agencies for livestock reporting are also from the kamnan and the phuyaiban. The problem of inaccurate data on livestock is the same as the data of crops from crop reporting. The main drawbacks of the present crop and livestock reports stem from the kamnan and the phuyaiban who are called upon to make these reports. The kamnan and the phuyaiban are not full-time employees of the government and they obtain only a meager compensation for their administrative duties. They are controlled by the Ministry of Interior and not by the Ministry of Agriculture. Their frequent meetings with individual farmers or groups of farmers to collect data add considerable work to their already heavy administrative duties. The agricultural data gathering activities tend to be treated rather lightly receiving less attention than they need. The kamnan and phuyaiban often do not even go out to the fields to examine a crop but rely instead on conversations with the farmers. This is an even greater problem with livestock estimates. In addition, there is little monetary incentive or administrative control for them to report accurately. The result is that the kamnan and phuyaiban

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[11] V.D. Thawani, A Pilot Project in Crop Reporting in Nakornpathom Province, 1966, Part I, Unpublished Report, July, 1967. p. 2.

produce repetitive figures year after year, with minor variations. Therefore the accuracy of these figure is dubious at best.

Although, in theory, village-based reports are to be made (cultivator-basis in the case of main crops), in practice the reports, particularly those on upland crops, emanate from the kamnan for his tambon. Sometimes, even tambon-basis figures are not available for upland crops. The amphur, changwad agricultural officers, and changwad veterinarians compile the statistics of the area and production of crops, and numbers of livestock by using their judgment and personal discussions with other officials and non-officials in the course of their field trips.

Moreover, some of the kamnan and the phuyaiban are quite old and uneducated, having hardly any interest in crop reporting and livestock reporting. Neither is there an effective check on their work. The result is that the data supplied by the kamnan and phuyaiban are mostly taken on trust, without check or correction.

Another drawback of the present system is that the reports on upland crops contain too many items. Thus there are 23 items on vegetable crops, 28 on fruit crops, and 31 on upland crops, other than vegetable and fruit crops. It is not expected that the kamnan and the phuyaiban, with limited time at their disposal, will be able to give reliable data on such a variety of items.

The information on livestock is collected only in the annual amount at the beginning of each year. The information on livestock is neither categorized on age nor production. Therefore, there is no opportunity for estimating the annual output of cattle for slaughter or checking against city slaughter records. Because of the methods of obtaining information it would be difficult to determine the extent to which the data are complete.

In compiling agricultural data the Division of Agricultural Economics, Ministry of Agriculture, must wait almost two years before it receives the basic information from the other government departments involved.[12] The reporting problems of the kamnan and phuyaiban were discussed earlier. Similar problems apply to higher officers in the changwad and amphur officers for whose time contributed to agricultural reporting duties are often minor and residual claimants. As a result, reports are often sent in late from the field offices and sometimes simply are never submitted.

The statistical offices in the departments involved do not have the authority to force these officials to return the reports on time or at all. Consequently, the staffs at departmental statistical offices have to estimate the missing changwad data. Accordingly, the Agricultural Statistics yearbook of Thailand, published by the Division of Agricultural Economics, usually comes out about two years late and its data are frequently thought to be inaccurate.

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[12]See Chapter II, Section A. Institutions and Persons Involved.

CHAPTER III

A PROPOSED SAMPLE SURVEY METHOD FOR ESTIMATING AGRICULTURAL STATISTICS IN THAILAND

A. Purpose of the Survey

While the agricultural statistics of Thailand are quite out-of-date and rather unreliable, and since the agricultural census is conducted every ten years, up-to-date and reliable agricultural statistics for the current year are needed by various sections of the Thai Government in making national policies and planning country development projects, and also by the private offices concerning agriculture. The national Statistical Office has general authority to collect all statistical information, but has not been staffed to do more than work on population census and the publication of a bi-monthly Bulletin of Statistics from data furnished by other government agencies.[13] On the other hand, the responsibility for the agricultural statistical work is placed in the Division of Agricultural Economics in the Office of the Under-Secretary of State, Ministry of Agriculture. This Division is asked to furnish all kinds of agricultural statistics to the users, both official and non-official sectors. To date, however, the Division has not been charged with the duty of gathering the data at the source. This has slowed down the rate of progress in improving the methodology and

[13]Joseph A. Becker, The Agricultural Statistics of Thailand, Unpublished Article, p. 1.

(1) It has two rai[14] or more of land for agricultural operations.

(2) It has one-half rai or more for growing vegetables.

(3) It has one or more hogs or goats or sheep.

(4) It has at least one head of cattle or buffalo.

(5) It has 20 or more chickens and/or ducks.

2. Sample Selection: Since all farm households in an amphur are a population unit of the survey, the farm household, hence, is the sampling unit. In conducting the survey, it is more expensive and much time is involved if the data are collected by the method of simple random sampling or systematic selection. The samples selected by these two methods will be scattered over the whole area of the amphur. It also takes much time to make a listing of the total farm households in an amphur. Also, the method of stratified sampling is not appropriate for this survey because the sizes of farms within an amphur are different. If stratified sampling is employed, the sample units could be stratified with respect to the size of the farm only. Then, the farm households selected would still be scattered over the whole area of the amphur. Thus, it takes much traveling time and cost in collecting data and in preparing a list of farm sizes.

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[14] Approximately, 2.5 rai = 1 acre.

Cluster and multi-stage sampling seems to be the most reasonable method in collecting data for this survey. In this method, the population is divided into several groups or clusters.[15] A number of these clusters are then drawn into primary samples, secondary samples, and elementary (tertiary) samples. A complete frame of secondary and tertiary units is unnecessary.[16] By this method, the cost and time for collecting data would be saved. The results of the estimates are reliable if the sample size is sufficiently large. The advantage of cluster and multi-stage sampling may be clearer by the statements below:

> Cluster or multi-stage sampling will often give a more precise estimate, for a given outlay, than unrestricted random sampling, if the sampling costs within selected clusters (primary units) are low. If a complete frame of ultimate (secondary, tertiary, etc.) units is available, selection can be made with probability proportional to size at all stages except the last: this method yields unbiased estimates of means and variances. . . .[17]

> ... The main advantage of cluster sampling is that it reduces the cost per elementary sampling unit.. ...With this procedure considerable travel time for the interviewer would be saved... A second advantage of cluster sampling is that it can be used sometimes where other methods are not applicable...[18]

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[15] William A. Spurr, and Charles P. Bonini, Statistical Analysis for Business Decisions, 2nd. ed., (Homewood, Illinois: Richard D. Irwin, Inc., 1968, p. 334.

[16] M.R. Sampford, An Introduction to Sampling Theory, (London, Great Britain: Oliver and Boyd Ltd., 1962), p. 190.

[17] Ibid.

[18] William A. Spurr, and Charles P. Bonini, Ob. cit., pp. 334-335.

> When individual selection of elements seems too expensive, survey tasks can be facilitated by selecting cluster; ...[19]

In selecting samples for this survey by the method of cluster and multi-stage sampling, the population (total farm households in an amphur) is divided into clusters by tambon. These clusters or tambon are primary sampling units. The samples of the tambon are drawn in proportion to size, without replacement, the criterion being approximately the cultivated area of the major crops of the last agricultural census. The total number of muban in the tambon sampled are the secondary sampling units. The samples of the muban are also drawn in the same manner as the tambon. Total farm households in each muban sampled are the elementary (or tertiary) sampling units. The samples of farm households are selected in proportion to size, without replacement, the criterion being the number of farm households in the muban. The number of farm households for each muban is available at the amphur office. The number of farm households on the list at amphur office, however, is not quite relevant to the actual number of farm households. Thus, it is suggested that a new listing of farm households in the muban sampled should be made before selecting farm household samples.

The procedure of sampling without replacement is employed in selecting samples at the various stages of the

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[19]Leslie Kish, Survey Sampling, 2nd. ed., (New York: John Wiley & Sons, Inc., April, 1967), p. 148.

survey because all sampling units have a more equal chance of being selected. This procedure is more efficient as mentioned in the statement below:[20]

> Remark 5.3. III The model calls for sampling with replacement. But sampling without replacement has distinct practical advantages. The difference between the two procedures generally has little effect, because the primary sampling fraction (a/A) is small. We can also choose between three alternatives.
>
> 1. In most cases I would select the PSU's[21] without replacement, because it is more efficient. With it, I would use the simple variance formula (5.3.3).[22] This design would tend to slightly overestimate the actual variance. It disregards a term that in most cases is positive and small (5.6.7).[23] The term vanishes when the homogeneity

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[20] Ibid., p. 160.

[21] PSU's stand for Primary Sampling Units.

[22] The formula (5.3.3): -

$$\text{var}(\bar{y}) = (1-f)\frac{s_a^2}{a}, \quad \text{where } s_a^2 = \frac{1}{a-1}\sum_{\alpha}^{a}(\bar{y}_\alpha - \bar{y})^2$$

$$= \frac{1}{a-1}\left(\sum_{\alpha}^{a}\bar{y}_\alpha^2 - a\bar{y}^2\right),$$

and a = sample size of cluster (number of clusters selected)
y = variable observed.

[23] The formula (5.6.7)

$$E\left[\left(1 - \frac{ab}{AB}\right)\frac{s_a^2}{a}\right] = \text{Var}(\bar{y}) + \frac{S_a^2}{A}\left(1-\frac{b}{B}\right)\left(1 - \frac{S_b^2}{BS_a^2}\right)$$

where A = population size of cluster (total clusters)
B = total elements in the cluster selected
b = number of elements selected out of B

within clusters is zero; negative values are possible but rare. It decreases with small sampling fractions a/A. Furthermore, if the fpc(1-f) is omitted from the formula (5.3.3), this will always overestimate the variance by only s_a^2/A. A slight overestimate of the actual variance often seems acceptable.

3. Sample Size: Since this survey is designed to be carried on as a routine work for the Division of Agricultural Economics, it is difficult to fix the sample size and the sampling rate because the determining factors are subject to considerable uncertainties. The unit variance of the design may be difficult to estimate. The unit cost of collecting the data may be obscure. There is also uncertainty in the budget appropriated for the survey. Determination of sample size is often complicated, since many factors must be taken into consideration, including the costs involved. The size of the sample to be selected, in general, depends upon whether data are to be used for estimation of a population mean, a population proportion, or for some other purpose. The size of the sample depends, as well, upon "how good" an estimate is required. "How good" implies how much error is acceptable when a point estimate is used to represent a population parameter and how much confidence is required so that maximum error does not exceed the amount stated.

Technically, sample size should depend on two factors:[24]

(1) The economic value of the information contained

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[24] William A. Spurr, and Charles P. Bonini, Ob.cit., p.268.

in the sample, and

(2) The cost of sampling.

The value of the sample information and the cost of the sample both increase as the sample size increases. The optimum sample size is that which balances the cost and value of the sample. However, the sample size, that depends upon the maximum error acceptable for a given sampling situation at a specific level of confidence, may be simply estimated by the relation between precision of the sample mean and size of sample with these three steps:[25]

1. Determine how small the standard error of the mean must be in order to obtain the necessary precision. The precision depends on how the results are to be used.

2. Take a random sample of any convenient size and compute the sample standard deviation as an estimate of the population standard deviation.

3. Substitute the desired value of standard error of the mean and the estimated population (sample) standard deviation in the equation of the relation between precision of the sample mean and sample size, and solve for sample size. This size of the sample will give the necessary precision. If a larger sample is then taken, its standard deviation can be used to provide a revised estimate of population and hence standard error.

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[25] Ibid., pp. 268-269.

C. Data Collection

1. Method of Data Collection: Since farm households are the elementary sampling unit for the survey, operators of the farm selected would provide the primary information. The methods of collecting data should be selected carefully in order to obtain data with respect to accuracy and economy.

Basically, the four major methods for collecting data for a survey are mail questionnaires, telephone interviews, personal interviews, and group interviews.[26]

Telephone interviews and mail questionnaires are not applicable for this survey because farmers in Thailand do not have telephones, and the mailing system in the rural area of Thailand is very poor. Moreover, most farmers in Thailand are poorly educated. Many of them cannot read and write. Thus, they may be unable to complete the questionnaire if the mail questionnaires are employed. Group interviews are not suitable for this survey either. The questionnaires for this survey may contain some personal questions such as farm income, farm credit, etc., which farmers are not willing to answer publicly. Thus, it is difficult for interviewer to obtain correct information for such questions by the group interviews.

Personal interviews are the most applicable and suitable for collecting data at the primary source for this survey.

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[26] Prasert Na Nakorn, and Udhis Narkswasdi, Principles and Techniques in Agricultural Economic Research, (Bangkok, Thailand: Boonsonge Unswasdi, September, 1962), p. 54.

The interviewer is able to ask the farmer questions in person and the farmer will give more facts in his answers. In addition, the interviewer has an opportunity to observe the physical characteristics and situation of the farm so that it may help him to obtain more correct information. The general advantages of personal interview may be oriented by the statement given below:

> The principal advantage of personal interview lies in the opportunity to secure nearly complete returns from the desired sample. Interviewer can usually reach nearly all of the people selected as a typical sample of the population to be surveyed.
>
> When mail questionnaires are used, on the other hand, a large proportion of the recipients may disregard them. ...questionnaires may be answered by a business subordinate or a junior member of a family rather than by the person to whom they are addressed. This situation creates an error quite apart from any tendency of respondents to give biased answers, a difficulty which the investigator faces in any case.
>
> ...personal interviewers can generally obtain accurate replies through explaining the questions, persuading the informant to provide the desired information, and judging the validity of the response...[27]

2. Field Work Personnel: The personnel drawback in collecting agricultural data of the current year in Thailand was already mentioned in the last chapter. The local officials, such as changwad officers, amphur officers, kamnan, phuyaiban, and local school teachers, seem incapable of doing a good job of collecting agricultural data. The most

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[27]William A. Spurr, and Charles P. Bonini, op.cit., p. 28.

crucial problem is that they do not have enough time or incentive to do such extra work. They do not feel that agricultural data reports are their responsibility. Therefore these people probably would not do a good job for this survey.

In collecting primary data for this sample survey, it is recommended that the new staff of field workers be created at the changwad and amphur level. There should be at least one amphur officer who works as an enumerator in the amphur under his direction. The changwad officer of this survey is regarded as a field supervisor in the changwad under his direction. The changwad officer also collects and checks all questionnaires completed by the amphur officer. He then passes on all questionnaires completed and checked to the head office in the Division of Agricultural Economics, Bangkok. The field work staff needs intensive training before being assigned a job. The work for this survey should be his routine work. The staff may be selected from the local people with, at least, literacy as a qualification.

3. Schedules of Data Collection: According to the crop year in Thailand, usually April to March, the schedules of data collection for this survey are divided into three periods.

(1) Schedule I: This survey would cover the period April 1 to September 30. It is the main survey for the areas planted. The survey should be made during September which by

that time most major crops are mature. The information for the Schedule I survey covers the areas planted for all crops under consideration and the number of livestock on hand fixed on a particular day.

(2) Schedule II: This survey would cover the period April 1 to December 31. It is the survey on crop damaged. Naturally, the damage of crops in Thailand occurs during this period. The information from the Schedule II survey covers the area damaged and cause of damage. It also gives the area that farmer expects to harvest and his expected production. This information is collected for the purpose of forecasting. In addition, the survey provides the general condition of crops that farmer expects to occur. The survey should be conducted during December.

(3) Schedule III: This survey would cover the period from October 1 to March 31. It is the main survey on the production of crops. The survey should be performed during March which is the last month of the crop year. Most farm operators usually finish harvesting their crops during this month. The information from the Schedule III survey covers areas harvested, yield and total production, and distribution of crop production.

The items of question for other information such as land tenure, farm expense, farm income, fertilizer and insecticide application, farm loan, etc., may be added on the questionnaires for any period of the survey. In addition,

the field staff may have time left after the survey periods, hence, they should be assigned to report other information involved in agriculture such as daily prices of farm products at the local markets, weather conditions (e.g. rainfall, temperature), etc.

D. Data Estimation

In preparing the direct expansion, each muban is expanded to an estimate for the tambon from which it was selected. The final estimate for the tambon is the total or average of these estimates. Tambon estimates are added to form amphur estimates. Finally, amphur estimates are added to give the changwad estimate. The same additive procedure is followed in computing the variance for the estimated changwad total. However, the sample size for this survey is expected to be small because of the budget limitations. Therefore, the sampling fraction is expected to be close to 0.05 and the finite population correction (fpc) factor is neglected in computing variance of the estimate for this survey.[28] The negligence of finite population correction may be clarified by the following statements:

> Clearly, when n is small relative to N, the fpc is so close to 1 that it is not worthwhile to compute it. Of course, when n is small relative to N, the sampling ratio n/N is small. Hence, when the sampling ratio is small, we may neglect

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[28] Ibid., p. 338.

the fpc when computing standard errors.[29]

> If the selection in the last stage, and in all other stages too, were made with replacement, then the fpc = (1-f) should become 1 and vanish from the variance formula. Typically (1-f) is negligible even when the last stage is selected without replacement.[30]

> The term $(1-\frac{n}{m})$ is called the finite population correction or fpc. If sampling is with replacement (not too common) or if the sampling fraction$(\frac{n}{m})$ is very small (say less than 1/20, the fpc may be omitted....[31]

The formulae for data estimation of this survey is designed as below: -

Let:

h = Amphur

i = Tambon

j = Muban

k = Farm household

N_h = Number of total tambon for the h^{th} amphur surveyed; h = 1...N

n_h = Number of tambon sampled for the h^{th} amphur surveyed; h = 1...n

N_{hi} = Number of total muban for the i^{th} tambon in the h^{th} amphur; i = 1...N_h

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[29]Sidney J. Armore, Introduction to Statistical Analysis and Inference, (New York: John Wiley & Sons, Inc., 1966), p. 328.

[30]Leslie Kish, Op. cit., p. 159.

[31]Frank Freese, Elementary Statistical Methods for Foresters, (Washington, D.C.: U.S. Government Printing Office, January, 1967), p. 6.

n_{hi} = Number of muban sampled for the i^{th} tambon in the h^{th} amphur; $i = 1...n_h$

N_{hij} = Number of total farm households for the j^{th} muban in the i^{th} tambon of the h^{th} amphur; $j = 1...N_{hi}$

n_{hij} = Number of farm households sampled for the j^{th} muban in the i^{th} tambon of the h^{th} amphur; $j = 1...n_{hi}$

X_{hijk} = Variable observed or number of total elements under consideration (e.g., area planted of rice, corn production, cattle number, etc.) for the k^{th} farm household of the j^{th} muban in the i^{th} tambon for the h^{th} amphur; $k = 1...n_{hij}$

1. Estimate for Muban Level: For the j^{th} muban of the i^{th} tambon in the h^{th} amphur.

(1) Estimate of total, $\hat{X}_{hij}$

$$\hat{X}_{hij} = \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (1)$$

(2) Estimate of mean $\hat{\bar{X}}_{hij}$

$$\hat{\bar{X}}_{hij} = \frac{1}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (2)$$

(3) Variance of estimates

(a) Variance of mean, $V(\hat{\bar{X}}_{hij})$

$$V(\hat{\bar{X}}_{hij}) = \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (3)$$

(b) Variance of total, $V(\hat{X}_{hij})$

$$V(\hat{X}_{hij}) = \frac{N_{hij}^2}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hij} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (4)$$

2. Estimate for Tambon Level: For the i^{th} tambon of the h^{th} amphur.

(1) Estimate of total, $\hat{X}_{hi}$

$$\hat{X}_{hi} = \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (5)$$

(2) Estimate of mean, $\hat{\bar{X}}_{hi}$

$$\hat{\bar{X}}_{hi} = \frac{1}{n_{hi}} \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (6)$$

(3) Variance of estimates

(a) Variance of mean, $V(\hat{\bar{X}}_{hi})$

$$V(\hat{\bar{X}}_{hi}) = \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (7)$$

(b) Variance of total, $V(\hat{X}_{hi})$

$$V(\hat{X}_{hi}) = \frac{\left(\sum_{j=1}^{n_{hi}} N_{hij}\right)^2}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \tag{8}$$

3. Estimate for Amphur Level: For the h^{th} amphur surveyed.

(1) Estimate of total, $\hat{X}_h$

$$\hat{X}_h = \frac{N_h}{n_h} \cdot \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \tag{9}$$

(2) Estimate of mean, $\hat{\bar{X}}_h$

$$\hat{\bar{X}}_h = \frac{1}{n_h} \cdot \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \tag{10}$$

(3) Variance of estimates

(a) Variance of mean, $V(\hat{\bar{X}}_h)$

$$V(\hat{\bar{X}}_h) = \frac{1}{\sum_{i=1}^{n_h} n_{hi}} \cdot \sum_{i=1}^{n_h} \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - X_{hij})^2}{n_{hij} - 1} \tag{11}$$

(b) Variance of total, $V(\hat{X}_h)$

$$V(\hat{X}_h) = \frac{\left(\sum_{i=1}^{n_h} N_{hi}\right)^2}{\sum_{i=1}^{n_h} n_{hi}} \cdot \sum_{i=1}^{n_h} \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (12)$$

The total for the changwad is the sum of the total amphur surveyed. The variance is also additive.

E. Precision Relative to Current Methods

The current methods used in collecting agricultural statistics in Thailand cannot furnish reliable and up-to-date data due to various problems. Most data on crops and livestock are from the reports by the kamnan and the phuyaiban who lack the responsibility and capability of doing a good job for such reports. The reports are often based on arbitrary estimates without statistical techniques involved. Furthermore, the standard error (or degree of precision) can not be computed by using the current methods of collecting data. Moreover, the delay of reporting from the primary sources, through several level offices, results in out-of-date data.

On the contrary, for the sample survey proposed, the collection and estimation of data are based primarily on statistical techniques. The procedures and techniques of probability sampling are employed both in collecting and estimating data. The special feature of probability sampling

is that it permits the use of the theory of probability for computation, from the sample itself, of probability limits of sampling variation in the estimates that come from repeated application of the prescribed sampling procedure to the same equal complete coverage, or to the same cause system.[32] The equal complete coverage is the result that would be obtained from examination of all the sampling units in the frame by the same field-workers or inspectors, using the same definitions and procedures, and exercising the same care as they exercised on the sample, and at about the same period of time.[33] Probability sampling makes possible the computation of a measure of precision from the sample data alone. When unbiased sample designs and estimating procedures are used, or when measures of bias are available, generally accepted measures of the quality of the estimates can be derived from the sample.[34] Therefore, statistical theory would provide a basis of selecting samples so that the chance, or probability, of each farm household being in the sample could be computed. This offers two definite advantages:

1. Since the probability sample would represent a true cross section of farms for each amphur in Thailand, the

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[32] W. Edwards Deming, Sample Design in Business Research, (New York: John Wiley & Sons, Inc., 1960), p. 24.

[33] Ibid., p. 50

[34] Statistical Reporting Service, U.S. Department of Agriculture, Statistical Reporting Service of the U.S. Department of Agriculture, Miscellaneous Publication No. 967, (Washington, D.C.: U.S. Government Printing Office, December, 1964), p. 15.

estimates would be unbiased estimates.

2. Probability sampling will provide information for computing sampling errors. Thus, estimates can be made with a known degree of precision.

In general, the advantages of probability sample are stated by the quotation below:

> Sample surveys and design of experiment by use of probability are reliable and indispensable tools for use in production, administration, accounting, marketing and consumer studies, census and government statistical series, and research in many fields.[35]

However, it cannot guarantee the accuracy for the data estimated by the sample survey alone. Accuracy refers to the success of estimating the true value of a quantity.[36] The sampling survey could provide data with more precision. Precision refers to the clustering of sample values about their own average, which, if biased, cannot be true value.[37] Accuracy, or closeness to the true value, may be absent because of biasedness, lack of precision, or both. The main purpose of the sample survey is to estimate the true value of a population. When a sample of the population is interviewed, the measure obtained enables one to estimate a true value of

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[35] W. Edwards Deming, op.cit., p. 24.

[36] Frank Freese, Elementary Forest Sampling, Agricultural Handbook No. 232, U.S. Department of Agriculture, (Washington, D.C.: U.S. Government Printing Office, December, 1962), p. 4.

[37] Ibid.

the population. Sampling usually yields some discrepancy between the actual and the estimated values. The discrepancy between the sample estimate and the number (value) that would have been found under identical conditions by a census of all residents is called sampling error.[38]

Hansen, Hurwitz, and Madow stated the definition of sampling error and its result as below:[39]

> In referring to sampling error, or to the precision of a sample result, we are referring to how closely we can reproduce from a sample the results which would be obtained if we should take a complete count or a census, using the same methods of measurement, questionnaire, interview procedures, type of enumerators, supervision, etc.... The difference between a sample result and the result from a complete count taken under the same conditions is measured by what we will refer to as the precision or the reliability of the sample result. The difference between the sample result and the true value, we call the accuracy of the sample survey. It is the accuracy of a survey in which we are chiefly interested; it is the precision which we are able to measure in most instances...
>
> With probability sampling methods one can get away completely from dependence upon judgment for determining precision. Under these circumstances, and with reasonably large samples, the precision of the results from the sample can be measured from the sample itself.

The precision (the reliability) of the sample estimate, hence, depends upon the amount of sampling error for a

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[38]Charles H. Backstrom, and Gerald D. Hursh, Survey Research, 3rd. ed., (USA: Northwestern University Press, 1967), p. 28.

[39]Morris H. Hansen, William N. Hurwitz, and William G. Makow, Sample Survey Methods and Theory, 7th. ed., (New York: John Wiley & Sons, Inc., November, 1966), p. 10.

particular sample size. There may also be some mechanical and clerical errors in the sampling process. Both sampling errors and non-sampling errors together affect the accuracy of a sample. How precisely the sample reflects a population value can be estimated from the sample itself, so long as the sample is a probability sample at all stages.

In addition, precision of data estimated also depends on the sample size. In random sampling, larger samples yield greater precision by reducing chance errors due to sampling. With a larger sample there is a broader and more varied base on which to make the estimate. Thus, the precision of the data estimated from samples depends on the risks in affording survey costs.

Backstrom, and Hursh stated the precision of data estimated from sample relative to its cost that:[40]

> Lack of resources often inhibits achieving huge samples. ...
>
> (...increased sample size heightens precision of sample estimates.)

Furthermore, if a new field-work staff, with intensive training, is created for conducting this sample survey, the Division of Agricultural Economics would have direct authority to supervise them. The survey would be strictly performed on time with the schedules. The return of the questionnaires completed would not be too late. The data,

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[40]Charles H. Backstrom, and Gerald D. Hursh, op.cit., pp. 29-30.

hence, would be processed and estimated, and be published on time. The computer services at the National Statistical Office are also available for this survey. Therefore data processing and computing would not consume too much time. Since sample data can be collected and processed in a fraction of the time required for complete inventory, the information obtained may be more timely.[41] Accordingly, agricultural statistics in Thailand, collected and estimated by this sample survey, would be more reliable and accurate.

F. Possibility of Error

Even though this sample survey would employ a modern statistical tool in gathering and estimating agricultural data, some errors may still occur. The expected errors might be: -

1. Sampling Errors: It has been stated in the last section that sampling error is the discrepancy between the data estimated from a sample and the data that would be obtained from a complete census by the same procedures of collection. Sampling error always arises when data are estimated from a sample. The result of a sample survey will hardly ever agree completely with that which would have been obtained from a complete enumeration carried out in the same manner.[42] Accordingly, sampling error could not be avoided in this sample survey. However, it could be controlled since probability

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[41] Frank Freese, Elementary Forest Sampling, op.cit., p. 2.

[42] Morris James Slonim, Sampling, (Forge Village, Mass.: The Murray Printing Company, 1966), p. 28.

sampling would be employed for this survey. When sampling is performed so that every unit in the statistical universe has a chance of being selected and the probability of selection is known, the errors of sampling can be controlled satisfactorily.[43] Hence, the sampling error in this survey can be controlled by changing sample size.

2. Non-sampling Errors: The important possible errors other than sampling errors that might arise in this survey are: -

(1) Response Errors: Response errors might occur because respondents might misunderstand a question or might not trust the interviewer. However, the size of these errors is expected to be very small since the enumerators would be selected from a group of people with at least a high school education and they would be intensively trained. In addition, the errors due to response might arise in the case that enumerator visits a farm when the farm operator is not at home, and the respondent, hence, is another member of the farm family such as the wife, son, or daughter. These would be reduced if the enumerator were instructed to visit a farm more than one time in order to interview the operator. For this purpose,it is suggested that the enumerator be provided traveling facility such as motorcycle or motorboat. The enumerator would also be expected to assure the farmers that

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[43] Ibid., p. 24

their information would be kept confidential. Therefore, the respondents would be more willing to give the facts in their replies. It is anticipated that the errors due to response of this survey would be small.

(2) Sample Selection Errors: Generally, the people in the rural areas of Thailand do not consist of farmers only, but they also include non-farmers such as local school teachers, traders, and handicraftsmen. In the sample selection, errors might arise in two cases. First, they might be errors due to missing elements. Some farm households might not be included in the sampling frame of the muban selected. Second, they might be errors due to foreign elements. Some non-farm households might be included in the sampling frame, and might also be selected as the elementary samples. Such samples, thus, would not represent the population. Since the farm household has been defined,[44] the errors due to sample selection should be small and the enumerators are intensively trained.

(3) Errors in Missing Report: In conducting a large scale survey, some insincere people might be included in the staff. Unfortunately, if some such undesirable persons were included in the field work staff of this survey, the error in missing reports might arise. However, since this field work staff is under the direction of the Division of Agricultural Economics, the problem due to missing reports of this survey would be much smaller than under the current methods.

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[44] See Chapter III, Section B. Sampling Plan.

(4) Errors in Data Processing: Errors in data processing such as tabulation and calculation, including publishing, might possibly occur. As it was suggested earlier if the data are computed by the computer at the National Statistical Office, the errors in data processing of this survey would be smaller than the current methods which are computed manually in various departments.

In most cases it is anticipated that the errors arising in the data estimation of this sample survey would be much smaller than with the present methods.

G. Relative Costs and Benefits

In order to conduct this sample survey effectively the emphasis would be placed on the procedure and technique in collecting data at the primary sources. Clearly, experiences have shown that the collecting and reporting of agricultural information by kamnan, phuyaiban, amphur and changwad officers as their extra work, result in unreliable and out-of-date agricultural statistics in Thailand. Therefore, a new staff for field work is needed for this survey. The most important factor in field studies, besides the researcher, is the interviewer.[45] To expand the office and employ a field staff (including facilities and equipment involved) will require an increased budget.

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[45]Charles H. Backstrom, and Gerald D. Hursh., op.cit., p. 10.

For the first year it is suggested that a changwad be selected in the Central Region which is close to Bangkok in order to conduct a pre-test for this sample survey. In the second, third, fourth, and fifth year, this survey should be extended into 10, 20, 40, and 71 changwad, respectively. The survey would be carried on throughout the country regularly in the later years. The approximate cost for the field work from the first year to the fifth year would be 210,000 baht,[46] 1,965,100 baht, 2,851,000 baht, 5,702,000 baht, and 9,514,000 baht per year respectively. The schedule for conducting this sample survey and its costs are shown in tables 1, 2, and 3. The total cost for each year of the five-year schedule would include the overhead costs (costs for vehicles and desks and chairs). After the fifth year, a stock of overhead items would be on hand and there would be only an operating cost of approximately 5,332,100 baht per year. These costs were estimated on the basis of the present currency and situation.

Processing data at the head office,the Division of Agricultural Economics, in Bangkok would be carried out by the existing staff. The computer services at the National Statistical Office are also available for this survey. Hence, it is not necessary to employ a new staff for data processing. Only a few more employees may be needed. This additional cost was not included in this cost estimate because it would not be very great.

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[46] U.S. $1 = 20 baht, approximately.

Table 1: Number Of Changwad Per Year For Conducting The Sample Survey In Estimating Agricultural Statistics of Thailand

Year	Northern region	Northeastern region	Central region	Southern region	Total
1st	-	-	1	-	1
2nd	1	2	5	2	10
3rd	2	4	10	4	20
4th	4	8	20	8	40
5th	7	15	35	14	71

Note: There are 7 changwad in the Northern Region, 15 changwad in the Northeastern Region, 35 changwad in the Central Region, and 14 changwad in the Southern Region.[47]

However, from the results of this sample survey, all users of agricultural statistics would have more precise and up-to-date data. For the public sectors, various government offices involved in agriculture could make more precise decisions in their policy planning. Several action programs in country development would be planned and carried out more effectively. For private sectors, various business organizations or business firms, individual businessmen and industrial organizations, which are involved in agricultural activities, including farmers, would be able to make better decisions in their businesses. Farmers could make better management and

[47]Division of Agricultural Economics, Ministry of Agriculture, Land Utilization of Thailand, 1965, (Bangkok, Thailand: Wholesale Cooperative Press of Thailand, 1968), pp. 12-21.

Table 2: Estimate Of Annual Costs Per Changwad To Establish And Operate A Survey System For Estimating Agricultural Statistics Of Thailand

Items	Costs (Baht)
I. Establishment (non-recurring) Cost:	
A. Vehicles	
1. One car (jeep) for supervisor @ 100,000 baht	100,000
2. Six motorcycles or motor boats for the amphur enumerators (there are approximately 6 amphur per changwad) @ 5,000 baht	30,000
B. Other	
1. Seven desk-and-chair sets for supervisors and enumerators @ 700 baht	4,900
Total establishment cost	134,900
II. Annual Operating Costs:	
A. Personnel	
1. One supervisor (at changwad level), with at least 3 year college diploma in statistics or agriculture: 900 baht per month, for 12 months	10,800
2. Six enumerators (at amphur level), with at least high school certificate: 600 baht per month, for 12 months	43,200
B. Other	
1. Miscellaneous (questionnaires, gas for vehicles, vehicle maintenance, etc.)	21,100
Total annual operating costs	75,100
Total first-year costs per changwad	210,000

Note: In Thailand, there are 71 changwad, and approximately 414 amphur.[48]

[48] Jere R. Behrman, Supply Response in Underdeveloped Agriculture, (Amsterdam, Netherland: North-Holland Publishing Company, 1968), p. 40.

Table 3: Estimate Of Cost To Establish And Operate A Complete Agricultural Statistics Survey System For Thailand

Year	Number of new changwad surveys begun	Total number of changwad surveys conducted	Total establishment cost (baht)	Total operating cost (baht)	Total annual cost (baht)	Total annual cost US $
(1)	(2)	(3)	(4) = 134,900X(2)	(5) = 75,100X(3)	(6) = (4)+(5)	(7) = (6)/20
1	1	1	134,900	75,100	210,000	10,500
2	9	10	1,214,100	751,000	1,965,100	98,255
3	10	20	1,349,000	1,502,000	2,851,000	142,550
4	20	40	2,698,000	3,004,000	5,702,000	285,100
5	31	71	4,181,900	5,332,100	9,514,000	475,700
6* and later	-	71	-	5,332,100	5,332,100	266,605

*In addition a fund would be needed to replace vehicles and equipment as they wear out.

production decision in their farm planning and marketing. They might know more precisely what and how much to raise, and when and at what price to sell their products. Traders would be able to know better the place and amount of supply for each farm product. Processors also could know better about the place and amount of farm product supplies. They could make more precise decision in their business. Since commercial lenders and bankers

need better and more reliable agricultural information, they could know better where and how much to loan farm credits, including credit for farm product traders. Consumers could improve their purchasing of farm products because they would know better where and when the farm commodities would be in good supply.

Accordingly, the people at all levels could reduce the cost of their business and the cost of living. This may imply that people in Thailand would have higher real income. Therefore, the government of Thailand would be able to levy higher taxes. Then the government would possibly have a greater budget for public investment.

Government offices would have better data on agriculture for planning their programs, such as the Agricultural Extension Program, the Farm Demonstration Program, the Soil Research Program, the Crop Breeding Program, the Livestock Improvement Program, the Insect and Pest Elimination Program, the Public Irrigation Program, the Highway Construction Program, the Rural Community Development Program, the Farm Credit Program, the Farm Cooperative Extension Program, the Fertilizer Production Program, the Agricultural Education Program, and many other programs. When these programs are properly planned with better agricultural information, they would result in an increase of Gross National Products and better level of living for the people in Thailand. Then the whole society and economy of Thailand would be improved effectively.

The reliable and up-to-date data would also be more useful for making commercial contracts both inside the country and in international trading. The exporters of agricultural commodities could make better decision in making commercial contracts with traders in the foreign markets. It would help Thailand to maintain and expand foreign markets of her agricultural products. In addition, the Thai government could make better decisions in regulating the quota exported for agricultural products. This would help to improve agricultural marketing of Thailand. The ultimate benefit would then belong to the whole nation. The prices of agricultural commodities would be stable, and probably higher. Thai farm families, who compose approximately 80 percent of the total population, would gain more income. They would be able to buy more consumer goods and services, and farm inputs. This would induce an expansion for all nonfarm activities too. Therefore, there would be a greater demand for employment. The industries that produce consumer goods and farm inputs would need more labor for their output expansion. People would have more opportunity to get a job. It would help to reduce the percentage of unemployment. Most people, for all sectors, would earn income and meanwhile they would have higher purchasing power to buy consumer's and production goods.

Since there would be a greater demand for consumer goods and farm inputs, producers of these goods would be able

to expand their output at a cheaper cost per unit of output. The prices of these goods would be lower so that people could buy more things. They would be able to improve their level of living. Then the whole society and the economy of Thailand would be improved effectively. This would be an indication of the prosperity of the Thai nation. Thus, the cost of this sample survey relative to the national benefit to the country would seem justified in regards to the investment made. Since the benefits obtained from this sample survey would exceed the costs of the survey, such a survey should be conducted in Thailand as soon as possible and on a continuing basis.

CHAPTER IV

SUMMARY AND CONCLUSION

While the economy of Thailand depends largely on agriculture, the situation in the agricultural sector itself seems still to be unfavorable. Agricultural marketing conditions are very poor. Farmers do not have accurate data for making decisions in farm planning and selling farm products. The problem of international trade consequently arises. Many national development projects of the government are rarely successful. One major cause of the worse situations is the lack of reliable and up-to-date agricultural data. To remedy this crucial problem, improvement in methods of collection and estimation of agricultural statistics are urgently needed. The main purpose of this paper is to propose a modern method that would be applicable in estimating agricultural statistics for the current year in Thailand.

In Thailand, besides the ten year interval agricultural census conducted by the National Statistical Office, annual agricultural data are regularly collected by various departments in the Ministry of Agriculture, and by some departments in the other ministries. Then, the data are ultimately compiled and published by the Division of Agricultural Economics, Ministry of Agriculture, in the annual

report "Agricultural Statistics of Thailand." Mostly, the data are collected at the primary sources by the kamnan and phuyaiban who do not have enough time to make all reports correctly and completely. There are frequent delays and even missing reports. This results in unreliable and out-of-date agricultural statistics in Thailand.

The Division of Agricultural Economics is responsible for compiling and publishing the annual agricultural statistics of Thailand but it can not acquire accurate and timely data. Any method that would furnish reliable and up-to-date data should be considered. The sampling survey is designed and proposed to furnish accurate and up-to-date data. This sampling survey is based on probability sampling techniques. It would provide the modern techniques and procedures in collecting and estimating agricultural statistics that would be reliable and up-to-date.

The method of cluster and multi-stage sampling is used in this survey. The population for the survey is the total farm households located in each amphur. The population is divided into clusters on the basis of administrative units ranked by tambon, muban, and the farm household which is the smallest sampling unit. The samples of farm households are selected from each muban sampled, and the samples of muban are selected from each tambon sampled. Sampling without replacement is employed at all stages of sampling because it is more efficient.

In collecting data at the primary source, it is suggested that a new staff be created for the field work. The field work staff is directly under the authority of the Division of Agricultural Economics, Ministry of Agriculture, and is responsible for the collection of primary data as routine work. The staff should be intensively trained for field work procedures and techniques. Therefore, this new staff for field work would perform the job in collecting data for this sample survey better than the kamnan and the phuyai-ban or the local school teacher. The data would be gathered objectively by the trained enumerator. The questionnaires completed would be returned on time for the schedules.

Personal interviews would be most appropriate in collecting information at the primary sources for this survey since most farmers do not have telephones, and they can not read or write. Many of questions in the questionnaires may require the interviewer to offer explanations to farmers. By personally interviewing the farmer, the enumerator also has the opportunity to observe the environment of the farm to obtain better information.

The schedules of field work are divided into three periods. Schedule I mainly covers area planted to crops during April 1 to September 30. The amount of livestock on hand on a particular day is also covered. The survey for this schedule is conducted during September. Schedule II deals with area damaged of crops during April 1 to December 31.

The survey is performed during December. Schedule III mainly involves production, area harvested of crops. However, the questions about other information involved in agriculture may be added to the questionnaires as the need arises.

In estimating data, the estimates for the muban sampled are used as the expansion factor in estimating final data for the tambon. The amphur estimates are the sum of the estimates for the tambon. The amphur estimates are also added to obtain the changwad estimate. The total for the whole country finally is the sum of the totals for the changwad.

This sample survey is based on the probability sampling principle, hence, the degree of precision of estimates (standard error of estimate) can be computed. The agricultural statistics estimated by this sample survey would be reliable. In addition, a new staff with intensive training for the field work of this survey would be directly authorized by the Division of Agricultural Economics. The survey should be performed strictly on time for each survey schedule, and questionnaires completed should be returned timely. There would be no delay in processing and estimating data. So the agricultural statistics estimated by this sample survey would be more reliable and up-to-date than the current method.

Clearly, this sample survey would furnish Thailand reliable and up-to-date agricultural statistics. These more accurate data are badly needed by various sectors of the country including international uses. The action program

for country development, and the condition of agricultural marketing, both inside and outside of the country, would be improved. The benefits would belong to the whole nation of Thai people. On the contrary, a small bulk of the budget is required for this sample survey. Because the expected benefits from this sample survey are greater than the expected budget required, this paper strongly recommends that the government of Thailand conduct this sample survey as soon as possible.

However, personal experiences have shown that the weak point of the current method in gathering agricultural data in Thailand is mainly from personnel problems. Although it is suggested that a new staff be created for this sample survey, it might not produce good work unless there is a good organization and administration. Poor work of the field staff could be a major cause of sampling error and even bias. For the success of this sample survey, the occurrence of any error should be minimized. Hopefully, this sample survey will be successful in providing reliable and up-to-date agricultural statistics with efficient uses of time and resources.

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APPENDIX

APPENDIX

Derivation of Estimates

I. Muban Level

A. The statistics for the j^{th} muban sampled of the i^{th} tambon sampled in the h^{th} amphur surveyed.

1. Total, X_{hij}

$$X_{hij} = \sum_{k=1}^{n_{hij}} X_{hijk}$$

2. Mean, $\bar{X}_{hij}$

$$\bar{X}_{hij} = \frac{X_{hij}}{n_{hij}}$$

$$= \frac{1}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk}$$

3. Variance of mean, $V(\bar{X}_{hij})$

$$V(\bar{X}_{hij}) = \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1}$$

B. The estimates for the i^{th} muban sampled of the i^{th} tambon sampled in the h^{th} amphur surveyed.

1. Estimate of total, $\hat{X}_{hij}$

$$\hat{X}_{hij} = \frac{N_{hij}}{n_{hij}} \cdot X_{hij}$$

$$= \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (1)$$

2. Estimate of mean, $\hat{\bar{X}}_{hij}$

$$\hat{\bar{X}}_{hij} = \frac{\hat{X}_{hij}}{N_{hij}}$$

$$= \frac{1}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (2)$$

3. Variance of estimates

a) Variance of mean, $V(\hat{\bar{X}}_{hij})$

$$V(\hat{\bar{X}}_{hij}) = \frac{1}{n_{hij}} \cdot V(\bar{X}_{hij})$$

$$= \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (3)$$

b) Variance of total, $V(\hat{X}_{hij})$

$$V(\hat{X}_{hij}) = N_{hij}^2 \cdot V(\bar{X}_{hij})$$

$$= \frac{N_{hij}^2}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (4)$$

II. Tambon Level

A. The statistics for the i^{th} tambon sampled in the h^{th} amphur surveyed.

1. Total, X_{hi}

$$X_{hi} = \sum_{j=1}^{n_{hi}} \hat{X}_{hij}$$

$$= \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk}$$

2. Mean, $\bar{X}_{hi}$

$$\bar{X}_{hi} = \frac{X_{hi}}{n_{hi}}$$

$$= \frac{\sum_{j=1}^{n_{hi}} \hat{X}_{hij}}{n_{hi}}$$

$$= \frac{1}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk}$$

3. Variance of mean, $V(\bar{X}_{hi})$

$$V(\bar{X}_{hi}) = \sum_{j=1}^{n_{hi}} V(\hat{\bar{X}}_{hij})$$

$$= \frac{n_{hi}}{\sum_{j=1}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1}$$

B. The estimates for the i^{th} tambon sampled in the h^{th} amphur surveyed.

1. Estimate of total, $\hat{X}_{hi}$

$$\hat{X}_{hi} = \frac{N_{hi}}{n_{hi}} \cdot X_{hi}$$

$$= \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (5)$$

2. Estimate of mean, $\hat{\bar{X}}_{hi}$

$$\hat{\bar{X}}_{hi} = \frac{\hat{X}_{hi}}{N_{hi}}$$

$$= \frac{1}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} Xhijk \qquad (6)$$

3. Variance of the estimates

a) Variance of mean, $V(\hat{\bar{X}}_{hi})$

$$V(\hat{\bar{X}}_{hi}) = \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot V(\bar{X}_{hi})$$

$$= \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{h_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (7)$$

b) Variance of total, $V(\hat{X}_{hi})$

$$V(\hat{X}_{hi}) = \left(\sum_{j=1}^{n_{hi}} N_{hij} \right)^2 \cdot V(\hat{\bar{X}}_{hi})$$

$$= \frac{\left(\sum_{j=1}^{n_{hi}} N_{hij} \right)^2}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (\bar{X}_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (8)$$

III. Amphur Level

A. The statistics for the h^{th} amphur surveyed.

1. Total, X_h

$$X_h = \sum_{j=1}^{n_h} \hat{X}_{hi}$$

$$= \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk}$$

2. Mean, $\bar{X}_h$

$$\bar{X}_h = \frac{X_h}{N_h}$$

$$= \frac{1}{N_h} \cdot \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk}$$

3. Variance of mean, $V(\bar{X}_h)$

$$V(\bar{X}_h) = \sum_{i=1}^{n_h} V(\hat{\bar{X}}_{hi})$$

$$= \sum_{i=1}^{n_h} \frac{1}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1}$$

$$\sum_{j=1}^{n_{hij}} n_{hij}$$

B. The estimates for the h^{th} amphur surveyed

1. Estimate of total, $\hat{X}_h$

$$\hat{X}_h = \frac{N_h}{n_h} \cdot X_h$$

$$= \frac{N_h}{n_h} \cdot \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \sum_{k=1}^{n_{hijk}} X_{hijk} \qquad (9)$$

2. Estimate of mean, $\hat{\bar{X}}_h$

$$\hat{\bar{X}}_h = \frac{\hat{X}_h}{N_h}$$

$$= \frac{1}{n_h} \cdot \sum_{i=1}^{n_h} \frac{N_{hi}}{n_{hi}} \cdot \sum_{j=1}^{n_{hi}} \frac{N_{hij}}{n_{hij}} \cdot \sum_{k=1}^{n_{hij}} X_{hijk} \qquad (10)$$

3. Variance of the estimates

a) Variance of mean, $V(\hat{\bar{X}}_h)$

$$V(\hat{\bar{X}}_h) = \frac{1}{\sum_{i=1}^{n_h} n_i} \cdot V(\bar{X}_h)$$

$$= \frac{1}{\sum_{i=1}^{n_h} n_{hi}} \cdot \sum_{i=1}^{n_h} \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (11)$$

b) Variance of total, $V(\hat{X}_h)$

$$V(\hat{X}_h) = \left(\sum_{i=1}^{n_h} N_i \right)^2 \cdot V(\hat{\bar{X}})$$

$$= \frac{\left(\sum_{i=1}^{n_h} N_{hi} \right)^2}{\sum_{i=1}^{n_h} n_{hi}} \cdot \sum_{i=1}^{n_h} \frac{1}{\sum_{j=1}^{n_{hi}} n_{hij}} \cdot \sum_{j=1}^{n_{hi}} \frac{1}{n_{hij}} \cdot \frac{\sum_{k=1}^{n_{hij}} (X_{hijk} - \bar{X}_{hij})^2}{n_{hij} - 1} \qquad (12)$$