PN-ABA-688

Grain Storage, Processing and Marketing

Research Report 19
October 1980

Application of Transportation Linear Programming for Optimum Number and Location of Public Rice Warehouses in Sri Lanka

KSU
KANSAS STATE UNIVERSITY

FOOD & FEED GRAIN INSTITUTE
MANHATTAN, KANSAS 66506

PN-AEL-680

REPORT SUMMARY

Title of Report/Publication: Application of Transportation Linear Programming for Optimum Number and Location of Public Rice Warehouses in Sri Lanka

Authors: Cornelius Hugo, Dr. Roe Borsdorf and Dr. Richard Phillips, Agricultural Economics Department, Kansas State University, Manhattan, Kansas

Period of Report/Publication: September 1978 through October 1980

Project Title: Technical Assistance in Grain Storage, Processing, and Marketing and Agribusiness Development

Contract Number: AID/ta-C-1162

Contractor: Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas

Principal Investigator: Cornelius Hugo

SUMMARY STATEMENT

The specific objective of this study was to evaluate the distribution characteristics of the current public rice rationing volume used in Sri Lanka and to suggest ways of improving the efficiency. Linear transportation analysis was used to determine optimum number and location of intermediate government rice warehouses.

Eighteen different combinations ranging from 54 to 13 locations for future public rice warehouses were analyzed. A range of 18 to 25 sites were found to affect total transportation costs on the most favorable way. Furthermore, for minimum inland transportation costs, the ports of Colombo and Galle are suggested as import points for required deficit coverage.

Finally, a core study format was used in the preparation of this report enabling its future use during in-house and country short courses.

APPLICATION OF TRANSPORTATION LINEAR PROGRAMMING FOR OPTIMUM NUMBER AND LOCATION OF PUBLIC RICE WAREHOUSES IN SRI LANKA

Prepared by

Cornelius Hugo
Dr. Roe Borsdorf
and
Dr. Richard Phillips

Prepared for the
AGENCY FOR INTERNATIONAL DEVELOPMENT
UNITED STATES DEPARTMENT OF STATE

AID/ta-C-1162
Technical Assistance in Grain Storage, Processing, and Marketing
and Agribusiness Development

at the

FOOD AND FEED GRAIN INSTITUTE
Kansas State University
Manhattan, Kansas 66506

Dr. Charles W. Deyoe, Director

TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF FIGURES	vi
ACRONYMS AND DEFINITIONS	vii
PREFACE	ix
CHAPTER	
I. BACKGROUND AND RECENT PRECEDENTS TO THIS STUDY	1
Introduction	1
The GSL Rice Rationing Scheme	1
Background of Food and Feed Grain Institute Involvement	4
Purpose, Scope, and Objective of First Food and Feed Grain Institute Study	7
Purpose and Objectives of this Study	8
II. SUMMARY OF RESULTS AND CONCLUSIONS	11
Introduction	11
Selection of Best Alternative	11
Qualifications	17
Further Recommendations	19
III. SUPPLY AND DEMAND ANALYSIS	21
Introduction	21
Population	21
Projections of Rice Ration Demand	22
Projections of Rice Ration Supply	25
Deficit and Imports	25
Import Allocation	30
IV. DISTRIBUTION AND LOCATIONAL ANALYSIS	35
Introduction	35
Transportation Cost Functions	35
Minimum Distance and Cost Distribution Networks for the Third and Fourth Marketing Levels	38
Linear Programming Solution	42

Page

V. TRANSPORTATION LINEAR PROGRAMMING METHODOLOGY AND PROCEDURAL APPROACH 55

Introduction 55
Application of the Transportation Linear Programming Model 56
1. The Model 57
2. Procedural Approach 63

VI. TRANSPORTATION LINEAR PROGRAMMING INPUT REQUIREMENTS METHODOLOGY AND PROCEDURAL APPROACH 69

Introduction 69
Projection of Supply 69
Projection of Demand 74
Transportation Network Requirements. 77
1. Node Identification and Link Measurements. 77
2. Basic Network. 80
3. Minimum Distance Network 81
4. Transportation Cost Functions. 82
5. Least Cost Distribution Networks 85
6. Combined Least Cost Distribution Networks for Alternative Modes 85

APPENDIX A 87

APPENDIX B 91

APPENDIX C 101

APPENDIX D 127

APPENDIX E 153

APPENDIX F 159

APPENDIX G 163

APPENDIX H 167

APPENDIX I 183

BIBLIOGRAPHY 187

LIST OF TABLES

TABLE		Page
1.	Projected Number of Rice Ration Recipients by District. . .	23
2.	Projected Volume of Ration Rice to be Distributed to Rice Ration Recipients in Tons	24
3.	Milled Domestic Rice Available 1979-1985 for Rice Ration System by District.	26
4.	Rice Rationing System Surplus and Deficit Balances by District.	27
5.	Annual Import Allocation for Minimum Internal Transportation Costs	32
6.	Transport Cost Functions.	37
7.	Minimum Distance and Cost Distribution Networks	39
8.	Combined Least-Cost Distribution Network File for Alternative Modes.	41
9.	Ranking of Food Commissioner Warehouses Indicating Locational Preference with Respect to Rice Mills and Multiple Purpose Cooperative Society Stores.	44
10.	Minimum Transportation Costs for Unconstrained Solutions.	48
11.	Summary of Transportation Costs Associated with Optimum Numbers and Locations of Food Commissioner Supply Stations.	50
12.	Summary of Transportation Costs Associated with Thirteen Preselected Food Commissioner Supply Stations and Additional Locations.	53

LIST OF FIGURES

FIGURE		Page
1.	Sri Lanka Paddy-Rice Marketing System.	2
2.	Minimum Transportation Costs Associated with Alternative Number and Locations of Rice Storage Facilities	12
3.	Optimum Ration Rice Distribution Pattern Associated with Thirteen Preselected Storage Facilities.	14
4.	Optimum Ration Rice Distribution Pattern Associated with Eighteen Storage Facilities.	15
5.	Projected Surplus and Deficit Districts.	29
6.	Relative Magnitudes of Ration Rice Surplus and Deficit by District	31
7.	Site Selection Configuration for Future Food Commissioner Storage Facilities	47
8.	Schematic Diagram of Procedural Approach to Linear Transportation Analysis	70
9.	Forecasting Approach for Supply and Demand Projections	73

ACRONYMS AND DEFINITIONS

FC - Food Commissioner

PMB - Paddy Marketing Board

RM - Rice Mills

PC - Purchase Centers

MPCS - Multiple Purpose Cooperative Society

GSL - Government of Sri Lanka

FFGI - Food and Feed Grain Institute

Tons - Long ton of 2,240 pounds

Rs - Rupee (Sri Lanka's currency)

PREFACE

This research report has been prepared from a dissertation research project carried out by Cornelius Hugo while attending Kansas State University on a University Research Assistantship. The research was entirely supported under Contract AID/ta-C-1162.

Since World War II, successive governments of Sri Lanka have been directly involved with the operation of a rice subsidy scheme whereby a significant segment of the population has been provided with a subsidized weekly rice ration. This welfare system, though providing sufficient additional caloric intake to those affected by it, has diverted significant quantities of limited resources from perhaps potentially more beneficial undertakings.

The awareness of the high costs incurred by the subsidy system and opportunities foregone brought about the involvement of the Food and Feed Grain Institute in assisting the Government of Sri Lanka in, among other things, reviewing the current rice ration distribution system and assessing potential improvements.

The focus of this study limited itself to a transportation-distribution analysis of the current ration rice distribution system. More specifically, it sought to find optimum location and number of public rice warehouses used in the distribution system throughout the country. However, due to the peculiar structure of the distribution system and the magnitude of the same, the solutions obtained are of a feasible-rational rather than feasible-optimum nature.

Parts of a computerized system for feasible agribusiness development was used for the analysis. Relevant projections of supply and demand were developed from primary data with the Master Projection Program. Necessary transportation cost functions and other network information was obtained from surveys, other studies, and other specific computer programs. Finally, the Linear Transportation Analysis Program was used to analyze the distribution of ration rice from rice

mills and import points to public warehouses and to distribution centers.

Given the number and locations of rice mills and distribution centers for ration rice, a total of 56 potential sites for public rice warehouses were analyzed. Successive eliminations of undesirable sites resulted in a total of 18 possible site selection combinations ranging from 54 to 13 sites. Also, 13 sites selected by the Office of the Food Commissioner prior to the analysis were analyzed. A total of eight (8) were found to be in less than desirable locations with respect to the rice mills and distribution centers. Finally, estimated annual deficits for the rice ration system were determined and allocated for importation to the ports of Colombo and Galle for "minimum" inland transportation cost and "optimum" distribution pattern.

The results of these analyses suggest that more than 50 percent of public rice warehouses currently used can be removed from the existing distribution system without impacting significantly on transportation costs. However, further reductions in the number of these storage facilities within a range of 25 to 13 locations tend to have increasingly greater impacts on transportation costs. Therefore, apparent significant benefits in terms of operational savings and increased overall efficiency can be derived by removing 31 to 43 storage facilities from the current distribution system of ration rice.

Due to data and other constraints, as well as scope of work, this study did not address exact tradeoffs between operational (storage) and transportation costs. For the same reasons long-term projections and analysis were not undertaken. Nevertheless, very attractive benefits can be obtained from a modification of the current ration rice distribution system, and changes should be implemented, since it is felt strongly that the omitted tradeoff analysis would only substantiate such changes.

CHAPTER I

BACKGROUND AND RECENT PRECEDENTS TO THIS STUDY

Introduction

This chapter summarizes in a brief manner the general background and recent precedents which brought about this study. The background material is approached from a current point of view which deals with the most recent developments leading up to this study.

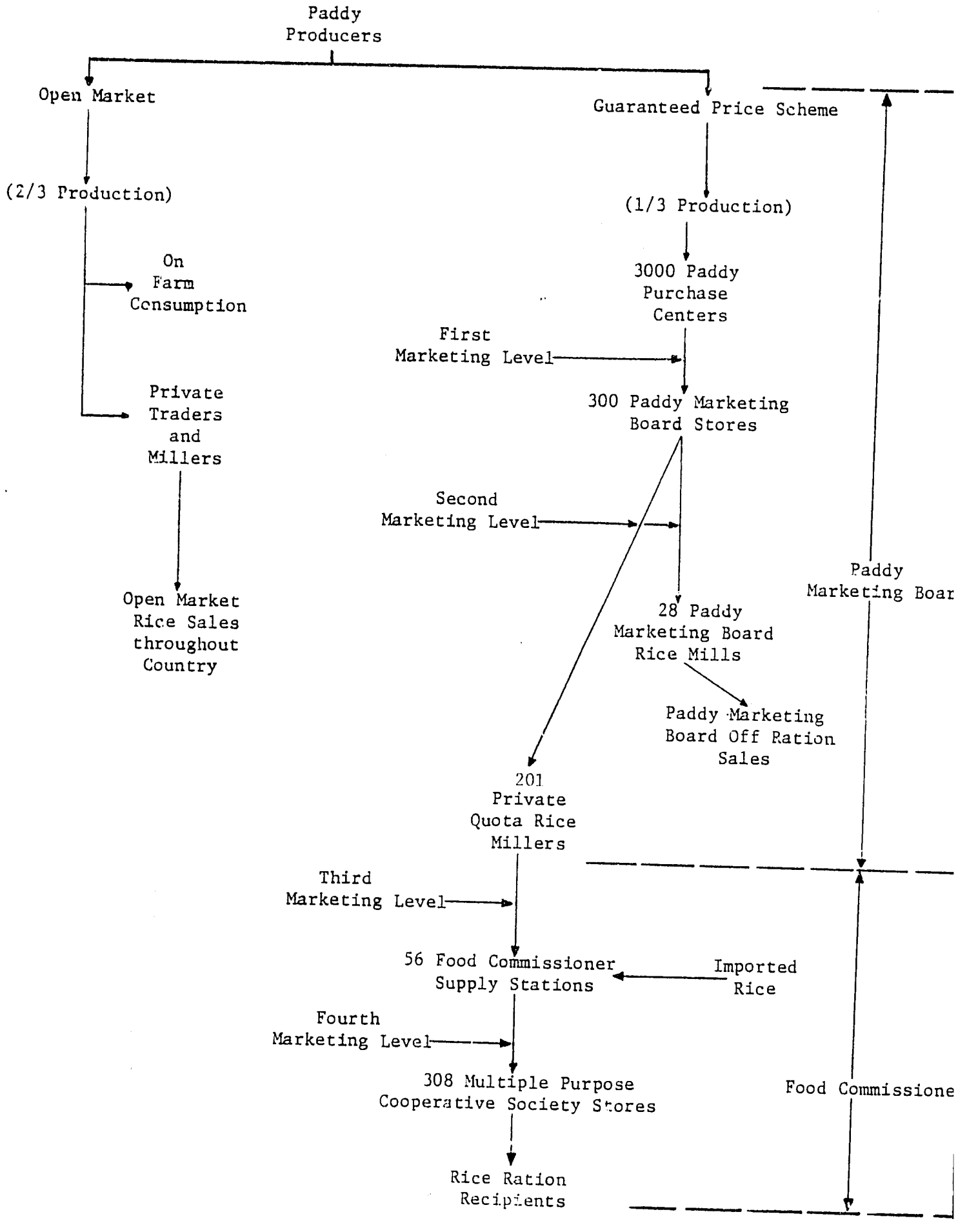
The GSL Rice Rationing Scheme

Since World War II, successive governments of Sri Lanka have been directly involved in maintaining and operating food rationing subsidy programs. The broad objectives of these social programs have been far reaching and include general welfare of consumer, employment, conservation of foreign exchange, national self-sufficiency, income enhancement of the farmer and the encouragement of adequate nutrition. One of the most important government activity has been the operation of a rice rationing scheme whereby consumers have been provided with a subsidized weekly rice ration, supplementary to that obtained from the open market or from their own production.

Figure 1 summarizes the current structure and channels of the paddy-rice marketing system in Sri Lanka. Roughly one-third of the paddy production available for marketing is siphoned off by the Paddy Marketing Board into the rice ration system via the Guaranteed Price Scheme. The Paddy Marketing Board procures the paddy at the first marketing level through approximately 3000 paddy Purchasing Centers located throughout the country which supply the paddy to 300 Paddy Marketing Board warehouses. At the second marketing level, the paddy is milled by 28 rice mills owned by the Paddy Marketing Board and 201 private millers under contract to the Board. At the third marketing level, the milled rice is then turned over to the Food Commissioner for storage at 56 warehouses and subsequent

FIGURE 1

SRI LANKA PADDY-RICE MARKETING SYSTEM



rationed distribution in the fourth marketing level through 308 Multiple Purpose Cooperative Society stores located throughout the country. The annual deficit in the rice ration is made up by imports under the jurisdiction of the Food Commissioner. Generally, imports arrive during the "lean" months of November through March.

The open market side of the rice industry is composed of hundreds of small private traders and millers who purchase directly from the farmer or intermediaries and resell the paddy or rice after storage and processing.

Movements in world prices for rice and quantities available in the international market have caused changes in the relative quantities of free and subsidized rice from time to time. More specifically, these external influences have been such that whenever a sharp rise in the world prices of rice occurred, it was followed by a change in the rice ration - either in the quantity issued or the price charged - and a further intensification of the domestic production program.

In spite of these changes in the rice rationing scheme, population growth alone has created a general tendency for the total volume of subsidized rice to increase. Today, there are about 8 million people, or one-half the total population, holding ration cards. These card holders are entitled to the present rice ration which consists of one pound of free rice, plus three pounds of rice at Rs. 1.0 per pound per person per week for a total of four (4) pounds at a total cost of Rs. 3.0 per person per week.

It is beyond the scope of this paper to study the historical and future welfare implications as well as the opportunity costs and/or complementarities with growth of the rice ration subsidy scheme. However, over the years this system has helped provide adequate nutrition to millions of people by assuring a regular supply of a certain amount of the staple food at subsidized price to a large portion of the population, which also, in a indirect way, has helped

increase the real income of the recipients. On the other hand, limited capital resources which have been expended on the rice subsidy might have been used on development projects of possibly greater social benefit from the point of view of economic growth. Although the impact on consumer welfare, particularly the welfare of those in low income groups, cannot be denied, the cost of the government when such a large number of people are involved has been great.

Sri Lanka's ration and subsidy programs, though effective due to their extensive coverage have preempted an average of 20 percent of total public expenditures in the past 15 years. Better targeting of such programs and streamlining of government agencies involved with their implementation would help reduce the cost of operating these programs and free limited resources for other development efforts.

In order to improve this situation, the current government has pledged to eliminate flour subsidies in return for foreign exchange support by the International Monetary Fund. Also, the government has agreed to devalue the rupee, liberalize imports, dismantle exchange and price controls, and reorganize inefficient state enterprises.[1]

Background of Food and Feed Grain Institute Involvement

The following is a brief chronological review of the developments during 1978 and 1979 which lead to the Food and Feed Grain Institute involvement in the GSL's sector of the paddy and rice marketing industry and subsequent analytical work.

In January 1978, the Food and Feed Grain Institute responded to a request made by USAID/Colombo regarding a review of the GSL's participation in the paddy and rice marketing industry. After consultations with government officials and

---

[1] Milling and Baking News, Sri Lanka Ending Flour Subsidies, March, 1980. Vol. 59, No. 4. p. 51.

USAID personnel, four general areas were identified for review, these being:[1]

I. Organizational Requirements.

II. Human Resource Development.

III. Critical and Unresolved Issues within the Total Marketing System.

IV. Related Policy Considerations.

While all four areas are relevant and important to the GSL's paddy and rice marketing sector, the subsequent Food and Feed Grain Institute study concerned itself with the third area which, among other things, dealt with the "effective use of transport" (and facilities).[2]

Due to the complexity and costs associated with an industry-wide study, however desirable, it was "suggested that the analysis of the transport problem be limited to commodity flow of paddy and rice within the Paddy Marketing Board/ Food and Commissioner complex."[3]

Assuming proper data could be found and assembled, several key questions could be answered by using a computerized system available to the Institute at Kansas State University. Key questions which could be addressed were given as follows:[4]

I. Cost of moving GSL procurement of paddy and rice in current channels.

II. Transport requirement levels.

III. Test locational storage and processing options, i.e., the idea presented by GSL staff of reducing the number of rice mills, paddy, and rice storage locations for improved quality control and transportation cost minimization.

---

[1]Roe Borsdorf, "Relevant Issues and Guidelines for Assessment of Issues Related to Phase II Development Projects within the Paddy and Rice Marketing Sectors of Sri Lanka." Food and Feed Grain Institute, January, 1978. p. 1.

[2]Ibid., (and facilities) has been added for clarification, p. 3.

[3]Ibid., p. 17.

[4]Ibid., p. 17.

Answers to the previous questions would provide a group of alternatives from which selections could be made regarding additional transport equipment needed, milling capacity requirements, and different configurations of paddy and rice storage facilities.

Subsequent consultations between the USAID/Colombo staff and GSL officials ended in Dr. Borsdorf's return to Sri Lanka in March 1978 for further assistance. During this trip, "a great deal of support for the suggested activity (study) from the Ministry of Agriculture"[1] was discovered and an outline for the required data for an analysis of the GSL's paddy and rice marketing sector was elaborated and presented to the USAID/Colombo staff and officials to be gathered, assembled, and delivered to Kansas State University. Also, the goals of the proposed transportation and commodity flow study were refined and modified to better suit the objectives of GSL.

Shortly thereafter, in May 1978, the author joined the project which, at that time, was in the process of reviewing the information received from Sri Lanka and was beginning to develop a tentative procedural outline and to measure highway distances on accurate maps provided by GSL officials.

The first Interim Report of June 1978 provided an up-to-date summary on the present status of data collection and assembly, further information requirements, and, in order to test the methodology, a trial analysis of paddy and rice movements in one of the 22 districts.[2]

In August of 1978, Dr. Borsdorf and the author spent 4 weeks in Sri Lanka explaining the preliminary work completed on future production potentials and locational analysis of the GSL sector of the paddy and rice marketing industry,

---

[1] Roe Borsdorf, "Outline for Sri Lanka Paddy and Rice Transportation Analysis," a Working Paper, Food and Feed Grain Institute, April 5, 1978, p. 1.

[2] Roe Borsdorf and Cornelius Hugo, Interim Report #1. Sri Lanka Transport and Locational Analysis. Food and Feed Grain Institute, June 15, 1978.

collecting and inspecting further required information for the study, and developing a final work plan with target dates for supplying results to USAID/Contractor in Colombo.[1]

During the fall of 1978, the procedural outline finalized during the previous TDY assignments in Sri Lanka was implemented as closely and extensively as possible. The results of that study are summarized in the final report.[2]

Purpose, Scope, and Objective of First Food and Feed Grain Institute Study

The basic purpose of the Food and Feed Grain Institute study is to discover means for reducing certain marketing costs associated with the purchasing, storage, and processing of paddy, and the distribution of milled rice by streamlining the existing government subsidy system and thereby reducing transportation costs.[3]

The study is limited to the government sector of the paddy and rice marketing industry.[4] This sector encompasses the purchasing, storage, distribution of paddy, and rice milling under the authority of the Paddy Marketing Board, and the receipt at warehouses and distribution of polished rice to distribution points under the authority of the Food Commissioner.

The basic objective is to determine needed storage, milling, and distribution configuration that minimize certain marketing costs in the paddy and rice distribution system under study. Other objectives are:

1. To project production of paddy and forecast required procurement levels to determine additional needs for storage and milling facilities.

2. To ascertain real transportation cost as related to rates paid for movement of paddy and rice.

---

[1] Assistance request, Sri Lanka, August 11 to September 10.

[2] Borsdorf, Roe and Cornelius Hugo, "Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lanka Rice Industry." Food and Feed Grain Institute, January, 1979.

[3] Ibid., p. 1.

[4] Ibid., p. 2.

3. To test for viable locations of needed paddy storage by cost minimizatior of transport.

4. To test for viable location of needed milling by cost minimization of transport.[1]

The Institute study sought to address transportation, sizing, and locational questions dealing with the flow of paddy at the first two marketing levels; that is, the flow of paddy from purchasing centers to the Paddy Marketing Board warehouses and from these warehouses to the rice mills, as well as related policy aspects, institutional development, and market research needs.

Purpose and Objectives of this Study

The basic purpose of this study is to undertake a transportation and locational analysis of the third and fourth marketing levels of the rice rationing scheme in order to complete a least-cost distribution network proposal for the system as requested by the Food Commissioner's office.[2]

The overall objective of the present study is to discover ways of reducing certain marketing cost associated with the distribution of milled rice to rice ration recipients. These cost reductions can be realized by a general streamlining of the current government rice ration distribution system and thereby reducing associated transportation and other operational costs. Accordingly, the scope of this study is limited to the government sector of the rice industry.

The specific objectives are based on a request by the Food Commissioner's office regarding 13 new Food Commissioner Complexes which would take over the functions of the existing 56 Supply Stations.[3]

---

[1] Chapter I, p. , #1, pp. 2-3.

[2] Appendix A. Attached memo from Y. Wimberly, USAID/Contractor.

[3] Chapter I, p. , #2.

In view of the above, the specific objectives of this study entail the following:

1. Determine optimum shipping pattern for minimum transportation costs for the 56 Supply Stations currently used in the third and fourth marketing levels of the rice rationing system.

2. Determine optimum shipping patterns for minimum transportation costs for a range of 56 to 13 Supply Stations by eliminating least desirable locations for intermediate storage facilities.

3. Using the same supply and demand quantities, determine optimum shipping patterns for minimum transportation cost for the third and fourth marketing levels using the proposed 13 Food Commissioner Complexes as milled rice warehouses.

4. Using sensitivity analysis, determine whether or not the proposed 13 Food Commissioner Complexes are optimally located, and whether or not 13 is the optimal number of facilities for transport cost minimization and optimum distribution pattern.

5. Determine optimum points of import and quantities of rice to be imported through each port for minimum inland transportation cost.

These specific objectives address improvement of the distribution system of the rice rationing system without altering its current basic structure of commodity flow. A linear transportation analysis of the rice rationing system is undertaken to determine optimum distribution patterns for minimum transportation costs under different conditions. More specifically, the current study addresses the impact of such determinant variables as location and total number of storage facilities.

A final objective of the author is to document this work in a case study approach. This will allow the report to be used as reference for teaching applied quantitative analysis during in-country short courses presented by the Food and Feed and Feed Grain Institute.

CHAPTER II

SUMMARY OF RESULTS AND CONCLUSIONS

Introduction

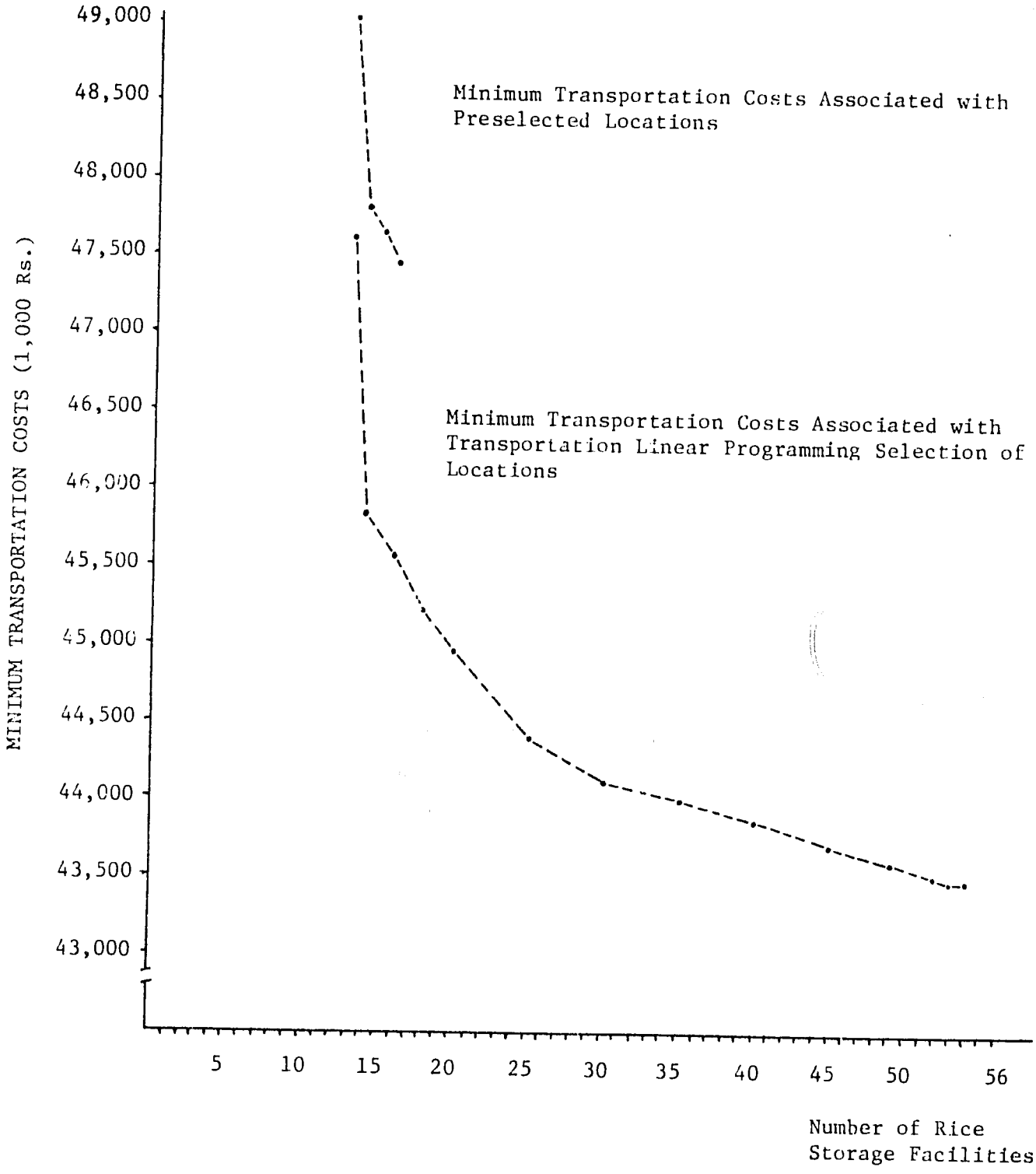
The basic purpose of this study was to analyze, from a transportation point of view, the current rice ration distribution system as well as modifications suggested for its improvement. Initially, alternative number and locations for intermediate supply centers were provided by the Office of the Food Commissioner. Subsequent transportation linear analysis of the existing distribution system and the suggested alternative resulted in a series of options ranging from a maximum of 74 intermediate storage facilities to as few as 13. Although the final selections of number and location for intermediate ration rice storage facilities will be influenced by other considerations besides those provided in this study, the transportation linear programming analysis of the ration rice distribution system sheds light on the tradeoffs available in terms of their impact on transportation costs.

Selection of Best Alternative

The results of the unconstrained linear programming solutions suggest that out of 56 supply stations being currently used, at least two (2), namely #7004 and #7176 in the districts of Jaffna and Amparai respectively, could be closed down without any detrimental effects on the current distribution system. Furthermore, as shown in Figure 2, a further reduction in the number of supply stations to around 25, as given by the modified solution F-8 of Table 11, would not tend to increase overall distribution costs significantly. These costs would increase by about Rs. 830,000 to approximately Rs. 44,400,000. However, further reductions in the number of supply station locations below those given

FIGURE 2

MINIMUM TRANSPORTATION COSTS ASSOCIATED WITH ALTERNATIVE NUMBER AND LOCATIONS OF RICE STORAGE FACILITIES



by the modified solution F-8 would tend to increase total transportation costs significantly. As shown in Figure 2, this is evident as the rate at which transportation costs increase steepens considerably as the number and location of supply stations drops below 20.

Finally, Figure 2 also shows the relative impact on transport costs of sites preselected by the Office of the Food Commissioner and the equivalent number of sites selected by linear transportation analysis. As stated before, eight (8) out of thirteen (13) preselected locations conflicted with the transportation linear programming selections. From a transportation point of view alone, the cost differential attributable to location conflicts in eight (8) out of thirteen (13) sites amounts to Rs. 1.5 million and increases to nearly Rs. 2 million when 16 sites are compared. Furthermore, the preselected number of supply stations would have to be increased to fifteen (15) in order to match the minimum transportation costs associated with thirteen (13) computer selected sites.

An illustration of the impact of alternative and/or additional sites on the assembly and distribution patterns to and from the supply stations and therefore on transportation costs is shown in Figures 3 and 4. Figure 3 shows the assembly and distribution patterns of ration rice associated with the thirteen (13) preselected sites. Figure 4 shows the same type of patterns for eighteen (18) computer selected sites. Some of the major impacts can be summarized as follows.

By adding the "best" computer selected sites in the districts of Jaffna and Mannar and abandoning the preselected site at the city of Mankulam for the "best" site in the district of Vavuniya, the assembly and distribution pattern for ration rice attains a high degree of unilateral flow. First, double hauling of milled ration rice from the district of Jaffna to the district of Vavuniya and back is totally eliminated. Second, the additional ration rice needed

FIGURE 3

OPTIMUM RATION RICE DISTRIBUTION PATTERN ASSOCIATED WITH THIRTEEN PRESELECTED STORAGE FACILITIES

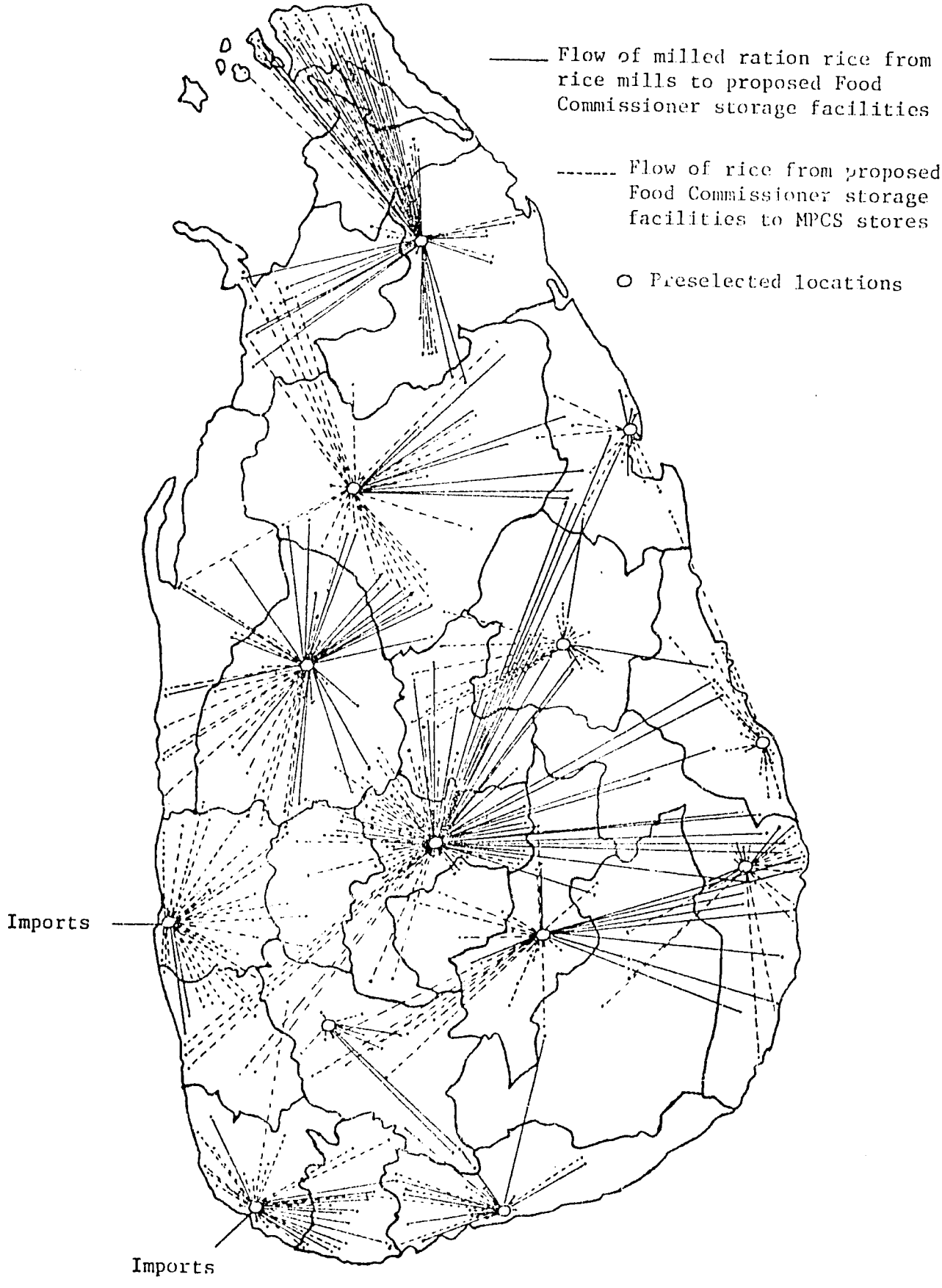
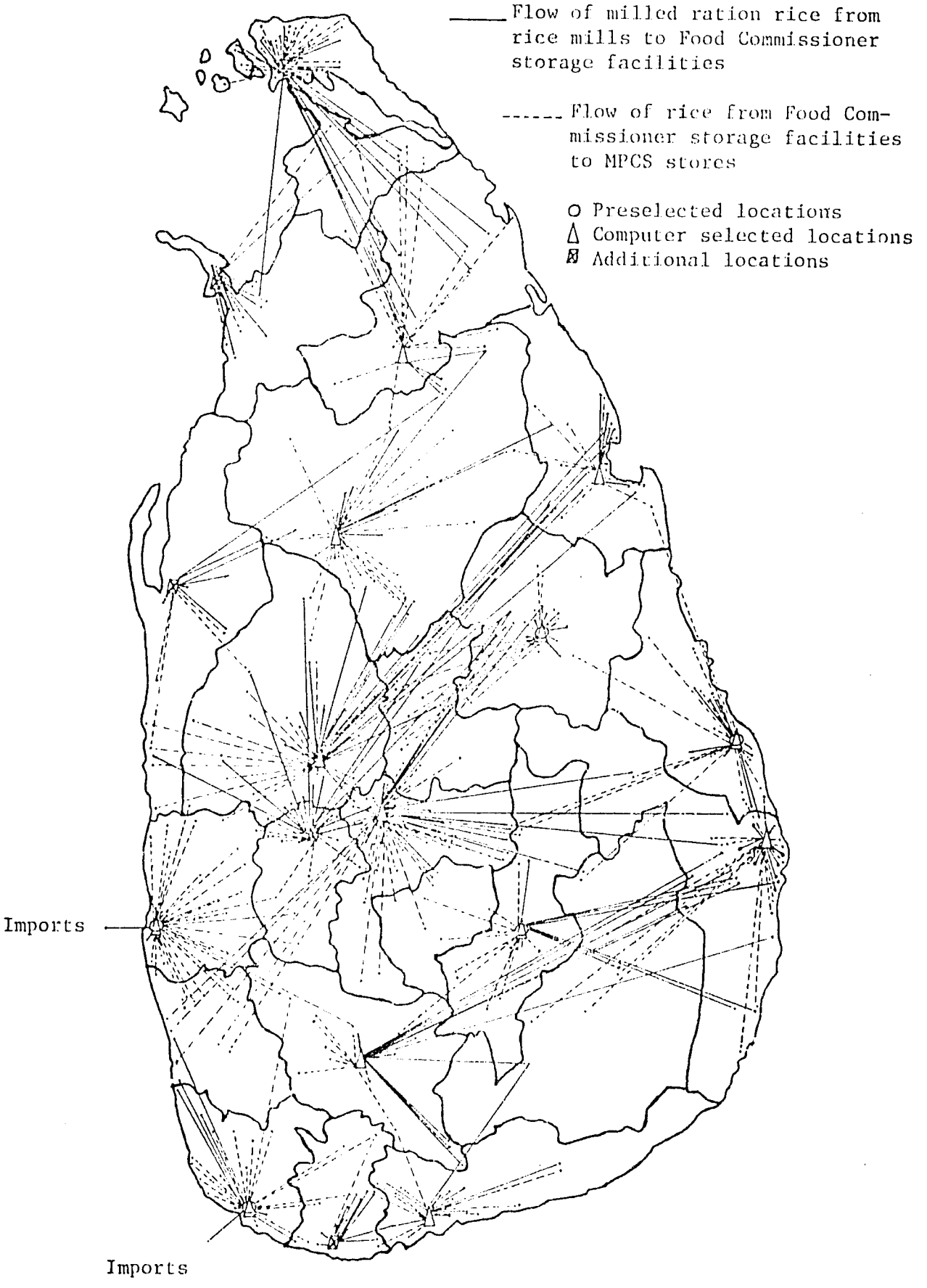


FIGURE 4

OPTIMUM RATION RICE DISTRIBUTION PATTERN ASSOCIATED WITH EIGHTEEN STORAGE FACILITIES



in the deficit district of Jaffna is provided directly from rice mills located in the surplus district of Mannar and Vavuniya without intermediate storage in Mankulam. Third, Multiple Purpose Cooperative Society Stores in the Southern part of Jaffna can be effectively supplied directly from the "best" supply stations at Mannar and Vavuniya. Fourth, double hauls within the surplus district of Vavuniya are reduced to a minimum, and fifth, long hauls from the district of Anaradhapura to Mannar are totally eliminated and supplemented by shorter hauls within the latter district. This first modification amounts to an annual transportation cost savings of more than Rs. 2 million (see Table 11).

Similar results are obtained by substituting the "best" sites in the districts of Anaradhapura and Kurunegala for the preselected locations, and adding another "best" location in the deficit district of Puttalam. First, backhauls are considerably reduced in all three districts. Second, the flow of ration rice into the district of Puttalam consists of a straight flow from surplus to deficit areas. Third, the long hauls of ration rice from rice mills in the district of Trincomalee to Kandy have been switched to the supply station in Kalutara, therefore reducing overall distance and transport costs.

The "best" selection in the district of Kandy and the additional "best" site in the district of Kegalle combine to reduce double hauls between those two districts and surrounding areas. Double hauls are virtually eliminated between the districts of Matara and Galle when an additional supply station is added at the "best" location in Matara. Similar results are obtained in the districts of Amparai, Hambantota, Ratnapura, and Trincomalee.

Finally, although not shown in Figure 4, the "best" location for a supply station in the deficit district of Matale would eliminate backhauls from Kandy into this district and change the distribution pattern to a more direct flow of ration rice from the surplus district of Polonnaruwa to the deficit districts of Matale and Kandy (see T.L.P. F-9, Appendix H).

In summary, the efficiency of the ration rice distribution system can be greatly improved if (1) conflicts between preselected and computer selected sites for ration rice supply stations are minimized, (2) more than thirteen (13) but perhaps less than twenty five (25) supply stations are used, and (3) imports are handled through the ports of Colombo and Galle.

Whichever alternative is finally selected, it is obvious that other not presently quantifiable benefits can be derived from an improvement of the present distribution system via a reduction in the number of warehouses and locational changes. These include:

(1) Reduced annual operation costs directly related with the warehouses.

(2) Improved operational logistics (quantity requirements, transport scheduling, inventory control, and reporting).

(3) Better central management and control from the Office of the Food Commissioner.

(4) Improved quality control and better loss prevention programs of stored ration rice.

(5) Easier training and improvement of personnel.

(6) As suggested by the Office of the Food Commissioner, fewer but bigger complexes can be used advantageously for other purposes connected with the rice ration subsidy system.

(7) Reduction in overall costs and system-wide improvements would probably result in a highly positive Social Rate of Return.

Qualifications

It is obvious that the above choices are based on analytical results dealing <u>only</u> with transportation and distribution. A more complete analysis would probably not change the results; however, it would have shed more light on those additional benefits and costs not quantified in this study. Sufficient and detailed data on design and construction costs, current and projected operation costs for the existing system and the different alternatives and other

information would have allowed for a more comprehensive analysis. Such a system-wide marketing analysis would have shed more light on an optimum distribution system by also optimizing operational costs of the system not included in this study. However, as suggested earlier, such a wide ranging analysis of the ration rice subsidy system was not within the scope of this study. Furthermore, manpower, time, and budget limitations as well as the lack of necessary data did not permit such as undertaking.

Basic reasons why this study did not project the analysis of the rice rationing system beyond the year 1985 are the constraints of the data,[1] current GSL rice policy, and the accelerated implementation schedule of the Mahawelli irrigation project. These limitations have been discussed previously in this report, the prior Food and Feed Grain Institute study, and in another Institute report dealing with grain policy development in Sri Lanka.[2]

The primary data required for this type of study was in some areas less than desirable in quality and, in some cases nonexistant, requiring brief surveys to fill the gaps. The impact of such data limitations on the findings of long-run analysis can be severe. Second, the GSL rice ration policy has changed many times in the past in a reactionary manner to extraneous changes rather than in a planned manner, making long-run policy guidelines for this study rather difficult. Finally, the implementation schedule of the ambitious Mahawelli irrigation project which is to bring irrigation water to thousands of acres in the Northeast section of the country has been reduced from the original 30 to less that 15 years. Therefore, it was deemed prudent not to analyze

---

[1] Borsdorf, Roe and Cornelius Hugo, "Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lankan Rice Industry," Food and Feed Grain Institute, Manhattan, Kansas, 1979, p. 193.

[2] Borsdorf, Roe, Dale Anderson, and Don Anderson, Grain Policy Development and Implementation in Sri Lanka, Food and Feed Grain Institute, Manhattan, Kansas, Kansas State University, March 1979.

supply projections beyond the irrigation implementation schedule the current GSL has committed itself to fulfill by 1985.

Nevertheless, this study clearly shows that very attractive benefits can be obtained from a modification of the existing inefficient distribution system of rice ration. The author recommends that these high-payoff changes be implemented, since it is felt strongly that the omitted analyses of the impacts associated with operational costs and benefits would only substantiate such changes.

Further Recommendations

As suggested by the title, the present analysis addresses only the question of location and number of warehouses to be used in a restructured rice ration distribution system. Close future cooperation with the Office of the Food Commissioner would be conducive to further research the impact of operational non-transport costs on the optimum size of the storage facilities. Also, whether or not transport costs can be offset by economies of scale in non-transport costs, and to what extent. Furthermore, simulation of "what if" questions would allow an evaluation of the impacts of increased or decreased demand and supply quantities such as an increase in government paddy procurement levels and/or a decrease in the rice ration.

Finally, more accurate estimates of total costs and savings accruable to an improved system, and leading to reductions in annual transportation and operational costs, would enable a useful quantifiable comparison of such a system to total annual public expenditures for social programs in Sri Lanka.

CHAPTER III

SUPPLY AND DEMAND ANALYSIS

Introduction

The supply and demand analysis contained in this study focuses only on the rice used in the subsidy system currently operated by the GSL. The projections of population, consumption, production, deficits, and imports presented herein represent trends of average or normal conditions and current government policies and do not consider the possible effects of unusual climatic conditions or major structural changes in the Sri Lankan economy or social system.

Population

The projections of rural and urban population by district are based on 1963 and 1977 census data obtained from the Department of Census and Statistics. Census figures were adjusted to mid-year estimates and projections made for 1972 through 1985.[1]

The relative growth rates by district for rural and urban populations during the inter-census years were used to prorate the annual growth in total population among the 22 districts of the country.[2]

The mid-year projected population figures for the ration rice subsidy system were developed from the projected rural and urban populations by district and the latest (1978) list of rice ration card holders provided by the Food Commissioner's office. Finally, assuming that there would be an increase in the number of ration recipients in direct proportion to population growth, each

---

[1] Borsdorf, Roe, and Cornelius Ango, "Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lanka Rice Industry, Food and Feed Grain Institute, Report No. 70, (Kansas State University, 1978) pp. 70-71.

[2] Ibid., pp. 66-69.

district's projection of ration rice card holders was prorated among the Multiple Purpose Cooperative Society stores using the 1978 base figures as proration factors. The mid-year projected ration card holder figures used to develop projected demand for the ration rice subsidy system are shown in Tables C-1 through C-22 of the Appendix.

Summary projections of ration rice recipients by district are shown in Table 1 in the text. The projections indicate that out of a total Sri Lankan population of approximately 16,752,000[1] by 1985, around 9,337,000 or 58 percent will be entitled to the rice subsidy. Also, excluding the district of Jaffna, the districts in the southwestern part of the country represent 77 percent of the total projected population entitled to receive ration rice by 1985. The coastal districts of Puttalam, Colombo, Kalutara, Galle, and Matara show the highest density with a combined projected ration rice entitlement for over 3.5 million people. Other centrally located districts such as Kandy, Kegalle, and Ratnapura also show high projected ration rice population figures.

Projections of Rice Ration Demand

The demand for ration rice exists as a component of the overall demand for rice in Sri Lanka. Following the procedural steps outlined in Chapter IV, the projected number of rice ration recipients by Multiple Purpose Cooperative Society store was multiplied by the factor representing four (4) lbs. ration rice allowance per week per ration card holder to obtain present and future ration rice demand by store. The results are summarized in Appendix Tables D-1 through D-22. Summary Table 2 in the text projects a total rice ration consumption for all districts of about 821,000 tons by 1982 and 867,000 tons by 1985.

---

[1]Chapter V, p. , #1, pp. 70-71.

TABLE 1
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY DISTRICT

1979-1985

PERIOD NO. YEAR	AMPARAI	ANARADHAPURA	BADULLA	BATTICALOA	COLOMBO	GALLE	HAMBANTOTA	JAFFNA	KALUTARA	KANDY	KEGALLE	KURUNEGALA
	DISTRICTS											
1 1979	240272	190682	290237	241976	1279593	716191	311833	504750	488376	577651	461844	849463
2 1980	246967	197872	295067	249221	1304561	725514	320124	511278	495228	582628	467124	865740
3 1981	253632	205158	299723	256466	1329488	734336	327240	517450	501751	587153	472063	881580
4 1982	260461	212700	304433	263903	1354809	743216	334493	523663	508327	591672	476604	894652
5 1983	267455	220504	309196	271539	1380524	752153	341885	529915	514954	596187	481580	913956
6 1984	274620	228579	314013	279377	1406632	761149	349416	536206	521634	600697	486576	930495
7 1985	281958	236934	318884	287423	1433132	770201	357090	542537	531718	605201	491592	947272

PERIOD	MANNAR	MATALE	MATARA	MONERAGALA	NUWARA ELIYA	POLONNARUWA	PUTTALAM	RATNAPURA	TRINCOMALEE	VAVUNIYA	TOTAL
	DISTRICTS										
1 1979	54048	212698	463302	145341	205053	99391	311180	549233	119292	66252	8378658
2 1980	55588	217415	468990	151748	207403	103563	318695	560239	123443	68558	8536966
3 1981	57123	222047	474345	158304	209601	107818	326115	570979	127630	70884	8690886
4 1982	58696	226764	479729	165132	211810	112241	333686	581887	131951	73284	8844113
5 1983	60309	231566	485143	172243	214027	116838	341409	592966	136409	75[illegible]0	9006518
6 1984	61962	236453	490585	179648	216254	121614	349289	604216	141008	78314	9168737
7 1985	63656	241428	496057	187360	218489	126578	357327	615637	145753	80950	9337177

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12 AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE 2

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1979-1985

DISTRICTS

PERIOD NO. YEAR	AMPARAI	ANARAD HAPURA	BADULLA	BATTI CALOA	COLOMBO	GALLE	HAMBAN TOTA	JAFFNA	KALUTARA	KANDY	KEGALLE	KURU NEGALA
1 1979	22311	17706	26951	22469	118319	66503	28956	46870	45349	53639	42886	78879
2 1980	22933	18374	27399	23142	121138	67369	29726	47476	45985	54101	43376	80390
3 1981	23552	19050	27831	23815	123452	68183	30387	48049	46591	54521	43834	81861
4 1982	24186	19751	28269	24505	125804	69013	31060	48626	47202	54941	44256	83075
5 1983	24835	20475	28711	25214	128192	69843	31746	49206	47817	55360	44718	84867
6 1984	25500	21225	29158	25942	130616	70678	32446	49791	48427	55779	45182	86403
7 1985	26182	22001	29611	26689	133077	71519	33158	50378	49374	56197	45648	87961

DISTRICTS

PERIOD NO. YEAR	MANNAR	MATALE	MATARA	MONE REGALA	NUWARA ELIYA	POLON NARUWA	PUTTALAM	RATNAPURA	TRINCO MALEE	VAVUNIYA	TOTAL
1 1979	5019	19751	43021	13496	19041	9229	28895	51000	11077	6152	778019
2 1980	5162	20189	43549	14091	19259	9617	29593	52022	11463	6366	792720
3 1981	5304	20619	44046	14700	19463	10012	30282	53019	11851	6582	807009
4 1982	5450	21057	44546	15334	19668	10422	30985	54032	12253	6805	821240
5 1983	5600	21503	45049	15994	19874	10849	31702	55061	12667	7035	836318
6 1984	5754	21956	45554	16682	20081	11293	32434	56106	13094	7272	851383
7 1985	5911	22418	46062	17398	20288	11754	33180	57166	13534	7517	867023

SOURCE:

CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

Reflecting the high population densities stated above, the coastal districts show a total demand of more than one third the total rice ration demand, with the district of Colombo alone requiring fifteen percent of the total. More centrally located districts ranging from Kurunegala to Ratnapura account for another third of the total rice ration demand.

Projections of Rice Ration Supply

The projected total domestic milled rice supply for the rice ration scheme is composed of domestic rice obtained by the Paddy Marketing Board through the Guaranteed Price Scheme system (price stabilization program). Table 3 summarizes the milled domestic rice availability through 1985 for the rice rationing system by district.[1] This table is the result of paddy procurement targets[2] for the Paddy Marketing Board less storage losses[3] multiplied by a milling yield of 68 percent. Total annual domestic availability ranges from 411,000 tons in 1979 to 620,000 tons in 1985. Two thirds of the domestic ration rice available comes from the five districts of Anaradhapura, Polonnaruwa, Amparai, Hambantota, and Trincomalee.

Finally, 1985 rice ration supplies by rice mill and simulated import points at Colombo and Galle are given in Appendix E to this report.

Deficit and Imports

A comparison of the rice ration demand and domestic availability by district shows a consistent distribution of deficits and surpluses among the districts. Table 4 summarizes these surpluses and deficit figures by district and shows

---

[1]Chapter V, p. , #1, p. 87.

[2]Ibid., p. 93.

[3]Ibid., Storage Losses of 6.2 percent.

TABLE 3

MILLED DOMESTIC RICE AVAILABLE 1979-1985 FOR RICE RATION SYSTEM BY DISTRICT

BASED ON PADDY MARKETING BOARD PROCUREMENT TARGETS

ANNUAL

PERIOD NO. YEAR	AMPARAI	ANARAD HAPURA	BADULLA	BATTI CALOA	COLOMBO	GALLE	HAMBAN TOTA	JAFFNA	KALUTARA	KANDY	KEGALLE	KURU NEGALA
1 1979	75481	59130	8683	22326	764	3579	30009	12990	2807	16764	2149	19373
2 1980	81769	64064	9624	24186	827	3877	32509	14072	3041	18160	2328	20986
3 1981	88019	68960	10359	26034	891	4174	34993	15148	3274	19548	2506	22591
4 1982	97493	76312	11463	28810	986	4619	38724	16763	3622	21632	2773	24999
5 1983	105490	82648	12416	31202	1068	5002	41939	18154	3923	23429	3004	27075
6 1984	110983	86950	13062	32827	1123	5262	44123	19100	4128	24648	3161	28484
7 1985	113759	89126	13388	33648	1151	5394	45227	19577	4231	25265	3240	29197

ANNUAL

PERIOD NO. YEAR	MANNAR	MATALE	MATARA	MONE REGALA	NUWARA ELIYA	POLON NARUWA	PUTTALAM	RATNAPURA	TRINCO MALEE	VAVUNIYA	TOTAL
1 1979	7198	7960	4920	9672	1002	62551	3245	11562	36147	13018	411536
2 1980	7798	8624	5330	10478	1086	67763	3516	12526	39158	14102	445824
3 1981	8394	9283	5738	11278	1169	72942	3784	13483	42151	15180	479899
4 1982	9289	10273	6349	12491	1294	80719	4188	14920	46645	16799	531063
5 1983	10061	11125	6876	13517	1401	87420	4536	16159	50518	18193	575156
6 1984	10584	11705	7235	14221	1474	91972	4772	17001	53148	19140	605103
7 1985	10849	11997	7415	14577	1511	94273	4891	17426	54477	19619	620238

SOURCE:
FOOD AND FEED GRAIN INSTITUTE STUDY. TABLE 27 LESS STORAGE LOSSES X MILLING FACTOR OF 0.68

TABLE 4
RICE RATIONING SYSTEM SURPLUS AND DEFICIT BALANCES BY DISTRICT

1979-1985

(TONS)

PERIOD NO. YEAR	AMPARAI	ANARADHAPURA	BADULLA	BATTICALOA	COLOMBO	GALLE	HAMBANTOTA	JAFFNA	KALUTARA	KANDY	KEGALLE	KURUNEGALA
1 1979	53170	41430	-18068	-143	-118055	-62924	1053	-33880	-42542	-36875	-40737	-59506
2 1980	58636	45690	-17775	1044	-120311	-63492	2783	-33404	-42944	-35941	-41048	-59404
3 1981	64467	49910	-17472	2219	-122561	-64014	4606	-32901	-43317	-34973	-41328	-59270
4 1982	73217	56561	-16806	4305	-124818	-64394	7664	-31863	-43580	-33309	-41483	-58076
5 1983	80655	62173	-16295	5988	-127124	-64841	10193	-31052	-43894	-31931	-41714	-57792
6 1984	85483	65725	-16096	6885	-129493	-65416	11677	-30691	-44309	-31131	-42021	-57919
7 1985	87577	67125	-16223	6959	-131926	-66125	12069	-30801	-45143	-30932	-42408	-58764

(TONS)

PERIOD NO. YEAR	MANNAR	MATALE	MATARA	MONERAGALA	NUWARA ELIYA	POLONNARUWA	PUTTALAM	RATNAPURA	TRINCOMALEE	VAVUNIYA	TOTAL
1 1979	2179	-11791	-38101	-3824	-18039	53322	-25650	-39438	25070	6866	-366483
2 1980	2636	-11565	-38219	-3613	-18173	58146	-26077	-39496	27695	7736	-346896
3 1981	3090	-11336	-38308	-3422	-18294	62930	-26498	-39536	30300	8598	-327110
4 1982	3839	-10784	-38197	-2853	-18374	70297	-26797	-39112	34392	9994	-290177
5 1983	4461	-10378	-38173	-2477	-18473	76571	-27166	-36902	37851	11158	-261162
6 1984	4830	-10251	-38319	-2461	-18607	80679	-27662	-39105	40054	11868	-246280
7 1985	4938	-10421	-38647	-2821	-18777	82519	-28289	-39740	40943	12102	-246785

SOURCE:
TABLE 3 LESS TABLE 2

estimated total annual deficits to be covered by imports.

Although the total annual deficit is expected to diminish by more than 100,000 tons between 1979 and 1985, the increased number of rice ration recipients and estimated procurement targets by the Paddy Marketing Board hinder any further shrinkage of the deficit, and under current government policies will require continuous imports each year, estimated at about 250,000 tons by 1984.

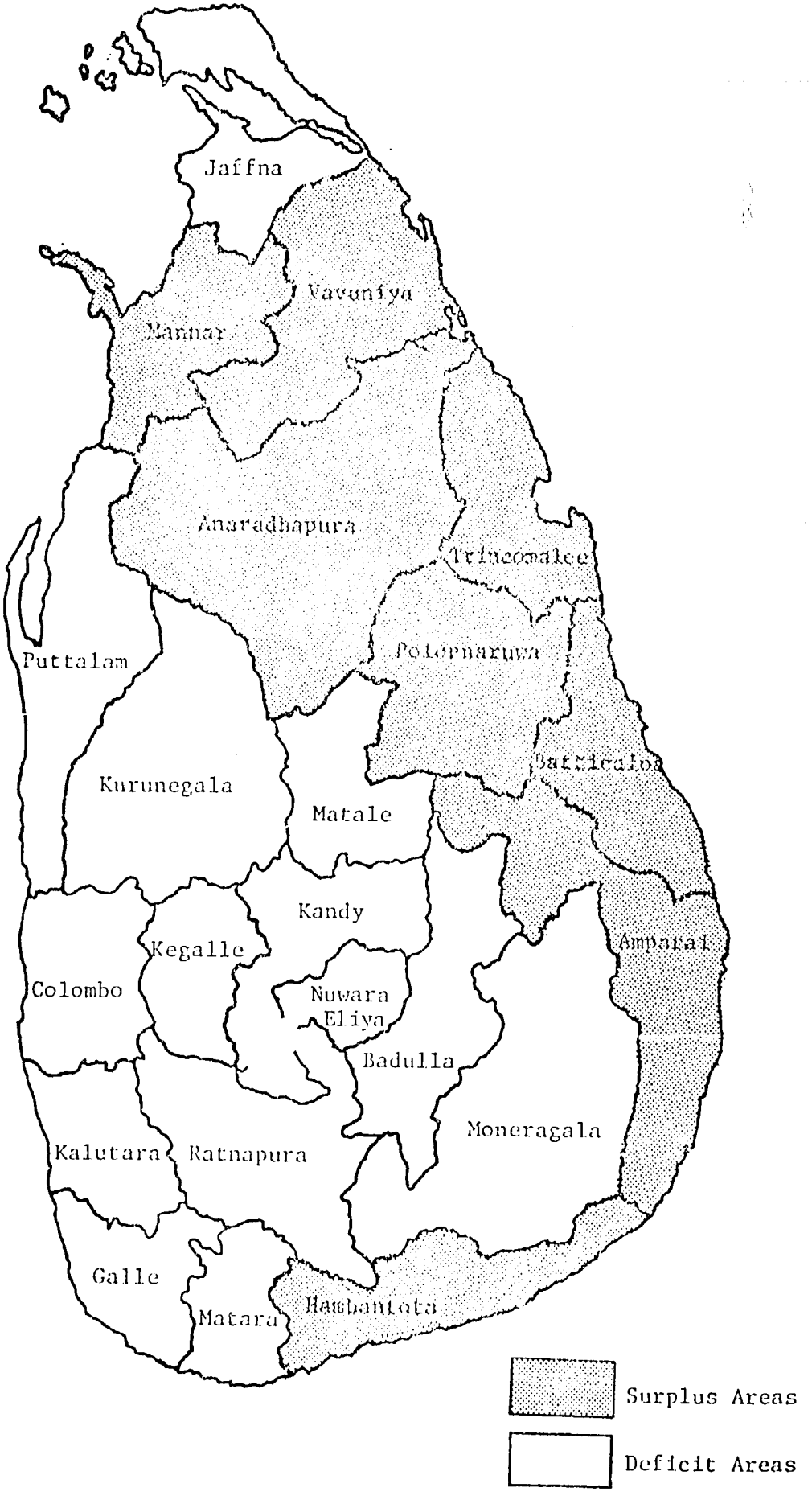
With a negligible exception during 1979 in the district of Batticaloa, all surplus districts are projected to show increasing surpluses above their own ration rice requirements. Some of these districts show big absolute increments in their surplus tonnage (Amparai, Anaradhapura, and others), and some double their surpluses available, even though the tonnage is small (Mannar and Vavuniya, for example).

Deficit districts, to the contrary, show either increasing, decreasing, or nearly constant deficits. Such high density deficit districts as Colombo, Puttalam, Kalutara, and Galle show the highest deficit increments between 1979 and 1985. Other more centrally located deficit districts such as Badulla, Kandy, Matale, and Moneragala as well as Jaffna in the North, show a decreasing deficit over the years. Finally, some deficit districts manage to maintain a nearly constant deficit over the years, among them are Matara, Nuwara Eliya, and Ratnapura.

The implications of Table 4 in terms of the linear programming solutions are summarized in Figures 5 and 6. Figure 5 shows that with the exception of Jaffna, all deficit districts are located in the western and southwestern area of the island which, as previously mentioned, contain higher population densities than the surplus areas. Such a layout would suggest a flow of domestic surplus ration rice from the North-east, East, and South-east parts of the island to the South-west and West. Also, from the northern surplus districts of Mannar and Vavuniya, enough ration rice is available to cover expected deficits

FIGURE 5

PROJECTED SURPLUS AND DEFICIT DISTRICTS



in the northern end of the island.

Figure 6 summarizes the projected relative magnitudes of surpluses and deficits by district in 1985. Using the results of Table 2 and 3 and taking the surplus district of Amparai as the base, all other districts have been proportioned to show their individual total ration rice availability, consumption, and ration rice surplus or deficit. Again, the implications for the linear programming solutions become evident. Surpluses of ration rice will flow from the north-eastern and eastern portions of the island towards the western and south-western areas. Also, most surpluses will be forthcoming from the districts of Amparai, Polonnaruwa, and Anaradhapura immediately adjacent to the deficit area.

Although the relative magnitudes of each district surplus or deficit does change from year to year, the comparative surplus and deficit areas remain the same over the projected horizon. Therefore, since the country as a whole will retain its deficit status in the foreseeable future this would imply imports of ration rice through ports in these deficit districts in order to minimize total inland distribution costs.

Import Allocation

Total annual import requirements to cover estimated deficits have been prorated to two import points located in the densely-populated deficit area of the country. The annual tonnages to be imported through Colombo and Galle minimize inland transportation costs, assuming that port facilities are not a constraint. As shown in Table 5, a constant annual import figure of 85,000 tons to be imported through Galle and a declining annual import throughput through Colombo was found to minimize subsequent inland transportation costs most effectively.

Most of the future increments in the supply of ration rice will be coming

FIGURE 6

RELATIVE MAGNITUDES OF RATION RICE SURPLUS AND DEFICIT BY DISTRICT

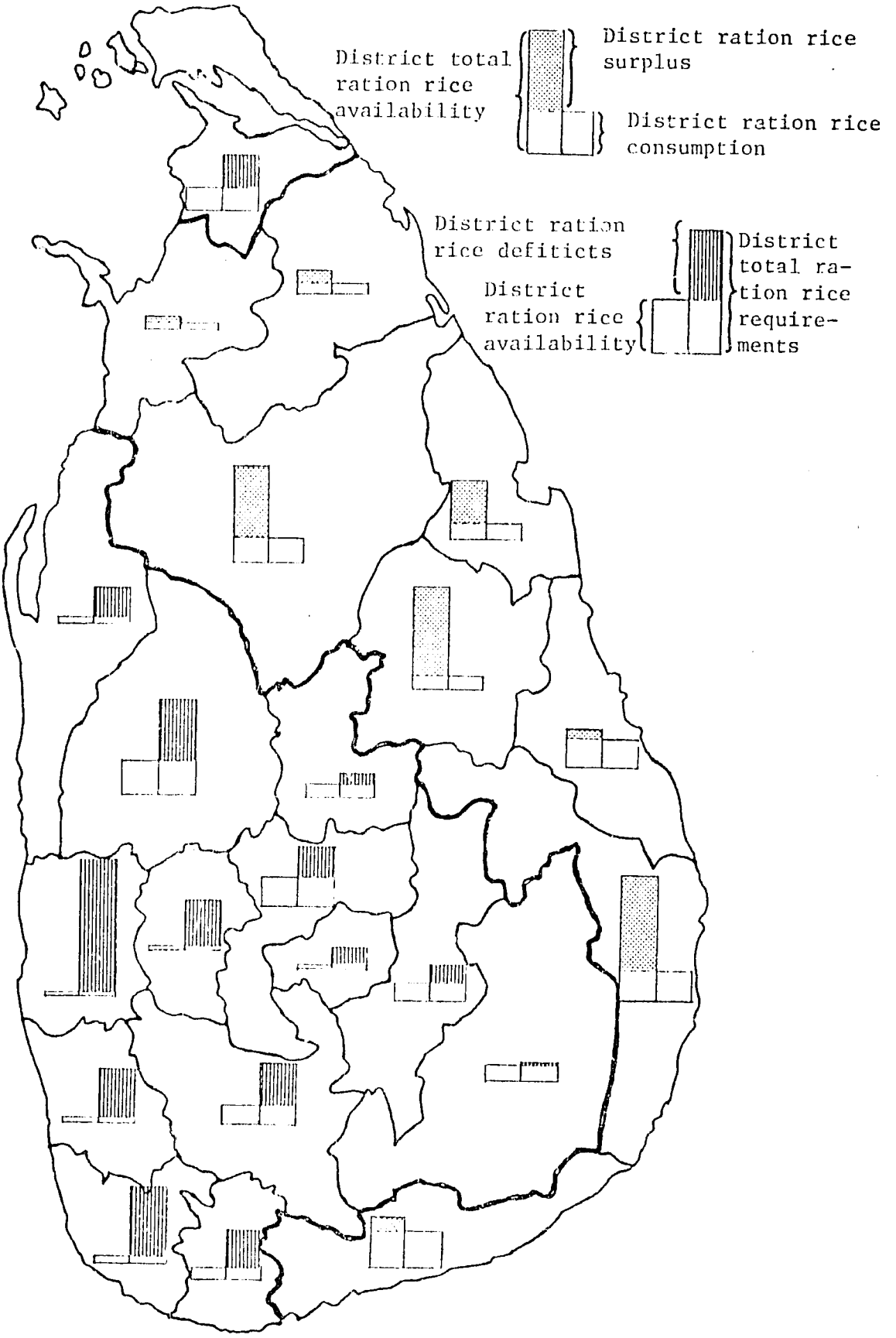


TABLE 5

ANNUAL IMPORT ALLOCATION FOR MINIMUM
INTERNAL TRANSPORTATION COSTS

(tons)

Year	Port of Colombo	Port of Galle	Total Annual[1] Imports
1980	261,896	85,000	346,896
1981	242,110	85,000	327,110
1982	205,177	85,000	290,177
1983	176,162	85,000	261,162
1984	161,280	85,000	245,280
1985	161,785	85,000	246,785

[1]Table 2 less Table 3

from the surplus districts lying to the northeast of Colombo. Surpluses will flow through Kandy towards the southwest and will be pushing the boundary of the area to be satisfied with domestic ration rice further and further towards Colombo. On the other hand, the deficit area in the south of the island, composed of districts of Galle, Matara, and parts of Kalutara and Ratnapura depend only on the district of Hambantota for the domestic surplus rice to be used in the rice rationing system. This sole source of domestic rice ration for this area cannot meet the demand, so that continued imports of 85,000 tons per year of ration rice through the port of Galle will be required by the minimum-cost solution.

CHAPTER IV

DISTRIBUTION AND LOCATIONAL ANALYSIS

Introduction

This chapter presents the results of ration rice transport cost determination and analysis to determine the optimum distribution network for the rice subsidy scheme. Transportation linear programming techniques explained in Chapter V were used to simulate optimum distribution patterns for imported and local ration rice in Sri Lanka and to estimate total interior distribution costs from the ports of entry and rice mills to government warehouses and Multiple Purpose Cooperative Society outlets throughout the country. The optimum distribution patterns and costs were compared under alternative sets of assumptions regarding removal of existing restrictions in rice storage capacities at alternative government warehouse locations. The results were used to estimate benefits that can be expected from alternative capital improvement programs.

Transportation Cost Functions

Because of the large number of transport movements to be evaluated, it is virtually impossible to determine the individual characteristics of each haul with its unique cost structure. Accordingly, generalized cost functions were derived for each transport mode. No costs were included for labor and equipment associated with loading and unloading rice.

Truck Transportation Cost Function

Following the procedural steps outlined in Chapter VI, linear functions of distance were developed for use in the network analysis. The primary data for the development of the truck transportation cost function were obtained

from the results of (1) a survey of freight costs for rough rice shipments from Purchasing Centers to Paddy Marketing Board warehouses, (2) a second survey which collected actual trucking operation costs, and (3) engineering estimates of operational truck costs. Including a fixed cost in each function to represent the minimum cost for a movement irrespective of distance and the variable costs which are associated with distances a set of straight linear, kinked linear, and exponential transportation cost functions were developed and statistically analyzed.[1] This procedure resulted in the selection of a straight linear cost function for standard five (5) ton capacity single axle trucks used in Sri Lanka as shown in Table 6.

Railroad Transport Cost Functions

Two basic railroad transport cost functions were developed for the Institute study based upon data in the "Sri Lanka Railroad Assessment Study" by Trimac Consulting of Canada, and upon limited additional data.[2] These two functions needed modification to reflect the lack of sidings at origin and/or destination points and subsequent transport by truck for one or two miles. These four functions are also summarized in Table 6.

The first rail transportation cost function ($Y = 18.56 + 0.30x$) reflects the availability of railroad siding at both shipping and receiving points. The second function ($Y = 36.36 + 0.30x$) reflects the absence of such sidings and "includes the additional cost of handling."[3] Finally, the third and fourth equations reflect the lack of sidings and additional transport by truck for one

---

[1] Borsdorf, Roe, and Cornelius Hugo, "Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lanka Rice Industry," Food and Feed Grain Institute, Manhattan, Kansas, 1979, pp. 261-269.

[2] Ibid., pp. 268-270.

[3] Ibid., p. 268.

TABLE 6

TRANSPORT COST FUNCTIONS
COSTS IN Rs/TON

Road Transport

Bagged rice $y = 13.213 + 0.518 \times$ length of haul in miles

Rail Transport

Bagged rice[1] $y = 18.56 + 0.30 \times$ length of haul in miles

Bagged rice[2] $y = 36.36 + 0.30 \times$ length of haul in miles

Bagged rice[3] $y = 41.09 + 0.30 \times$ length of haul in miles

Bagged rice[4] $y = 63.82 + 0.30 \times$ length of haul in miles

Notes:

1. Reflects the availability of railroad siding at both origin and destination.

2. Reflects the absence of railroad siding at both origin and destination.

3. Reflects the absence of railroad siding at either origin or destination and subsequent transport by truck for one mile at either origin or destination.

4. Reflects the absence of railroad siding at both origin and destination and subsequent transport by truck for one mile each at origin and destination.

5. The functions shown in the table do not include the cost of bags nor losses and shrinkages in handling and transit.

and two miles respectively.[1]

Minimum Distance and Cost Distribution Networks for the Third and Fourth Marketing Levels

This section summarizes the results of the formulation of the minimum distance and cost distribution networks connecting the import points and the rice mills with the government warehouses and the Multiple Purpose Cooperative Society stores. With this complete network, the linear programming computer runs to determine optimum shipment patterns for the rice ration system can be made, given the specific ports, rice mills, government warehouses, destination points for the commodity and quantities.

The minimum distance and cost distribution networks were generated with the series of computer programs designed for this purpose available to the author (see Chapter VI).[2] The programs used in sequences were the Key-Link Check Program, the Network Generator Program, the Network Conversion Program, and the Mode Selector Program.

Individual Minimum Distance and Cost Distribution Networks

Following the procedural steps of Chapter VI, individual minimum distance and cost distribution networks for highway and railroad were developed with the first three computer programs mentioned above.

The voluminous computer output of these three intermediate steps is not reproduced herein. However, Table 7 summarizes the results of these steps. A total of four basic networks were generated representing separate highway and

---

[1]Appendix F.

[2]Phillips, Richard, Leonard W. Schruben, Joe M. Tiao, Roe Borsdorf, and Cornelius Hugo, "User's Guide to Computerized System for Feasible Agribusiness Development," Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, Special Report No. 2., Revised August, 1972.

TABLE 7

MINIMUM DISTANCE AND COST DISTRIBUTION NETWORKS

HIGHWAY

CODE			REPRESENTS
6001 to 6617	through	7001 to 7593	Minimum highway distance and cost distribution network from 228 rice mills and two (2) simulated ports of entry for imports to 56 government rice warehouses.
7001 to 7593	through	8001 to 8666	Minimum highway distance and cost distribution network from 56 government rice warehouses to 308 Multiple Purpose Cooperative Society Stores.

RAILROAD

CODE			REPRESENTS
6001 to 6617	through	7001 to 7593	Minimum railroad distance and cost distribution network from 48 rice mills and two (2) simulated ports of entry for imports to 37 government rice warehouses.
7001 to 7593	through	8001 to 8666	Minimum railroad distance and cost distribution network from 37 government rice warehouses to 60 Multiple Purpose Cooperative Society Stores.

railroad networks connecting each rice mill and two (2) simulated ports of entry for imports with the government warehouses for milled rice and the Multiple Purpose Cooperative Society stores. Thus, the first minimum highway distance and cost distribution network connects all 228 rice mills and two (2) simulated import points with all 56 government warehouses for milled rice. The second highway network represents the fourth marketing level and connects each of the 56 government warehouses with all 308 Multiple Purpose Cooperative Society stores.

In a similar manner, separate minimum railroad distance and cost distribution networks were developed for the third and fourth marketing levels. Since not all rice mills, government warehouses, and Multiple Purpose Cooperative Society stores have railroad connections, the railroad networks show fewer origin and destination points.

Combined Least-Cost Distribution Network File for Alternative Modes

Using the Mode Selector Program and following the procedural steps of Chapter VI, a final tape file was generated containing two least-cost distribution networks with mode identification. Thus, for the third marketing level a combined least-cost distribution network was derived from the first and third code sequence of Table 7. This combined network shows which mode (truck or rail) represents the least-cost means of transport between given origin and destination points. In a similar manner, combined minimum cost distribution networks for the fourth marketing level were derived from the second and fourth code sequence of Table 7. Again, the computer printouts are too voluminous to be included in this report; however, the results are summarized in Table 8.

Summary

The above summarizes the results of the preparatory steps required prior

TABLE 8

COMBINED LEAST-COST DISTRIBUTION NETWORK FILE
FOR ALTERNATIVE MODES

CODE			REPRESENTS
6001 to 6617	through	7001 to 7593	Combined least-cost highway and railroad distribution network from 228 rice mills and two (2) simulated ports of entry for imports to 56 government rice warehouses.
7001 to 7593	through	8001 to 8666	Combined least-cost highway and railroad distribution network from 56 government rice warehouses to 308 Multiple Purpose Cooperative Society Stores.

to the linear transportation analysis of the rice ration subsidy system. Due to the relatively high cost of railroad transport, only few key links were served by rail. Thus, in the first combined least-cost distribution network only 34 key links show rail as the least-cost transport mode out of a total of 13,056 links within that network. These few key links represented distances over 150 miles which favor railroad service. Very similar results were obtained in the combined least-cost distribution network for the fourth marketing level. As a result, truck is favored over rail as the least-cost mode of transport in the relatively short distances applicable in these networks.

Linear Programming Solution

This portion of Chapter IV presents the results of the comparative linear programming analysis for optimum distribution patterns of ration rice from rice mills and import points to the government warehouses and Multiple Purpose Cooperative Society stores throughout the country.

As explained in Chapter V, the computerized transportation model used for the analysis utilizes a mathematical linear programming technique designed to solve for the shipment and distribution pattern for locally produced and imported ration rice which results in the minimum total distribution costs for the country as a whole. However, due to the particular characteristics of this problem, the entire distribution system cannot be proven optimum. Nevertheless, the individual marketing levels, namely the third and fourth levels, are optimum under their particular constraints. The analysis was stopped when it became obvious that further improvements in one marketing level led to greater offsetting detriments in the other level and vice versa.

Unconstrained Solutions

As explained in Chapter V, these solutions represent the year 1985 rice

ration requirements and distribution pattern which result in the absolute least-cost transportation by marketing level and are designed to help determine the optimum annual throughput of rice ration by storage facility location. Furthermore, these unconstrained solutions indicate where alternative and/or additional sites would be useful for diminishing total transportation costs and improving distribution patterns of the constrained solutions.

By assigning a total demand quantity to the government storage facilities in excess of total supply provided by the rice mills, absolute least-cost and locational preferences regarding the intermediate supply stations with respect to the rice mills are obtained at the third marketing level. Alternatively, by assigning to all warehouses a quantity in excess of total rice ration demand at the fourth marketing level, an absolute least-cost and locational preference of the supply stations with respect to the Multiple Purpose Cooperative Society stores is established.

The results of the unconstrained solutions together with the thirteen (13) preselected locations for the new complexes as selected by the Food Commissioner's office are summarized in Table 9. The computer ranking of locational preference is based on total unconstrained throughput achieved by each supply station at each marketing level. While the RM-FC column ranks the existing 56 supply stations by district at the third marketing level, the FC-MPCS column ranks the same number of supply stations with respect to the Multiple Purpose Cooperative Society stores. Also as shown in Table 9, a total of eleven (11) supply stations did not receive any milled rice from the rice mills in the optimum unconstrained solution for the third marketing level, implying ill location with respect to the rice mills. Several others received very little rice, showing less than desirable location for receiving from existing rice mills. At the fourth marketing level, two (2) supply stations failed to ship any rice, implying ill location with respect to the Multiple Purpose Cooperative

TABLE 9

RANKING OF FOOD COMMISSIONERS WAREHOUSES INDICATING LOCATIONAL PREFERENCE WITH RESPECT TO RICE MILLS AND MULTIPLE PURPOSE COOPERATIVE SOCIETY STORES

District	FC #	Food Commissioner's Selection	Computer Ranking of Locational Preference		
			RM-FC	FC-MPCS	OVERALL
Amparai	7001	x	1	3	
	7002		3	2	
	7003		2	1	x
	7004		4 (0)	4 (0)	
Anuradhapura	7026	x	2	2	
	7027		1	1	x
Badulla	7041	x	1	2	x
	7042		2 (0)	1	
	7043		2 (0)	3	
Batticaloa	7061	x	1	1	x
Colombo	7076	x	1	1	x
	7077		2	2	
Galle	7101	x	1	1	x
	7102		2 (0)	2	
Hambantota	7131	x	1	2	
	7132		3	3	
	7133		2	1	x
Jaffna	7171		1	1	x
	7172		4	6	
	7173		2	3	
	7174		3	5	
	7175		5	2	
	7176		6 (0)	7 (0)	
	7177		6 (0)	4	
Kandy	7211		1	1	x
	7212		4	3	
	7213		3	5	
	7214		5	4	
	7215	x	2	2	
Kegalle	7251		1	2	x
	7252		2 (0)	1	
	7253		2 (0)	3	

TABLE 9 (Continued)

District	FC #	Food Commissioner's Selection	Computer Ranking of Locational Preference		
			RM-FC	FC-MPCS	OVERALL
Kurunegalla	7281		1	1	x
	7282	x	2	2	
Mannar	7311		1	2	x
	7312		2	1	
Matale	7341		1	1	x
Matara	7371		1	1	x
	7372		2	2	
Moneregala	7401		1	1	x
Nuwara Eliya	7431		1	1	x
Polonnaruwa	7461	x	1	1	x
	7462		2	2	
Puttalam	7491		1	1	x
	7492		2	2	
Ratnapura	7521	x	3 (0)	3	
	7522		2	2	x
	7523		1	5	
	7524		3 (0)	1	
	7525		3 (0)	4	
Trincomalee	7551	x	2	3	
	7552		1	1	x
	7553		3	2	
Vavuniya	7581		1	1	x
	7582		3	3	
	7583	x	2	2	

Notes:

(0) implies zero quantities received and/or shipped.

Society stores. Since these two locations also failed to receive any rice on the optimal unconstrained solution for the third marketing level, they were eliminated from the existing network of 56 supply stations.[1]

From the individual rankings of supply stations by marketing level and district, one was selected as the "best" overall location for a supply station in each district. In districts where conflicting rankings developed, additional computer runs were used to decide which location was most effective in minimizing transportation cost. Also, a comparison between the preselected locations for future Food Commissioner complexes and those locations ranked "best" overall by the unconstrained linear programming solutions reveals conflicting locational preferences in eight instances.

Figure 7 shows the geographical location for the preselected sites and the "best" location by district as revealed by the unconstrained linear programming solutions. The sites preselected by the Office of the Food Commissioner have been identified with a circle. Alternative "best" sites selected by the unconstrained linear programming solutions are identified with a triangle. Conflicting locational preferences can be identified in the districts of Vavuniya, Anuradhapura, Trincomalee, Kalutara, Kandy, Amparai, Ratnapura, and Hambantota. Also, five of the preselected sites for rice ration storage facilities matched the computer selection in the districts of Polonnaruwa, Batticaloa, Badulla, Colombo, and Galle. Finally, for the remaining districts of Jaffna, Mannar, Puttalam, Matale, Kegalle, Nuwara Eliya, Moneregala, and Matara, the "best" overall locations for supply stations are identified with a boxed-in X.

The minimum transportation costs for optimum distribution pattern for the unconstrained solutions are summarized in Table 10. While the individual marketing levels could be optimized at low transportation costs in the unconstrained

---

[1] Appendix G.

FIGURE 7

SITE SELECTION CONFIGURATION FOR FUTURE FOOD COMMISSIONER STORAGE FACILITIES

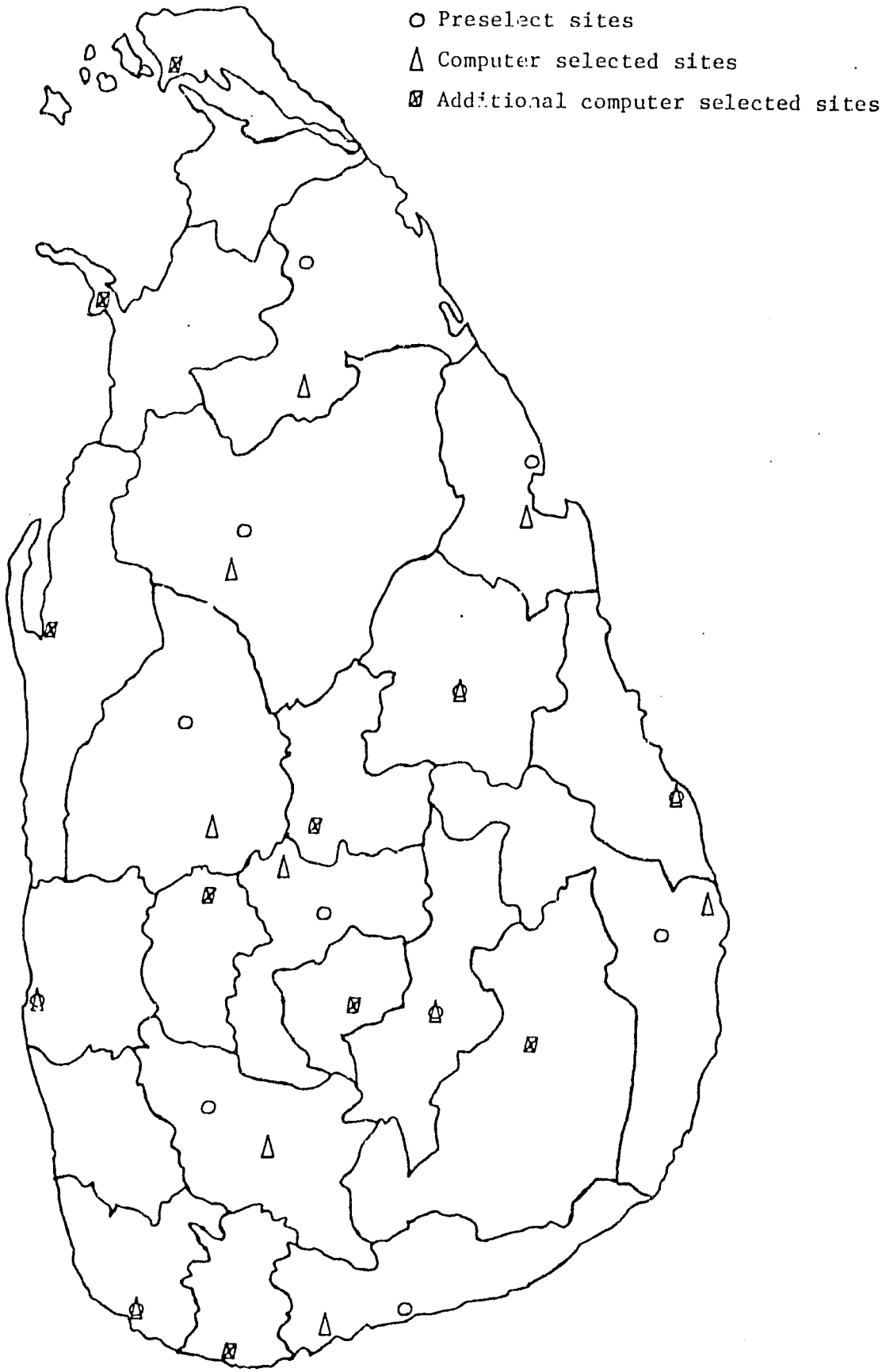


TABLE 10

MINIMUM TRANSPORTATION COSTS FOR UNCONSTRAINED SOLUTIONS

1985

(Rs.)

	Transportation Cost RM-FC	Transportation Cost FC-MPCS	Total Transportation Costs
Infinite Government Warehouse Demand	14,780,335[1]	---	---
Infinite Government Warehouse Supply	---	16,424,928[2]	---
Distribution Pattern of Infinite Government Warehouse Demand Used as Government Warehouse Supply	14,780,335	30,777,353	45,557,688
Distribution Pattern of Infinite Government Warehouse Supply Used as Government Warehouse Demand	28,182,463	16,424,928	44,607,391

[1]Eleven Government Rice Warehouses failed to receive rice.

[2]Two Government Rice Warehouses failed to ship rice.

solutions, their incompatibility increases total transportation costs considerably when one unconstrained solution is imposed on the other. These results underscore the incompatibility of existing supply station locations with respect to the rice mills and the Multiple Purpose Society stores.

Using marginal costs as indicators of alternative throughput allocation to the supply stations, a series of linear transportation computer runs determined compatible minimum transportation costs for optimum distribution pattern for a range of 13 to 54 supply stations.

Base Case and Modified Solutions

The base case and modified solutions presented in this section were designed to aid in determining an optimum feasible range of number and locations for intermediate ration rice supply stations as well as optimum throughputs by location. Following the procedural steps of Chapter V, a total of 43 intermediate supply stations were eliminated from the existing network in a series of transportation linear programming computer runs.

The results of these analyses are summarized in Table 11. Included are the number of supply stations for each modified solution as well as the corresponding transportation cost by marketing level, total transportation costs, differentials, and comparative increases. Also, Tables 1 through 14, Appendix H, summarize optimum compatible throughput by location for the base case as well as each modified solution.

Successive reductions in the number of least desirable intermediate supply stations resulted in higher total transportation costs due to increasing distances of hauls as well as more numerous localized and regional back hauls of ration rice. Also, fewer intermediate supply stations implied increasingly higher throughputs for each of the remaining storage facilities in the distribution network.

TABLE 11

SUMMARY OF TRANSPORTATION COSTS ASSOCIATED WITH OPTIMUM NUMBERS AND LOCATIONS OF FOOD COMMISSIONER SUPPLY STATIONS
1985
(Rs.)

REFERENCE NUMBER	NUMBER OF SUPPLY STATIONS	TRANSPORTATION COST RM-FC	TRANSPORTATION COST FC-MPCS	TOTAL TRANSPORTATION COST	TRANSPORTATION COST DIFFERENTIAL	COMPARATIVE INCREASE IN TRANSPORT COST
T.L.P. F-0	54	25,002,130	18,533,225	43,535,355	-	
T.L.P. F-1	53	25,045,610	18,482,171	43,527,781	- 7,574	- 7,574
T.L.P. F-2	52	25,019,366	18,545,797	43,565,163	29,808	37,382
T.L.P. F-3	49	25,007,015	18,592,439	43,599,454	64,099	34,291
T.L.P. F-4	45	24,893,897	18,823,046	43,716,943	181,588	117,489
T.L.P. F-5	40	24,965,004	18,908,854	43,873,858	338,503	156,915
T.L.P. F-6	35	25,024,329	18,987,439	44,011,768	476,413	137,910
T.L.P. F-7	30	25,030,858	19,088,693	44,119,551	584,196	107,783
T.L.P. F-8	25	24,683,966	19,724,601	44,408,567	873,212	289,016
T.L.P. F-9	20	24,855,936	20,124,383	44,980,319	1,444,964	571,752
T.L.P. F-10	18	24,855,069	20,357,532	45,212,601	1,677,246	232,282
T.L.P. F-11	16	24,480,658	21,108,231	45,588,889	2,053,534	376,288
T.L.P. F-12	14	24,423,217	21,292,052	45,715,269	2,179,914	126,380
T.L.P. F-13	13	24,646,882	22,991,614	47,638,496	4,103,141	1,923,227

The lowest transportation cost option, base case F-0, used 54 of the existing 56 supply stations and its optimum distribution pattern required a minimum of Rs. 43.5 million in transport costs for both marketing levels. The highest transportation cost option, modified solution F-13, used only 13 of the existing 56 supply stations. Its minimum transport cost requirements amounted to Rs. 47.6 million. Other intermediate numbers and locations were tested to determine their impact on distribution pattern and total transport costs. This is reflected in the transport cost differentials and comparative increases in transport costs between the base case F-0 and all other modified solutions, (Table 11).

While the transport cost differential and comparative increases in transport costs are not very significant between the base case and the first eight (8) modified solutions, the additional transport costs accruing to the last five (5) modified solutions are considerably higher, reflecting the removal of more desirable locations from needed intermediate storage. Therefore, reducing the number of intermediate storage facilities below the 25 associated with intermediate solution F-8 tends to increase transport cost considerably.

Finally, as the remaining intermediate supply stations are few in number, i.e., below 20 as given by intermediate solution F-9, removing only a few tends to have a dramatic impact on transport cost. For example, while intermediate solution F-10 retains 18 intermediate supply stations, the last solution F-13 contains only three less, namely #7171 in Jaffna, #7311 in Mannar, and #7371 in Matara. Moreover, the difference in the number of supply stations between the last two intermediate solutions is one, #7171 in Jaffna, which eliminates double hauling 20,000 tons of ration rice in intermediate solution F-12 for a total transport cost savings of close to Rs. 2 million.

Proposed and Modified Proposed Alternatives

The proposed alternative is in accordance with present planning policy of the office of the Food Commissioner and represents the suggested thirteen (13) new Food Commissioner Complexes as summarized in Appendix A to this report and Table 9 in the text. This new distribution system would keep the same number of rice mills and Multiple Purpose Cooperative Society stores but would close down or put to other uses 43 of the existing government warehouses.

The modified proposed alternatives reflect additional facilities to those proposed and their impact on transportation costs and distribution pattern. Three additional supply stations were added due to their advantageous location and capability of reducing and/or eliminating unnecessary back hauls of ration rice.

Initial workable annual throughput of rice ration for each of the thirteen (13) new complexes and additional facilities by marketing level was derived from the unconstrained linear transportation computer runs with infinite demand at the third marketing level (demand > supply) and infinite supply at the fourth marketing level (supply > demand). A series of computer runs determined a compromise optimum annual throughput for each facility for both marketing levels. The linear transportation analysis of the proposed and modified proposed alternatives was stopped once an annual throughput by location was achieved which would no longer permit further reductions in transportation cost in one marketing level without offsetting increases in the other.

The results of these analyses are summarized in Table 12. Included are the number of supply stations, transportation costs by marketing level, total transportation costs, transportation cost differentials and comparative cost decreases by alternative. Also, Tables 1 and 2, Appendix I, summarize optimum throughput of ration rice by location for the proposed alternative and the modified option.

Total transportation costs for the proposed alternative amount of Rs. 49

TABLE 12

SUMMARY OF TRANSPORTATION COSTS ASSOCIATED WITH THIRTEEN PRESELECTED FOOD COMMISSIONER SUPPLY STATIONS AND THREE ADDITIONAL LOCATIONS
1985
(Rs.)

REFERENCE NUMBER	NUMBER OF SUPPLY STATIONS	TRANSPORTATION COST RM-FC	TRANSPORTATION COST FC-MPCS	TOTAL TRANSPORTATION COST	TRANSPORTATION COST DIFFERENTIAL	COMPARATIVE DECREASE IN TRANSPORT COST
T.L.P. 0-B	13	25,442,888	23,625,498	49,068,386		
T.L.P. III-B	14	25,341,132	22,479,108	47,820,240	-1,248,146	1,248,146
T.L.P. IV-B	15	25,359,479	22,304,081	47,663,560	-1,404,826	156,680
T.L.P. VIII-B	16	25,275,682	22,211,420	47,487,102	-1,581,284	176,458

million, which exceeds the minimum transport cost for the 13 locations selected from the results of the unconstrained solutions by Rs. 5.5 million, or 12.7 percent.

The impact of additional facilities on back haul reduction or elimination and thus on transportation costs and distribution pattern is similar to those achieved in the unconstrained solutions. By including an extra facility at Jaffna (#7171) double hauls on 20,000 tons of ration rice are avoided and total transport costs are reduced by over Rs. 1 million. In a similar manner, extra facilities at Mannar (#7311) and Matara (#7371) help reduce back hauls to a minimum in those areas. Though their comparative decrease in transport cost is not as marked as the one obtained from locating another supply store in the district of Jaffna, their total contribution to transport cost savings amounts to over Rs. 330,000.

CHAPTER V

TRANSPORTATION LINEAR PROGRAMMING METHODOLOGY AND PROCEDURAL APPROACH

Introduction

The following material describes the transportation linear programming methodology used in this transportation and locational study and relies heavily on Volume I and II of User's Guide to Computerized System for Feasible Agribusiness Development.[1] Relevant parts of this proven system are used in this study with minor modifications and adaptations. A user's point of view is taken in interpreting the concept of optimization, the use of shadow prices, the model itself, and its algorithm. Also, the logical sequence of the procedural approach used in the locational analysis is given in the end of this chapter. Though most of the basic material included in the description of the Transportation Model can also be found in the User's Guide, parts are based on unpublished material provided to the author by Mr. Tiao and some of the references reviewed and cited in the bibliography.[2]

Application of the Transportation Linear Programming Model

The transportation linear programming model is designed to solve for the minimum cost pattern of transporting a commodity through space from a series

---

[1] Phillips, Richard, Leonard W. Schruben, Joe M. Tiao, Roe Borsdorf, and Cornelius Hugo, "User's Guide to Computerized System for Feasible Agribusiness Development," Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, Special Report No. 2., Revised August 1972.

[2] Dantzig, B. George, "Linear Programming and Extensions," Princeton, N.J.: Princeton University Press, 1963.

Gass, I. Saul, "Linear Programming," McGraw-Hill Book Company, 1969.

of origin points, each of which with known surplus quantities, to a series of destination points, each with known requirements. The least-cost transportation network file contains the cheapest mode available to link each origin point with each destination point. The model allocates the surplus quantities from the multiple origin points among the deficit quantities at the multiple destination points, so that requirements of all the destination points are satisfied at a minimum total transportation cost for the system as a whole.

Global conditions are imposed by the model to insure that the solution is optimal, i.e., that there is no other way of allocating the commodity in the movement through space which will result in a lower total transportation cost. The solution does not depend upon each origin shipping to its own least-cost destination, because lower total transport costs may be possible if the origin ships to its second or third best alternative, freeing its best alternative for another origin from which the savings gained are greater than those foregone by the first origin.

Also, the transportation model provides shadow prices which are very useful when storage and/or processing capacity limitations are part of the constraints. They are very useful because they indicate the marginal cost of the last unit before the capacity restriction is encountered. In other words, since they indicate the magnitude of the marginal least-costs sacrificed because of each capacity limit which becomes an effective restriction in the optimum flow pattern, shadow prices provide a direct measure of the potential benefits to the distribution or marketing system of removing the capacity restrictions. Also, relative magnitudes of the shadow prices provide an indication of the priority for the number, type, and location of the new storage and processing facilities for maximum benefit to the marketing system as a whole.

In making the comparative runs through the transportation linear programming model with and without specific proposed changes, the quantities of supply

and demand normally are held constant while the facilities of the marketing network are modified to reflect the improvements. The optimum flow patterns may be quite different with and without the proposed improvements, even though by definition both must meet the total demand requirements during the projected year for which the runs are made. The total transportation cost for the solution without the improvements minus the total transportation cost with the proposed improvements equals the transportation savings (benefits) which can be attributed to the improvements suggested by each alternative. The different distribution patterns can be compared to see how these benefits are distributed among supply points and demand points over the distribution network.

However, as explained in Chapter I, the peculiar structure of the ration rice distribution system forced the setup of four marketing levels; therefore, the analytical methodology will provide an overall feasible-rational rather than a feasible-optimal solution.

1. The Model

The computerized transportation model utilizes a mathematical linear programming technique designed to solve for the shipment and distribution pattern for local and imported ration rice which results in the minimum distribution cost for the country as a whole. The distribution costs are minimized mathematically, subject to a set of constraints regarding capacities, transportation networks, and transport facilities.

The inputs required for the transportation linear program are (1) supply quantities, (2) demand quantities, and (3) the optimum routing distribution cost network connecting the supply points with the demand points. For the Sri Lankan ration rice distribution system, supply quantities are defined as locally produced ration rice and deficits complemented by imports. Demand quantities are the projected ration rice consumption requirements by each Multiple Purpose

Cooperative Society Store. The optimum routing networks connecting ports and milling points with the public warehouses and the Multiple Purpose Cooperative Society stores include highway and railway networks serving each point.

This transportation problem is summarized in the following cost and requirement table.

DESTINATIONS

ORIGINS i \ j	1	2	3	...	n	s_i
1	C_{11}	C_{12}	C_{13}	...	C_{1n}	s_1
2	C_{21}	C_{22}	C_{23}	...	C_{2n}	s_2
3	C_{31}	C_{32}	C_{33}	...	C_{3n}	s_3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
m	C_{m1}	C_{m2}	C_{m3}	...	C_{mn}	s_m
d_j	d_1	d_2	d_3	...	d_n	

Where:

$i = 1, 2, 3, \ldots m$ is the number of origins

$j = 1, 2, 3, \ldots n$ is the number of destinations

That is, i = 228 rice mills and j = 56 government warehouses in the third marketing level and i = 56 government warehouses and j = 308 Multiple Purpose Cooperative Society stores in the fourth marketing level.

C_{ij} = transportation cost of shipping one unit of product (one ton of ration rice) from origin i to destination j, identified by mode.

s_i = the row requirements or the individual quantities available for shipping at each origin; $i = 1, 2, 3, \ldots m$

d_j = the column requirements or the individual quantities required at each destination; $j = 1, 2, 3, \ldots n$

Since the objective of the problem requires shipping the surplus ration rice quantities s_1, s_2, s_3, ... s_m from the supply points to satisfy the demand requirements d_1, d_2, d_3, ... d_n of the destination points at minimum transportation cost, the above problem can be stated more compactly as

$$S = C_{11} X_{11} + C_{12} X_{12} + \ldots + C_{21} X_{21} + C_{22} X_{22} + \ldots + C_{mn} X_{mn}$$

or

$$S = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$$

This represents the objective function of the primal problem for the transportation linear programming model. The model seeks to minimize this function subject to the following constraints which must be satisfied

$$\sum_{j=1}^{n} X_{ij} = s_i \quad \text{for } i = 1, 2, 3, \ldots m$$

that is, total quantity demanded must be equal to total quantity supplied, and

$$\sum_{i=1}^{m} X_{ij} = d_j \quad \text{for } j = 1, 2, 3, \ldots n$$

that is, total quantity supplied must equal total qantity demanded. Also, since negative quantities have no meaning, the problem solution requires that

$$X_{ij} \geq 0 \text{ for all } i \text{ and } j$$

Thus the variable in the linear programming analysis is the shipment pattern mix; what quantities of ration rice to handle from each port and rice mill through each government warehouse and ship to each Multiple Purpose Cooperative Society Store in such a way as to minimize the total distribution cost. The output from each computer run is the least-cost distribution pattern and the distribution cost associated with this pattern. In the formulation used, the linear programming model does not address the dynamics of day-to-day shipments.

Rather, it assumes that demand quantities and per unit distribution costs for the year are known at the beginning of the year, and makes allocations accordingly. Because the formulation is static, and because the consumption requirements change each year, separate runs are required to determine the optimum patterns for each year in the planning horizon.

Also, every linear programming problem has an associated optimization problem called the "dual." This association is revealed by the fact that the optimum solution of either problem reveals information concerning the optimum solution of the other. More specifically, if there is a unique solution to the problem, then the optimal solution of either problem yields an explicit solution to the other.

The dual problem for the transportation linear programming model can be represented as follows:

Objective Function:

(1) $\text{Max } Q = \sum_{i=1}^{m} s_i u_i + \sum_{j=1}^{n} d_j v_j$

(2) Subject to $u_i + v_i = C_{ij}$ for all i and j where the "shadow prices" of u_i and v_j (also called accounting or unit prices) are unrestricted in sign and represent the decision variables of the dual problem.

The dual problem is beneficial in at least three ways. First, it reduces the number of constraints in the problem which reduces computation time and costs. Second, the decision variables of the dual problem which are based on the constraints of the same are used in a series of steps in determining whether or not the basic feasible solution just obtained is optimal. Also, the dual problem provides necessary information in terms of the decisions variables which are taken as shadow prices in the constraint cases (capacity limitations). Such information allows the user to make intelligent decisions regarding the most beneficial reduction of capacity constraints for minimum transportation costs and optimum distribution system.

The Transportation Algorithm

The following section summarizes in a brief manner the transportation algorithm used in this study.

The basic solutions for the transportation model are defined in exactly the same way as in the general linear programming model. However, the solution procedure is executed directly on the transportation matrix rather than with the original set of equations.

Since there are m origins and n destinations, the original mathematical model contains (m + n) equations. However, since the sum of the origin requirements equals the sum of the destination requirements, any one of the original equations can be derived from the rest of them. Therefore, with one redundant equation, there are only (m + n - 1) linearly independent equations, so that a non-degenerate basic feasible solution must have exactly (m + n - 1) non-zero allocations in the transportation array. Finally, degenerate solutions are resolved by small part perturbations of the cells causing the degeneracy problem.

The Transportation Simplex Procedure

The transportation simplex procedure is characterized by a series of iterations or repetitive steps. The number of iterations will depend greatly on the size of the problem and will continue until an optimal solution is reached. Each iteration consists of a series of substeps which are repeated with each iteration.

(1) First iteration

The first substep in the first iteration deals with the criterion for finding an initial basic feasible solution to the transportation problem. Among the many methods available for this purpose, this computer program uses the Russell method which has been found to be, on the average, a solution closer to the optimum than the others.

Assuming that we have a basic feasible solution to the transportation problem, the second substep generates the indirect cost of the basic feasible solution from the decision variables u_i and v_j of the dual problem. This requires the calculation of all $u_i + v_j = C_{ij}$ equations and finding the values for u_i and v_j.

The third substep entails the construction of the $u_i + v_j - C_{ij}$ matrix, or the indirect cost table for the initial basic feasible solution. This indirect cost table provides the necessary information required to decide whether or not the initial basic feasible solution (and all other basic feasible solutions) is optimal. Based on the constraints of the dual problem, i.e., $u_1 + v_j \leq C_{ij}$, then, if all cells in the indirect cost table are equal to or less than zero, i.e., $u_i + v_j - C_{ij} \leq 0$, then the initial basic feasible solution (and all other basic feasible solutions) reaches optimality. If for any i and j the indirect cost table shows a positive value ($u_i + v_j - C_{ij} > 0$), an improved solution is possible and the next substep is then required.

In order to find an improved solution, a new basis must be formed which requires the exchange of variables. Therefore, this substep determines the new basic variable entering into the basis. As in the general simplex procedures, the variable having the maximum ($\bar{C}_{ij} - C_{ij} \geq 0$) is selected for entry into the new basis. That is, of those variables having a positive entry cost, the one with the largest is determined to be the new entering variable.

Selection of a new entering variable requires an existing basic variable to leave the basis. This substep selects the new leaving basic variable according to the same criterion used in the general linear programming model. The new leaving basic variable is selected as the one that reaches zero first as the new entering basic variable is increased.

Finally, the introduction of a new allocation will create a unique closed loop. This last substep of the first iteration alternatively subtracts and adds

the amount of this allocation to the other corners of the loop to restore feasibility.

(2) Second iteration

After restoration of feasibility the program returns to the second and third substeps to determine whether or not this new basic feasible solution is optimal. Should optimally not be the case, the program continues through in the third iteration. This iterative process is continued until an optimal basic feasible solution is found according to the criterion provided by the constraints of the dual problem.

2. Procedural Approach

This final procedural step represents the actual analysis of the current ration rice distribution system and probable alternatives and is achieved by using the Linear Transportation Program in conjunction with the key information previously obtained. This final analysis proceeds under the following assumptions:

1. The Institute study recommendations regarding Paddy Marketing Board warehouses and rice mills will be implemented.
2. Demand quantities will be the calculated annual rice ration needs by each Multiple Purpose Cooperative Society store.
3. Supply quantities will be the annual rice mill output as optimized in the Institute study, plus the deficits to be covered by imports.
4. The total supply will equal the total demand quantity.
5. The number of rice mills and Multiple Purpose Cooperative Society stores, together with their locations, are given.
6. The analysis is to be targeted for the projected supply and demand quantities in 1985.

The current system as well as all alternatives will be analyzed in two steps. The first step will optimize the third marketing level while the second step will optimize the fourth marketing level. The combination of the optimized third and fourth marketing levels will represent the Optimum Shipping Patterns for Minimum Transportation Cost for the distribution of milled ration rice.

Basically, the analysis is made by comparing the optimized current system with proposed changes (alternatives) which will impact on transportation costs. The current distribution system as well as each alternative reflects particular characteristics which are used in the final comparison with associated transportation costs.

Unconstrained Solutions

These solutions represent the year 1985 rice import and distribution patterns which result in the absolute least-cost by marketing level. They are obtained by assigning to each supply station a demand quatity in excess of the total 1985 demand for ration rice for absolute least-cost and optimum distribution pattern at the third marketing level. Likewise, an excess quantity over total 1985 requirements at each government storage facility provides absolute least-cost and optimum distribution pattern at the fourth marketing level. This assignment allows the computer program to optimize from both rice mills and import locations and indicate which of the 56 government warehouses are favorably located with respect to the rice mills and import points and/or the Multiple Purpose Cooperative Society stores.

Base Case

The Base Case reflects optimized rice ration flow for the year 1985 through the current distribution system given its location constraints. Those government warehouses having received and/or shipped ration rice in the unconstrained

solutions are included in the Base Case. Those warehouses not having received and shipped any rice are excluded from the distribution system. In order to find optimum distribution pattern for minimum transportation cost no capacity limitations are assumed. This establishes a compatible throughput capacity by supply station for the third and fourth marketing levels.

Modified Solutions

This sequence of alternatives measures the effects of reducing the number of government storage facilities on distribution patterns and transportation costs. Again, using the results of the unconstrained solutions, the number of storage facilities now being used is reduced step by step according to the following guidelines:

a. Eliminate those warehouses which received little (or no) ration rice from the rice mills in the unconstrained solution of the third marketing level but shipped no (or little) ration rice to the Multiple Purpose Cooperative Society stores in the unconstrained solution of the fourth marketing level.

b. Eliminate those warehouses which received and/or shipped relatively small quantities of rice in the unconstrained solutions of the third and fourth marketing levels.

c. Finally, where warehouses are grouped together in close proximity in a given area, eliminate those which received and/or shipped the smallest amount of rice ration in the unconstrained solutions of the third and fourth marketing levels.

This elimination procedure reduces the number of supply stations to thirteen which matches the minimum number of ration rice warehouses proposed by the office of the Food Commissioner for subsequent comparison.

Proposed Alternative

The impact of the proposed thirteen ration rice warehouses on commodity flow and transportation costs is obtained as follows:

a. Two linear transportation computer runs, one with infinite demand at the third marketing level, and the other with infinite supply at the fourth marketing level are used to determine absolute optimum throughput of ration rice through 13 proposed locations for the new complexes by marketing level.

b. A series of linear transportation computer runs is used to compromise the above results such that total transportation costs reach a compatible minimum for optimum throughput by complex in both marketing levels.

Modified Proposed Alternative

This alternative looks into the possibility of using more warehouse locations in addition to the 13 proposed by the office of the Food Commissioner. This is achieved as follows:

a. From the results of the unconstrained solutions, select additional sites which will tend to diminish or abolish unnecessary back hauls of ration rice.

b. Incorporate these additional sites, one at a time, to the 13 proposed sites and run a series of linear transportation computer runs to determine their individual and combined impact on transportation costs and distribution pattern.

Import Allocation

In order to determine optimum import points and quantities by point such

that inland transportation costs are minimized the best results of each alternative above are used as a basis for reoptimization of previous years' supply and demand quantities. This is done as follows:

1. Take 1980 and 1982 Multiple Purpose Cooperative Society store demand projections as the quantity demanded.
2. Take 1980 and 1982 rice mill output and imports as the quantity supplied.
3. Prorate these supply and demand quantities to the government warehouses in the Base Case and all other alternatives according to the 1985 results of the linear transportation computer runs.
4. Rerun the Base Case and all alternatives using the previously developed input to determine best import points and annual quantities by point.
5. Use 1980, 1982, and 1985 linear transportation computer run results to extrapolate import allocation by alternative between years 1980 and 1985.

CHAPTER VI

TRANSPORTATION LINEAR PROGRAMMING INPUT REQUIREMENTS METHODOLOGY AND PROCEDURAL APPROACH

Introduction

As explained in Chapter V, the Transportation Linear programming technique used in the analysis of the Sri Lankan rice ration distribution system requires three basic key inputs which are developed from primary and other essential information. These key inputs are: (1) projection of supply requirements by node, (2) projection of demand requirements by node, and (3) the transportation network requirements.

This chapter presents the methodology and procedural approach used to develop these basic inputs. The complete analytical system showing the individual computer programs, the step by step approach, intermediate, and final results is highlighted in Figure 8. Starting with identification of nodes, distance measurement for each possible mode of transport and other required primary information the methodology uses a series of subprograms to generate the required final inputs for the Transportation Linear Programming Model. Again, while the methodology, as represented by the use of the different computer programs, relies heavily on the User's Guide,[1] the procedural approach details the steps undertaken and relevant assumptions pertaining to each step.

Projection of Supply

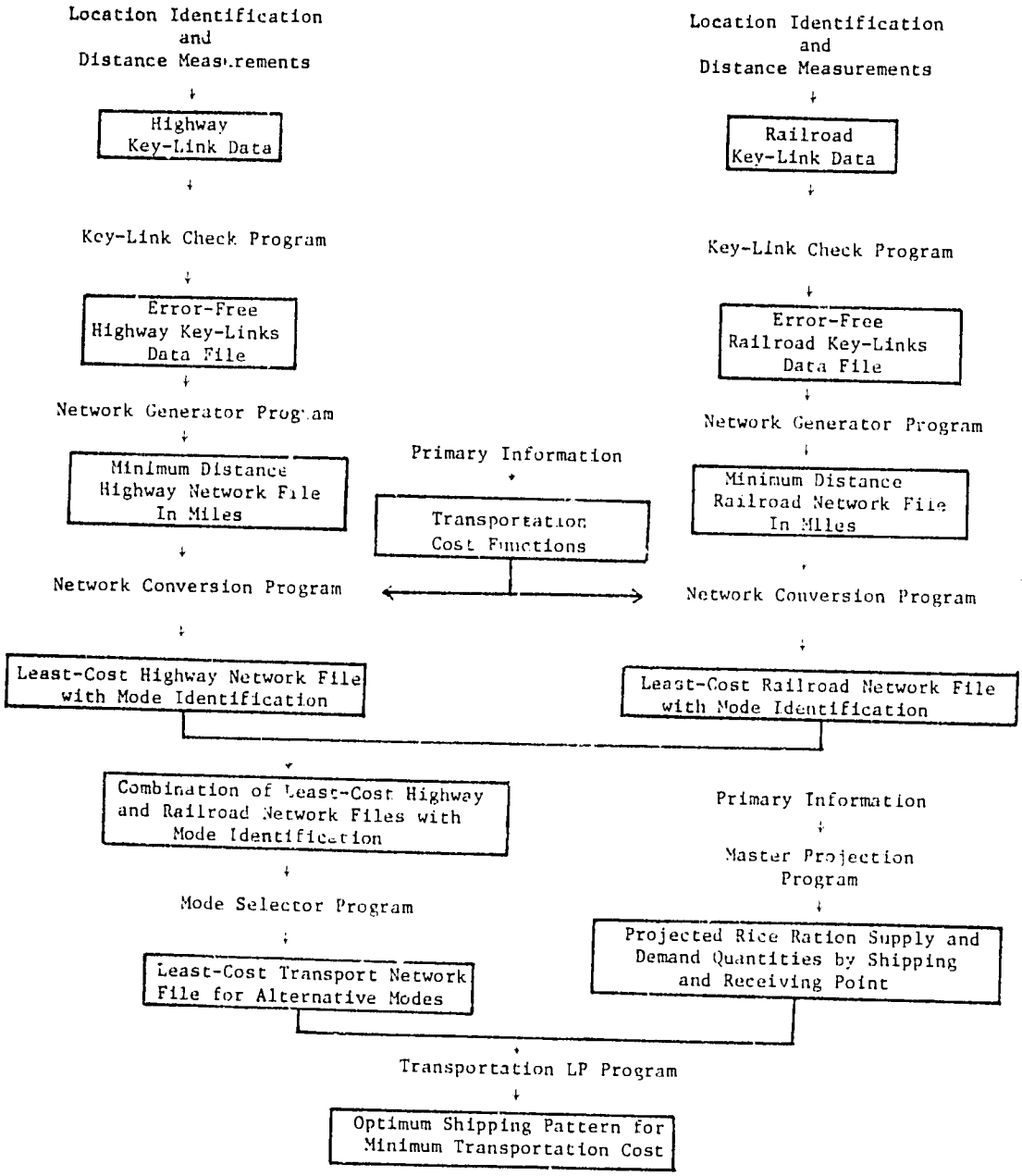
The purpose of production projections is to develop a projection of supply

---

[1]Phillips, Richard, Leonard W. Schruben, Joe Tiao, Roe Borsdorf, and Cornelius Hugo. "User's Guide to Computerized System for Feasible Agribusiness Development," Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, Special Report No. 2., Revised August, 1972.

FIGURE 8

SCHEMATIC DIAGRAM OF PROCEDURAL APPROACH
TO LINEAR TRANSPORTATION ANALYSIS



potential and forecast of purchases by the government sector of the paddy and rice industry. The result will be used to determine future storage requirements as well as future locations of facilities and facility size requirements. Therefore, these supply projections represent the raw requirements or the individual quantities available for shipping at each origin in the cost and requirement table of the Transportation Linear Programming model.

The supply projections for this study are developed from historical figures. These figures are entered to computer programs for measurement of trend patterns by least squares regression. Since time series analysis uses only the time series history of the variable being forecast, the development of a model for projecting future values requires the representation of the behavior of the projection process by a mathematical model that can be extended into the future.

In this study, projections of supply trends are generated by the Master Projection Program.[1] This program is designed to fit mathematical regression trends to historical time series data and develop projections by extending the fitted trends. The projections which may be specified in the program include (1) linear, (2) exponential, (3) logarithmic, and (4) given coefficients (as developed for previous studies). The computer program handles both simple and multiple regression techniques.

The basic exponential model is $Q = a + bX^n$, where

Q is the projected quantity

a is the intercept quantity at the y axis

b is the average incremental (annual) change

X is the number of periods from the first period in the time series (for example, if 1971 is the first period in the series, then X for 1981 is 11)

n is the exponent

---

[1] Chapter IV, p. , #1.

The exponent can be any number, but exponents in the range from 0.1 to 2.0 have the most relevance for normal time series projections. The exponential formula is linear in the special case where the exponent is 1.0 and quadratic in the special case where the exponent is 2.0.

An important advantage of the exponential model as formulated in the Master Projection Program is that complete projections can be fitted to a given set of historical data for a series of alternative exponents in the same computer run. This permits comparison of the projected values, regression coefficients, correlation coefficients, and other statistical parameters before selection of the final projection trend.

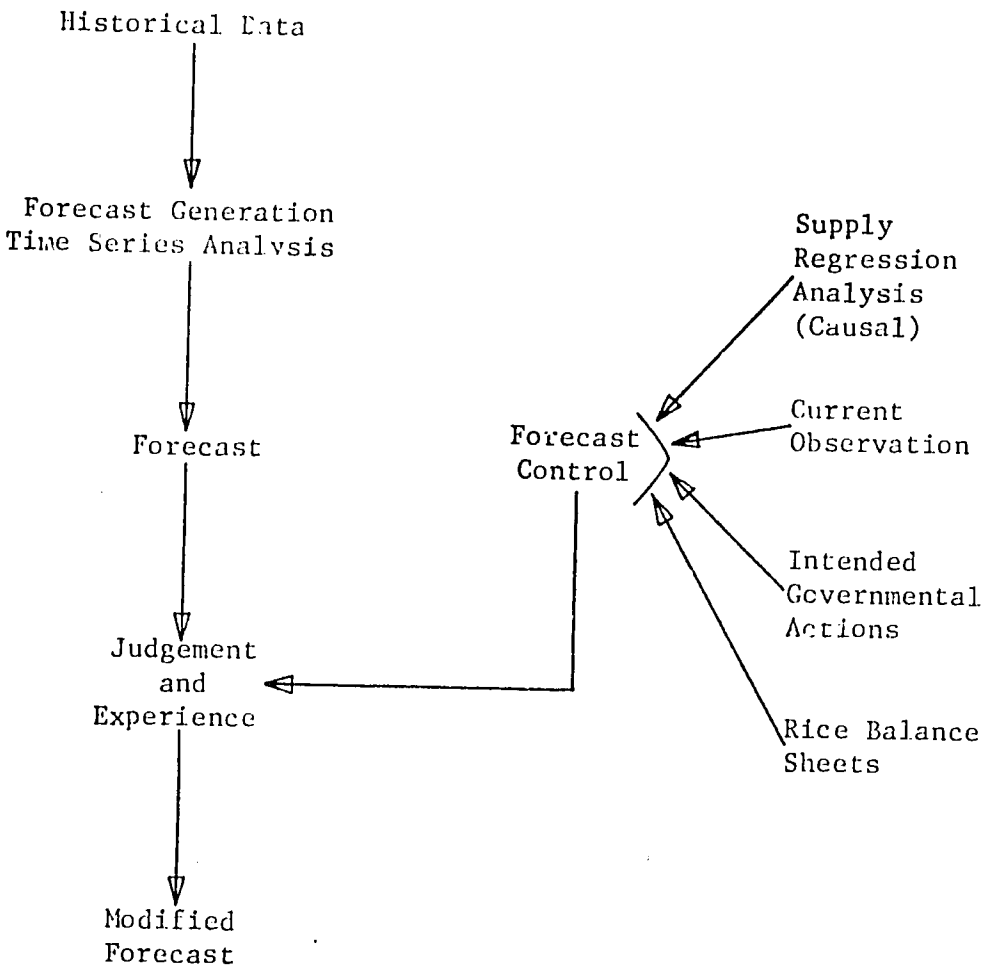
Nevertheless, judgement must be exercised in selecting the most realistic exponential trend from the alternatives. In making short-run projections, the trend that yields the highest R^2 value normally will be selected. However, if there are physical, biological, managerial, market, or other limits to continued extension of the trend, the trend providing the best statistical fit may not yield realistic long-run projections.

Since time series analysis is predicated upon the past representing the future, certain limitations exist. The basic limitation of these models is that changes in market or production structures being planned through outside influences (i.e., governmental development programs) cannot be directly applied to the model.

Therefore, in order to obtain well-defined projections that include significant factors of change, a forecasting system is used as illustrated in Figure 4. While still using time series analysis as the main vehicle for the projection of trends, a forecast control is used which allows the projections to be modified based upon structural changes occurring or changes that will occur within the production system being analyzed. Therefore, results of causal models, current observations, intended governmental actions, and rice balance

FIGURE 9

FORECASTING APPROACH FOR SUPPLY AND DEMAND PROJECTIONS



Source: Roe Borsdorf and Cornelius Hugo, Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lanka Rice Industry. Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, p. 180.

sheets may be used to alter the trend line developed from the time series analysis where the trend line does not reflect the expected impact of future development programs.

One of the most important assumptions impacting on the accuracy of the supply and procurement projections deals with the scheduled implementation of the accelerated Mahawelli irrigation project and several minor irrigation projects scattered throughout the country.[1]

Finally, the procedural steps used to determine the future potential supply of paddy by district and forecast government purchases through the Guaranteed Price Scheme for the rice ration system are given in the Institute study.[2]

Projection of Demand

The second key input for the transportation linear programming model is given by the projections of demand. This input by node represents the column requirements or the individual quantities required at each destination within the cost and requirement table of the transportation linear programming model.

Generally, the key factors for volume of domestic demand for rice in any given year are total population and average per capita consumption. Average per capita consumption is affected by eating habits and food preferences, by average income levels, and by the price of one food relative to prices of complementary or substitute foods. Rural populations generally have different eating habits than urban populations, so the average per capita consumption is different among the two populations. As income increases, different shifts in the consumption level of foods occur. The magnitude of these shifts depends

---

[1] Borsdorf, Roe, and Cornelius Hugo, "Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lankan Rice Industry," Food and Feed Grain Institute, Manhattan, Kansas, 1979, pp. 226-227.

[2] Ibid., pp. 182-183, 196-199.

on the income elasticity of demand as well as the price elasticity of demand for the particular food. Income elasticity measures the percentage increase or decrease in consumption with a given percentage increase in income. Price elasticity measures the percentage decrease/increase in consumption with a given percentage increase/decrease in price.

In this study, elasticities cannot be constructed because of the lack of adequate data on per capita consumption and because the subsidized ration system for rice and flour distorts any results because of governmental subsidies, price controls, and government manipulations of the ration system.

This set of circumstances dictates that another approach be devised for construction of future domestic consumption. Using the same generalized forecast system illustrated in Figure 9, the methodology for constructing total demand is as follows:

1. Projection of population by national and district levels.
2. Proration of total district population projections to urban-rural projections by district.
3. Projection of urban and rural per capita consumption for rice, (a) with wheat flour supplies, and (b) without wheat flour supplies.
4. Construction of total demand for rice by district.

This process involves the use of the master projection model as previously described in the Supply Projections time series analysis. Because of the restrictions previously stated, regression analysis to measure elasticities and determine relationships is not feasible for this study.

The demand for ration rice distributed by the government represents a subsidiary component to total rice demand in Sri Lanka. This subsidiary demand volume for the rice rationing system is obtained by multiplying the yearly rice ration allowance times the projected number of rice ration recipients. Using

the master projection model, this result is achieved with a series of substeps as follows:

1. Multiply each district's proportion of 1978 rice ration card holders times the projected district population.
2. Prorate each district's projected rice ration card holders into the district's Multiple Purpose Cooperative Society stores, using 1978 base figures as proration factor.
3. Multiply each Multiple Purpose Cooperative Society store projected number of rice ration card holders times 0.092857 {(4 lbs/week x 52 weeks) ÷ 2240 lbs/ton}, to obtain the yearly demand of milled rice by store in tons.

The above calculation of rice ration demand requires several key assumptions regarding the rice rationing system, government policies, and population growth and pattern. First, it assumes that the present form of rice rationing will be maintained by the government. This presumes that the proportion of people qualifying for rice ration will stay the same as in 1978 and that per capita income will not increase at such a rate as to induce a change in government policy with regard to the rationing scheme. Second, it assumes that no major migratory changes will occur to offset present population projections by district. Finally, it assumes that the proportion of people receiving rice ration will grow at the same rate as national population growth.

Under these assumptions, the projections of future rice ration recipients by district and volumes of ration rice to be distributed by each Multiple Purpose Cooperative Society store are made and summarized in tables printed by the Master Projection Program. These projections are taken to be the yearly demand for ration rice for use in the linear transportation analysis to determine best location and number for the proposed government storage facilities.

Transportation Network Requirements

The third major input required by the Transportation Linear Programming Model is represented by the least cost distribution network for alternative modes. It indicates the minimum transportation cost by mode of shipping one unit of product from origin i to destination j. This final requirement is itself the result of a series of substeps.

1. Node Identification and Link Measurements

An accurate picture of the current commodity distribution system is obtained by survey. Such survey serves the purpose of determining the exact location of each facility or point within the existing marketing system through which the commodity moves on its way from the producer to the consumer. Each point, i.e., supply or demand point, is known as a node, and each node is connected to another node via a highway, rail, or waterway, which are known as links. In order to determine exactly the location of each node, accurate and up-to-date maps of the region or country are needed. Such maps should have a scale of at least one inch to the mile and includue the latest road or other link construction and improvements. Also for sensitivity analysis on location possibilities, future links such as planned roads should also be included.

Each identified node is then tabulated and identified by number and written at the map location of the node. For convenience, identification numbers are assigned in ascending order with a series of numbers such as 100 to 299 identifying a specific type of node such as rice mills and another series of numbers such as 200 to 399 identifying retail outlets or other type of node. These results are given in Tables 1 through 3 of Appendix B to this report.

The commodity flow through the existing marketing system serves as a basis for locating and numbering in a sequential manner all the facilities (nodes) through which rough and milled rice used in the ration scheme flows as it goes

from the producer to the consumer.

Once the process of locating and identifying the nodes comprising the marketing channels for the commodity has been completed, the nodes are connected to each other via links. This is achieved by accurately measuring all the alternative highway and other transport mode link distances between two adjacent nodes. Taking into account current link constraints such as type and condition of roads which may or nay not be passable year-round, weight limits of bridges and others, the distances between links are measured with the use of a pair of dividers to the nearest decimal point. The distance measurement between links made can be easier with the help of an Electronics Graphic or Linear Calculator. This machine is an electronic divider which measures the distance between nodes by tracing the link and converting this measured distance into actual miles according to the scale of the map, by using an equation for distance along a curved line.

Finally, all measured links are tabulated in a form acceptable for input into the computer (for example, perforated computer cards) for further processing. This first step of the methodology is also the last manual step to be undertaken. The rest of the methodology depends on specially developed computer programs.

However, the complexity of the marketing structure used by the GSL to channel ration rice from domestic sources and import points to final demand points makes impossible a simple transportation analysis with just two sets of given numbers for origin and destination points.

Such a market structure with multiple numbers of origins and destinations at each marketing level and computer capacity limitations necessitates transportation linear programming analysis by marketing level. Therefore, each marketing level is treated essentially as a separate market whose own optimum distribution pattern will impact on the next marketing level.

In this fashion, all four marketing levels are connected according to

current commodity flow and later programming requirements to reflect present distribution system and possible alternatives. These links by marketing levels are measured as follows:

First Marketing Level:[1]	Purchasing Center to nearest Paddy Marketing Board warehouse.
	Paddy Marketing Board warehouse to nearest Paddy Marketing Board warehouse.
Second Marketing Level:[1]	Paddy Marketing Board warehouse to nearest rice mill.
	Rice mill to rice mill.
Third Marketing Level:[2]	Rice mill to government warehouse.
	Government rice warehouse to government rice warehouse.
	Rice mill to nearest Multiple Purpose Cooperative Society store.
Fourth Marketing Level:[2]	Government warehouse to nearest Multiple Purpose Society store.
	Multiple Purpose Society store to Multiple Purpose Society store.

Since all highway links for all four marketing levels have been measured at the district level, a national highway key-link data file for the third and fourth marketing levels is obtained the following substeps.

1. From each district Error-free Highway key-link Data File extract those links pertaining to the third and fourth marketing levels.
2. Combine these 22 separate Highway key-link Data series into two national files by marketing level providing proper highway links to adjacent districts.
3. Provide identification numbers and measured highway links for

---

[1]Pertain to the first Food and Feed Grain Institute Study.

[2]Pertain to this paper.

proposed rice mills.[1]

4. Code and punch to computer cards the result of the two previous substeps before running a nationwide key-link check to assure proper linkages.

Since railroad transportation seems economical over relatively long distances,[2] generation of railroad key-links is done on a national scale under the following assumptions:

1. For those rice mills, government warehouses and Multiple Purpose Cooperative Society stores having direct rail links, distances are measured as before using an Electronic Graphic Calculator.
2. Those rice mills, government warehouses and Multiple Purpose Cooperative Society stores having indirect access to nearby railroad stations are assumed, based on limited observation, to be one mile from each station. Also, these railroad stations are assumed to have adequate loading and unloading facilities, since they occasionally use rail facilities. Finally, this extra mile (s) is later reflected in the railroad transportation cost function (which is adjusted for the handling and trade transport costs).
3. Those rice mills, government warehouses, and Multiple Purpose Cooperative Society stores having no direct or indirect access to nearby railroad stations are excluded from the rail network.

After measuring the above links, the key-link distance data is coded and punched to computer cards in preparation for the key-link check program run.

2. Basic Network

The next step in developing the input for the Transportation Linear Programming Model is to identify the key links connecting each node with all those

---

[1] Chapter IV, p. , #1, p. 169.

[2] Ibid., p. 269.

directly adjoining it. This is achieved using the Key Link Check Program,[1] and results in a basic network containing all potential links. The program checks the primary network input data for duplicate links and nodes, lack of connecting links, and key punch errors. After the errors have been corrected, the final output contains, among other things, (1) a listing of the original keylink data, (2) a listing of sorted keylink input, (3) a listing of all links serving each node, and (4) a summary table of links from each mode by ascending order of links and nodes.

In separate runs, the highway and railroad keylink data are analyzed for errors. This step results in two separate basic networks containing error-free highway and railroad keylinks for the third and fourth marketing levels.

3. Minimum Distance Network

Once the basic network has been obtained, the next step entails the development of an optimum routing network for each mode available. This optimum or minimum distance routing network is developed from the basic network of each mode in which each link has an associated length and the Network Generator Program[2] finds the shortest path from a specified node to each of the other nodes. The total minimum distances between each pair of nodes in the system are stored on magnetic tape. For some problems, costs, or time coefficients are used instead of linear or physical distances, depending on the nature of the problem.

Thus, in the Network Generator Program, the coefficients of the objective function represent the distance measurements of the links and in optimizing the basic network of each mode a least-distance path is found from any one node to all other nodes for each mode transportation. This step is based on the assumption that, given no undue constraints, any commodity will travel the shortest distance between shipping point and receiving point.

---

[1] Chapter VI, p. , #1.

[2] Ibid.

4. Transportation Cost Functions

This basic highway and railroad transportation cost functions employed in this study were developed from primary information obtained during the Food and Feed Grain Institute study phase. Different highway transportation cost functions were developed and statistically analyzed for soundness and appropriateness. Likewise, using primary information from the "Sri Lanka Railroad Assessment Study" by Trimac Consulting of Canada and other information, appropriate railroad transport cost functions were developed for the analysis. In order to make this presentation self-contained, the methodology used in that study to develop the transportation cost functions is presented here in summary form. Also, necessary assumptions regarding the rail cost function are included.

When conducting transport and/or locational analysis, two cost structures may be considered. First, trnasportation rates may be used to calculate the transportation function. However, transport rates may not reflect the true cost of transport involved in the physical distribution of any individual product. This is because transport rates cannot reflect any governmental subsidies, preferential rates on specific products below costs, nor the economic cost differences due to different load sizes of hauls.

The second cost structure is the estimated true cost of transport by taking into consideration all known costs involved in a given mode of transport. These costs may be constructed by survey of actual operations or by engineering economics.

Transportation functions are generally linear equations, expressed as $Y = A + bX$, or in some cases a kinked linear expression such as $Y = A + b(X - K)$. This is not to say that a quadradic or exponential expression cannot be used to reflect estimated true costs, but this type of equation was not proven to be empirically superior to the appropriate linear expression.

Truck Transportation Cost Function

The basic model for estimating operating costs of trucks consists of three components: (1) variable costs which are associated with distances, (2) fixed costs, and (3) transfer costs which involve the cost of loading and unloading trucks and/or drivers time during the loading-unloading process. In this study, transfer costs are deleted because they are considered to be a warehouse cost associated with the storage and handling of paddy and rice. Also, truck drivers' salaries are in this study a fixed cost because the drivers are paid a monthly salary. The following general equation reflects the total cost component of a given truck:

$$TCv = TFCv + VCv\ Mv,$$

where for vehicle type v,

TCv = total cost annually per truck
TFCv = total fixed cost annually per truck
VCv = variable cost per mile
Mv = miles per year.

Variable costs include fuel, maintenance (oil, oil filters, lubrication, repair), and tires which are calculated as variable costs per mile of operation.

Those costs which are not associated with mileage, but which are accrued whether or not the truck is moved are considered as fixed costs. Fixed costs include interest, depreciation, license fees, insurance costs, highway use taxes, management expenses (administration), and drivers and helpers wages.

The process of constructing a truck transportation function such as $Y = A + bx$ involves computation of fixed costs A, on a per-ton hauled basis. Therefore, additional information is required on length of trips, number of trips, percentage of capacity load, and annual mileage.

The above data requirements are ascertained by a survey of operating vehicles. Applying the procedural approach discussed in the Food and Feed Grain Institute Study, a linear transportation cost function is generated to reflect

the costs associated with hauling rice by truck in Sri Lanka.

A second approach to constructing a transportation function involves determining actual payments per ton per specific trip. If payment data can be ascertained to contain no excess profit levels, then these data can be regressed against distances involved to construct a workable function.

Both methodologies are used in this study because a lack of data and lack of previous transport cost studies require collection of data by survey. Results from the two methodologies are compared and selection is based upon the best result obtained.

Rail Transportation Cost Function

Due to the nature of rail transport, this mode exhibits high fixed costs. While the basic procedure for estimation of costs differs little from truck transport cost estimation, the basic rail cost function is developed from information contained in a Railroad Assessment study[1] and limited additional survey data.[2] Two basic linear function are constructed and subsequently modified to reflect specific conditions of the railroad network.[3]

The following facts and assumptions are used to modify the basic rail functions to reflect the lack of rail sidings at facilities and the intermediate truck transport made necessary as consequence:

1. The basic railroad cost functions are assumed to reflect only true economic costs of transporting goods via the railroad.
2. Only three rice mills are documented to have railroad sidings at this time.

---

[1]Sri Lanka Railway Assessment Study, prepared for CIDA by TRIMAC Consulting Services LTD, September, 1976.

[2]Chapter VI, p. , #1, p. 268.

[3]Ibid., pp. 268-270.

3. Those rice mills, government warehouses, and Multiple Purpose Cooperative Society stores which do not have any railroad services have been excluded from the railroad network.

4. The rest of these facilities located along the railroad and near a railroad station and/or siding have been included in the railroad network. Since their exact location with regard to the railroad is not known at this time, they are all assumed to be one (1) mile from such stations and/or sidings. It is also assumed that these stations and/or sidings are suitable for loading and unloading sacked rice.

5. Least Cost Distribution Networks

The least-cost transportation mode network for any commodity reflects the minimum distance routing network for that particular mode and the appropriate mode transportation cost function for that commodity. Therefore, the least-cost transportation mode network is developed by multiplying each link in the Minimum distance network by the appropriate mode transportation cost function for the commodity. Thus, for example, the Network Conversion Program[1] will retrieve the minimum distance highway network file and multiple it times the appropriate highway transportation cost function to obtain and store the least-cost highway distribution network with mode identification. Least-cost network files for rail or other modes of transportation are obtained and stored in similar fashion. In this manner, separate least-cost truck and rail distribution networks with mode identification are generated for the third and fourth marketing levels.

6. Combined Least Cost Distribution Networks for Alternative Modes

In order to obtain a single least-cost transportation network file covering all shipping and distribution points by marketing level, the least-cost highway

---

[1]Chapter VI, p. , # 1.

and railroad network files are combined in such a manner so that all points are connected by the least-cost transportation mode. This is achieved using a special Mode Selector Program[1] to combine the individual network files by marketing level, and then select the least-cost mode for any pair of supply and demand points.

Should mode combination be feasible, then the extra transfer costs involved in changing from one mode to another is included and the selection is also made of combination shipments of two or more modes for origin-destination pairs served at lower cost in this manner than be a single mode. (This option was not feasible in this study).

These results are combined into a total least-cost distribution network by marketing level for the commodity and stored on tape. Each rate selected from one node to another is identified with the corresponding mode associated with that rate. In case of combination rates, the transfer point (say from highway to rail) is also indicated.

---

[1]Chapter VI, p. , #1.

APPENDIX A

PROPOSED FOOD COMMISSIONER COMPLEXES

JAMES E. WIMBERLY
ADVISOR

RICE POST HARVEST INDUSTRY

May 6, 1978.

MEMO:

TO: Dr. Roe Borsdorf

FROM: J. Wimberly

The Food Commissioner would like for you to test a new proposed program along with the transport analysis.

The proposal would be to have 13 Food Commissioner Complexes, each complex would be used for receiving milled rice from rice millers, rice distribution centres to the M.I.C.Ss, storage and distribution centres for sugar and wheat flour. Each complex could then be managed by a higher grade officer and would include such things as quality control laboratory, adequate storage facilities, supplemental cleaning and drying facilities, weighing and handling facilities.

This would replace his existing 54 F.C. Supply Stations, and in the process the storage now available at F.C. Supply Stations could be used for other things, mainly PMB paddy storage. This idea incorporates building 13 new FC complexes.

We would like to know the transport requirements if we go through this proposed system. It would also be desirable to know the FC transport requirements of the new proposed system vs the existing system transport requirements. Attached is a list of the proposed FC complexes by districts and locations. You would have to assign new code numbers to these locations and by using the projected rice ration system by districts you could figure out the storage requirements. This system would cover island requirements excluding existing port facilities. Also attached is a map showing these 13 proposed FC complexes.

The theory of 13 FC complexes is not restricted to 13 only. The idea the F.C. has is to operate 12 - 15 such complexes, each with approximately 50 miles radius. As we divide up the island it appears that 13 would be adequate. If you revalue this we might find that 11, 12, 14, or 15 would be more appropriate.

On the computer study that the proposed FC complexes plan on a minimum of one month stocks of rice, flour and sugar at each complex, plus storage capacity to take in and despatch rice from surplus production areas. We all agree that any reserve stocks more than one month should be kept with the PMB in the form of paddy.

If you have any questions concerning this idea please let me know.

MAIL: P.O. BOX 1642, COLOMBO, SRI LANKA. CABLE: WIASI, COLOMBO.
OFFICE: 151, DHARMAPALA MAWATHA, COLOMBO, SRI LANKA. TEL. 35811.

it

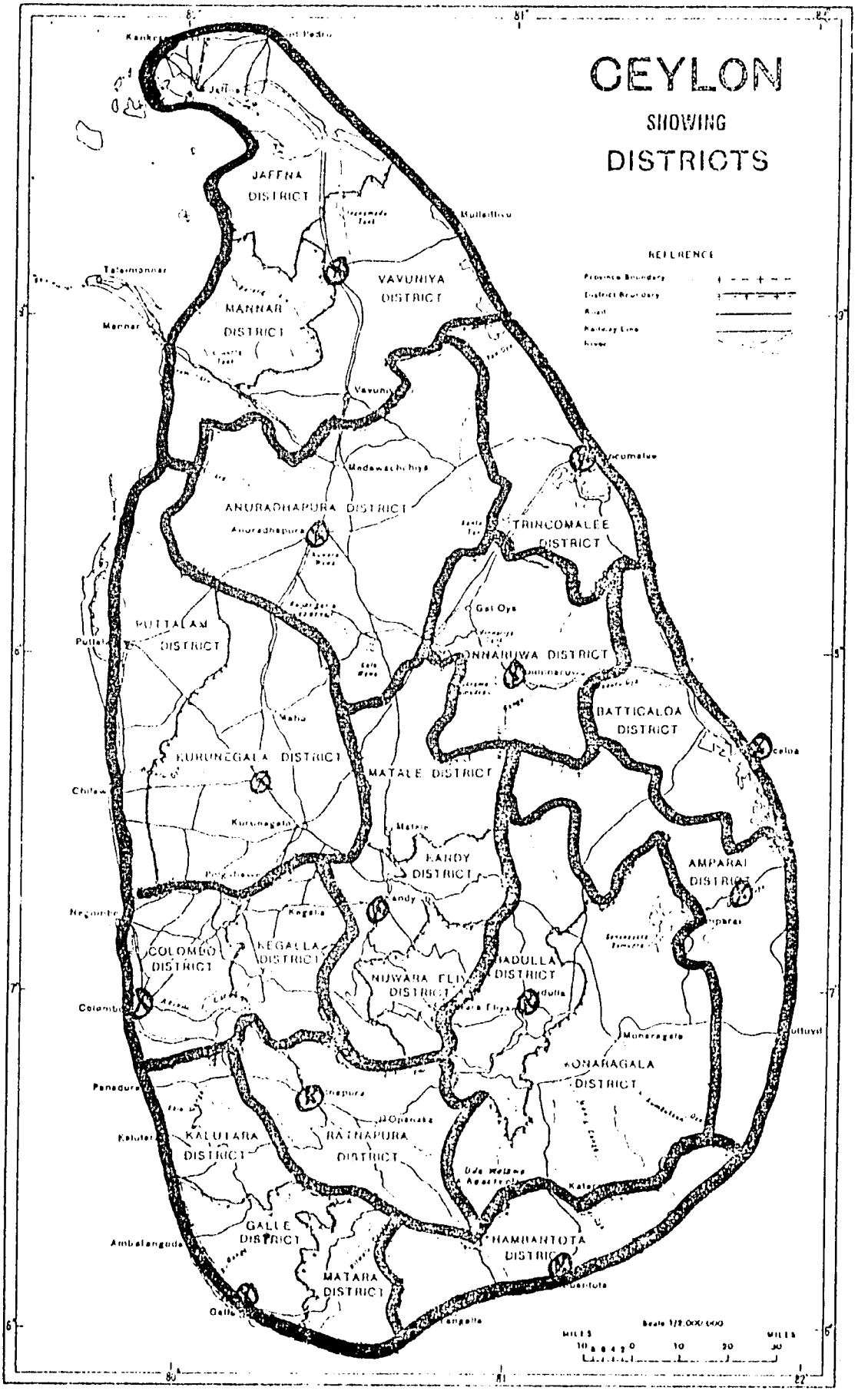
Attachment

PROPOSED F.C. "COMPLEXES"

NO.	DISTRICTS	LOCATIONS
1.	Jaffna Mannar Vavuniya	Mankulam
2.	Anuradhapura	Anuradhapura
3.	Trincomalee	Trincomalee
4.	Polonnaruwa	Polonnaruwa
5.	Batticoloa	Batticoloa
6.	Amparai	Amparai
7.	Badulla Moneragala	Badulla
8.	Kandy Matale Nuwara Eliya	Matale
9.	Kurunegala Puttalam	Nikaweratiya
10.	Colombo Kegalle	Colombo
11.	Ratnapura	Ratnapura
12.	Kalutara Galle Matara	Galle
13.	Hambantota	Ambalantota

6/5/1978

it


CEYLON
SHOWING
DISTRICTS
REFERENCE
JAFFNA DISTRICT
VAVUNIYA DISTRICT
MANNAR DISTRICT
ANURADHAPURA DISTRICT
TRINCOMALEE DISTRICT
PUTTALAM DISTRICT
BATTICALOA DISTRICT
KURUNEGALA DISTRICT
MATALE DISTRICT
KANDY DISTRICT
AMPARAI DISTRICT
COLOMBO DISTRICT
NEGALLA DISTRICT
NUWARA ELIYA DISTRICT
BADULLA DISTRICT
MONARAGALA DISTRICT
KALUTARA DISTRICT
RATNAPURA DISTRICT
GALLE DISTRICT
HAMBANTOTA DISTRICT
MATARA DISTRICT

APPENDIX B

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICTS

TABLE 1

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

RICE MILLS

AMPARAI

6001	Hingurana
6002	Uhana
6003	Samanthurai
6004	Amparai
6005	Lahugala
6006	Camana
6007	Pottuvil
6008	Kalmunai
6009	Akkaraipattu
6010	Bakkiella
6011	Inginiyagala
6012	Erargama
6013	Karativu
6014	Weeragoda
6015	Addalachavai
6016	Nintavur
6017	Chavalakada-PMB
6018	Inginiyagala-PMB
6019	Samanthurai-AID
6020	Sagama
6021	Maha Oya

ANURADHAPURA

6041	Medawachchiya
6042	Anuradhapura
6043	Hidogama
6044	Tayawa
6045	Sravastipura
6046	Kekirawa
6047	Kahatgasdigiliya
6048	Mankadewela
6049	Horowpothana
6050	Maradankadawala
6051	Macatugama
6052	Vijithapura
6053	Mihintale
6054	Puliyankulama
6055	Anaradnapura-PMB
6056	Medwachchiya-PMB
6057	Kalawewa-PMB
6058	Padaviya-PMB
6059	Rapawala-PMB-AID
6060	Rajangana-PMBAID
6061	Kekirawa-PMB-AID
6062	Kebithigollema
6063	Mochchiyagama

BADULLA

6081	Hali-ela
6082	Badulla
6083	Keppetipola
6084	Mahiyangana
6085	Meegahakivula

BATTICALOA

6101	Kattankudi
6102	Chenkaladai
6103	Karaveddi
6104	Palamunai
6105	Murukottachenai
6106	Eravur
6107	Batticaloa
6108	Batticaloa-PMB
6109	Eravur-PMB-AID

COLOMBO

6131	Kelaniya
6132	Wattala
6133	Colombo*

GALLE

6141	Unawatuna
6142	Bentota
6143	Urugasmanhandiya
6144	Galle*

HAMBANTOTA

6161	Ambalantota
6162	Tangalle
6163	Bellatta
6164	Tissamaharama
6165	Marmadela
6166	Valgsmulla
6167	Hambantota
6169	Hungama
6170	Weeraketiya
6171	Ambalantota-PMB
6173	Kachchigale-PMG

*Represent simulated import points

TABLE 1

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

RICE MILLS

JAFFNA

6191	Karaveddi
6192	Musalai
6193	Killinochchi
6194	Kondavil
6195	Velanai
6196	Chunakam
6197	Manipae
6198	Paranthan
6199	Karavanai-South
6200	Poonalai-Kaduvan
6201	Kokkuvil
6202	Suthumalai
6203	Elalai
6204	Jaffna
6205	Karainggar
6206	Vadukoddai
6207	Kankesanthurai
6208	Kaithady
6209	Chankangi
6210	Uduppidy

KALUTARA

6231	Kalutara
6232	Aluthaama
6233	Moronthuduwa

KANDY

6251	Kandy
6252	Ambatenne
6253	Gampola
6254	Wattegama
6255	Akurana
6256	Kundasalge
6257	Hasalake
6258	Veragantota
6259	Menikhinna
6260	Poojapitiya
6261	Muruthalawa
6262	Verallagama
6263	Katugastota
6264	Teldeniya
6266	Minipae
6267	Kadugannawa
6269	Galagedera
6271	Pallewaite-PMB
6272	Hasalaka-PMB
6273	Denuwara-PMB
6274	Gannaruwa-PMB

KEGALLE

6291	Kegalle
6292	Warakapola
6293	Thulhiriya
6296	Mawanella
6297	Rambukkana

KURUNEGALA

6321	Nikaweratiya
6322	Horombawa
6324	Kurunegala
6325	Pannala
6327	Nikadalupotha
6328	Pannala
6329	Dambadeniya
6330	Kuliyapitiya
6331	Polganawela
6332	Mallawapitiya
6333	Ibbagamuwa
6334	Katupotha
6335	Wariyapola
6336	Pothuhera
6337	Maho-PMB
6338	Nikaweratiya-PMB
6339	Galgamuwa-PMB
6340	Maho

MANNAR

6361	Mannar
6362	Adampan
6363	Paliyankulam
6364	Uilankulam
6365	Murunkan
6366	Sillavatturai
6367	Thirukethiswaara

MATALE

6391	Galewela
6392	Dambulla
6393	Matale
6395	Mahawela
6396	Alubihara
6397	Devahuwa
6398	Konagahawela
6399	Karnku-Palalla
6400	Kandalama-PMB
6401	Naula-PMB
6402	Hettipola

TABLE 1

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

RICE MILLS

MATARA

6421	Matara
6422	Devinuwala
6423	Weligama
6424	Kamburugamuwa
6425	Kamburupitiya
6426	Dikwella
6427	Walasgala
6428	Ratmalae
6429	Hakmana
6430	Diyagaha
6431	Yatiyana
6432	Thihagoda

MONEREGALA

6451	Moneragala
6452	Bibile
6453	Tanamalvila
6454	Sirigala
6455	Moneragala-PMB
6456	Wellawaya
6460	Rikillagaskada

POLONNARUWA

6501	Polonnaruwa
6502	Manampitiya
6503	Kalahagala
6504	Kaduruwela
6505	Elahera
6506	Kaudulla
6507	Giritalae
6508	
6509	Palastigama
6510	Hingurakgodd
6511	Polonnaruwa-PMB
6512	Hingurakgoda-PMG
6513	Bakamuna-PMB
6514	Minneriya-PMB-AID

PUTTALAM

6531	Puttalam
6532	Madampae
6533	Rajakadaluwa
6534	Anamaduwa
6535	Tabbowa

RATNAPURA

6551	Opanaike
6552	Pelmadulla
6553	Balangoda
6554	Padalangala
6555	Embilipitiya
6556	[illegible]aketiya

TRINCOMALEE

6581	Kinniya
6582	Kantalai
6583	Gantalarwa
6584	Uppuveli
6585	Pankulam
6586	Trincomalee
6587	Sambalativu
6588	Nelaveli
6589	Kantalai-PMB
6590	Kantale Comp-PMB
6591	Muttur I-PMB
6592	Muttur II-PMB
6593	Kallor
6594	Kilireddi
6595	Thoppur

VAVUNIYA

6611	Omantai
6612	Vavuniya
6613	Mankulam
6614	Mulliavelai
6615	Nedunkerni
6616	Oddu-Suddan
6617	Vavuniya-PMB-AID

TABLE 2

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

FOOD COMMISSIONER WAREHOUSES

AMPARAI

7001	Amparai
7002	Chavalakadae
7003	Naipattimunai
7004	Batti Transit

ANURADHAPURA

7026	Anuradhapura
7027	Sravastipura

BADULLA

7041	Badulla
7042	Bandarawela
7043	Haputale

BATTICALOA

7061	Batticaloa

COLOMBO

7076	Colombo
7077	Wharf

GALLE

7101	Galle
7102	Boosa

HAMBANTOTA

7131	Hambantota
7132	Werrawila
7133	Kahandawa

JAFFNA

7171	Jaffna
7172	Point Pedro
7173	Kankasannturai
7174	Kayts
7175	Navatkuli
7176	Delft
7177	Palali

KANDY

7211	Katugastota
7212	Gampola
7213	Wattegama
7214	Nawalapitiya
7215	Kundasale

KEGALLE

7251	Kegalle
7252	Warakapola
7253	Karawanella

KURUNEGALA

7281	Kurunegala
7282	Maho

MANNAR

7311	Mannar
7312	Murunkan

MATALE

7341	Matale

MATARA

7371	Matara
7372	Welligama

MONEREGALA

7401	Moneregala

NUWARA-ELIYA

7431	Nuwara-Eliya

POLONNARUWA

7461	Polonaruwa
7462	Hingurakgoda

TABLE 2

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

FOOD COMMISSIONER WAREHOUSES

PUTTALAM

7491	Puttalam
7492	Madampe

RATNAPURA

7521	Ratnapura
7522	Kahawatta
7523	Opanaike
7524	Eheliyagoda
7525	Dela

TRINCOMALEE

7551	Trincomalee
7552	Kinniya
7553	Clappenburg

VAVUNIYA

7581	Vavuniya
7582	Mullaitivu
7583	Mankulam

TABLE 3

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

MULTIPLE PURPOSE COOPERATIVE SOCIETY STORES

AMPARAI

8001	Panama
8002	Gal-Oya
8003	Veeragdda
8004	Amparai
8005	Samanturai-Pathu
8006	Potthuvil
8007	Akkarapattu-Cent
8008	Kalmunai
8009	Bintenna-Patthu
8010	Sahindamuruttu
8011	Nintavur
8012	Akkarapatu-North
8013	Akkarapatu-South
8014	Karathiua
8015	Upper Amparai

ANURADHAPURA

8026	Villachiya-Pemad
8027	Konapatairawa
8028	Nochchiyagama
8029	Kabitigollewa
8030	Rambewa
8031	Rajangana-Sirisa
8032	Rajan-Tharu-Goni
8033	Talarwa
8034	Kekirawa
8035	Anaradhapura
8036	Kahatagasdigiliy
8037	Padavi-Siripura
8038	Eppawela
8039	Padavi-Parakrama
8040	Katiyawa
8041	Ratmalgamawewe
8042	Galnewa-Hiripiti
8043	Kargama
8044	Rajangana-Sarliy
8045	Huruluwewa-Gatul
8046	Sravastripura
8047	Madawachchiya
8049	Maradankadawela
8050	Horowapothana

BADULLA

8071	Kotalia-Navajeev
8072	Badulla
8073	Wiyaluwa
8074	Mali-Ela
8075	Bandarawela
8076	Mahiyangana
8077	Udapalatha
8078	Uva-Paranagama
8079	Passara
8080	Demiwini-Palatha
8081	Welimada
8082	Maputale

BATTICALOA

8101	Oddamawadi
8102	Koralai
8103	Eravur
8104	Eravur-N.W.
8105	Karadiyanaru
8106	Batticaloa
8107	Arapata-Kudirupu
8108	Kattankudy
8109	Ichentivu-Kanank
8110	Mammunai-S.W.
8111	Mammanai-S.E.
8112	Palugamam
8113	Kallarthurai
8114	Koralai North

COLOMBO

8131	Maharagama
8132	Hanwella
8133	Kaduwela
8134	Homagama
8135	Piliyandala
8136	Attanagalla
8137	Moratuwa
8138	Divulapitiya
8139	Kotadeniyawa
8140	Jaela

TABLE 3

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

MULTIPLE PURPOSE COOPERATIVE SOCIETY STORES

COLOMBO (cont.)

8141	Dehiwala
8142	Padukka
8143	Negombo
8144	Mirigama
8145	Kotikahawatte
8146	Hewagam-Korale
8147	Avissawella
8148	Gampaha
8149	Biyagama
8150	Pugoda
8151	Minuwangoda
8152	Dompe
8153	Kirindiwela
8154	Colombo-North
8155	Colombo-South
8156	Kolonnawa
8157	Kotte
8158	Dehiwala-Mt.Lavi
8159	Battaramulla
8160	Homagama-West
8161	Kehelella
8162	Wattala
8163	Dalugama
8164	Kaleniya
8165	Mahara
8166	Karagala
8167	Katana

GALLE

8171	Niyagama
8172	Elpitiya
8173	Balapitiya
8174	Karandeniya
8175	Bentota
8176	Yakkalamulla
8177	Rathgama
8178	Gonadeniya
8179	Ambalangoda
8180	Ihala Lelwela
8181	Akmeemana
8182	Kosgoda
8183	Hinduma-Pattu
8184	Yatalmatta
8185	Nagoda
8186	Baddegama-Thelik
8187	Habaraduwa
8188	Madampe
8189	Hikkaduwa
8190	Galle

HAMBANTOTA

8211	Weeraketiya
8212	Hungama
8213	Hambantota
8214	Giruwapatu South
8215	Walasmulla
8216	Tissamaharama
8217	Ambalantota

JAFFNA

8241	Karachchi-North
8242	Karachchi-South
8243	Vavunikulam
8244	Poonagari
8245	Thunukkai
8246	Manipay
8247	Themmarachchi-We
8248	Themmarachchi-Ea
8249	Pandatherappu
8250	Chavajachchi
8251	Alaveedy-Mallaka
8252	Kaddeiveli-Nelli
8253	Valikaman North
8254	Vankawai
8255	Valikamam East
8256	Chunnakam
8257	Thellipallai
8258	Uppuppady
8259	Pulali
8260	Punkudathivv
8261	Wallur
8262	Yaffna
8263	Tharau Wagar
8264	Peduru Thu Duwa
8265	Velanai
8266	Kayts
8267	Pavilai-Palleli

KALUTARA

8271	Totamuna
8272	Bulathsinhala
8273	Matugama
8274	Raigam-Udupattuw
8275	Agalawatte
8276	Munwatte
8277	Paiyagala
8278	Kalutara
8279	Polgampola
8280	Horana

TABLE 3

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICT

MULTIPLE PURPOSE COOPERATIVE SOCIETY STORES

KALUTARA (cont.)

8281	Bandaragama
8282	Panadura
8283	Munwatte-West
8284	Beruwala

KANDY

8301	Kurunduwatte
8302	Gampola
8303	Nawalapitiya
8304	Minipe
8305	Hasalake
8306	Galagedera
8307	Hatton-Dickoya
8308	Udunuwara
8309	Thatu-Oya
8310	Kundasale
8311	Maha Nuwara
8312	Wattegama
8313	Teldeniya
8314	Udispattuwa
8315	Yatinuwara-Hillo
8316	Harispattuwa So
8317	Hataraliyadda
8318	Yatinuwara Midco
8319	Yatinuwara River
8320	Gampola-Upper Hi
8321	Gampola-Bottom H
8322	Gampola-River Hi
8323	Harispattuwa
8324	Galaha Deltota

KEGALLE

8341	Rambukkana
8342	Kegalle
8343	Mawenella
8344	Aranayake
8345	Ussapitiya
8346	Deriniyagala
8347	Warakapola
8348	Galigamuwa
8349	Bulathkottupitiy
8350	Yatiyantota
8351	Ruanwella
8352	Dewalagama

KUKUNEGALA

8371	Kurunegala
8372	Alawwa
8373	Polgahawela
8374	Nikaweratiya
8375	Hiriyala
8376	Dambadeniya
8377	Ridigama
8378	Mawathagama
8379	Maharwa
8380	Koreiganae
8381	Wariyapola
8382	Panduwas-Nuwara
8383	Bingiruya
8384	Kuliyapitiya
8385	Galgamuwa
8386	Sandalankawa
8387	Katugampola
8388	Boyaganae

MANNAR

8411	Nanattam
8412	Musalai
8413	Mantai-North
8414	Mantai-South
8415	Mantai-West
8416	Mannar

MATALE

8431	Karandapola
8432	Matale
8433	Ambanganga
8434	Asgiriya
8435	Navaukuwela
8436	Nava-Rattota
8437	Ranjini-Dambulla
8438	Wagapanaha
8439	Laggala
8440	Pallepola
8441	Gampaha-Siyapatt

TABLE 3

TRANSPORT NETWORK CODE NUMBERS AND NAMES BY DISTRICTS

MULTIPLE PURPOSE COOPERATIVE SOCIETY STORES

MATARA

8461	Matara
8462	Akuressa
8463	Weligama
8464	Berelapanathara
8465	Kamburupitiya
8466	Kotapola
8467	Dikwella
8468	Hakaman

MONERAGALA

8491	Bibile
8492	Makulla
8493	Wellawaya
8494	Buttala
8495	Moneragala

NUWARA-ELIYA

8521	Ramboda
8522	Morape
8523	Pundalu-Oya
8524	Ragala
8525	Rikillagaskada
8526	Hanguranketa
8527	Nuwara-Eliya
8528	Hatton-Dickoya
8529	Maskeliya

POLONNARUWA

8541	Vijithapura
8542	Hingurakgoda
8543	Elehera
8544	Jayanthipura
8545	Palugas-Damana
8546	Polonnaruwa
8547	Manampitiya
8548	Medirigiriya
8549	Kaudulla

PUTTALAM

8571	Puttalam
8572	Arachchi-Katuwa
8573	Anamaduwa-Thabbo
8574	Chilaw
8575	Narthandiya
8576	Madampe
8577	Vennappuwa

RATNAPURA

8601	Balangoda
8602	Ellerawa
8603	Atakalan
8604	Kuruwita
8605	Kiriella
8606	Kiriella-North
8607	Pelmadulla
8608	Pannil-Pattu
8609	Kolonna-Korale
8610	Rathnapura
8611	Kalawana
8612	Nivithigala
8613	Bambara-Kotjwa

TRINCOMALEE

8631	Seruwila
8632	Kantalae
8633	Thambalagamuwa
8634	Muttur
8635	Trincomalee
8636	Nilaweli
8637	Gomarankadawela
8638	Kinniya
8639	Weppankulam
8640	Morawewa

VAVUNIYA

8661	Vavuniya-North
8662	Maritime-Pattu
8663	Vavuniya-Tamil
8664	Vavuniya-Sinhala
8665	Cheddikulam
8666	Muttu-Ayan-Kattu

APPENDIX C

PROJECTED NUMBER OF RICE RATION RECIPIENT BY MULTIPLE PURPOSE COOPERATIVE SOCIETY STORE

TABLE C-1
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

AMPARAI
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8001	# 8002	# 8003	# 8004	# 8005	# 8006	# 8007	# 8008	# 8009	# 8010	# 8011	# 8012
1	1978	7743	6975	5294	30306	34912	6446	27112	32679	17718	13090	12891	13541
2	1979	7959	7170	5442	31152	35887	6626	27869	33591	18213	13456	13251	13919
3	1980	8181	7370	5593	32020	36887	6811	28646	34527	18720	13830	13620	14307
4	1981	8402	7568	5744	32884	37882	6994	29419	35459	19225	14204	13988	14693
5	1982	8628	7772	5899	33770	38902	7183	30211	36414	19743	14586	14364	15089
6	1983	8860	7981	6057	34677	39947	7376	31022	37392	20273	14978	14750	15494
7	1984	9097	8195	6220	35606	41017	7573	31853	38394	20816	15379	15145	15909
8	1985	9340	8414	6386	36557	42113	7776	32704	39419	21373	15790	15550	16334

AMPARAI
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8013	# 8014	# 8015	TOTAL
1	1978	9577	6518	8943	233745
2	1979	9844	6700	9193	240272
3	1980	10119	6887	9449	246967
4	1981	10392	7073	9705	253632
5	1982	10672	7263	9965	260461
6	1983	10958	7458	10232	267455
7	1984	11252	7658	10506	274620
8	1985	11552	7862	10788	281958

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-2
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1976-1985

ANARADHAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8026	# 8027	# 8028	# 8029	# 8030	# 8031	# 8032	# 8033	# 8034	# 8035	# 8036	# 8037
1 1978	2407	6268	4926	3005	8134	3873	0	9509	26408	31357	8106	3568
2 1979	2498	6505	5112	3118	8441	4019	0	9869	27405	32541	8412	3703
3 1980	2592	6750	5305	3236	8760	4171	0	10241	28439	33768	8729	3842
4 1981	2688	6999	5500	3355	9082	4324	0	10616	29486	35012	9051	3984
5 1982	2786	7256	5702	3479	9416	4483	0	11007	30570	36299	9384	4130
6 1983	2889	7522	5912	3606	9761	4643	0	11410	31692	37631	9728	4282
7 1984	2994	7798	6128	3738	10119	4818	0	11831	32852	39009	10084	4439
8 1985	3104	8083	6352	3875	10489	4994	0	12260	34053	40435	10453	4601

ANARADHAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8038	# 8039	# 8040	# 8041	# 8042	# 8043
1 1978	5998	3563	4073	1926	3604	2116
2 1979	6225	3698	4227	1999	3740	2196
3 1980	6459	3837	4386	2074	3881	2279
4 1981	6697	3978	4548	2150	4024	2363
5 1982	6943	4125	4715	2230	4172	2449
6 1983	7198	4276	4888	2311	4325	2539
7 1984	7462	4432	5067	2396	4483	2632
8 1985	7734	4594	5252	2484	4647	2729

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

(CONTINUED)

TABLE C-2
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO.-YEAR	ANARADHAPURA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8044	# 8045	# 8046	# 8047	# 8049	# 8050	TOTAL
1 1978	6980	9701	9271	14739	11738	2472	183742
2 1979	7244	10067	9621	15296	12181	2565	190682
3 1980	7517	10447	9984	15872	12641	2662	197872
4 1981	7794	10832	10352	16457	13106	2760	205158
5 1982	8080	11230	10732	17062	13588	2862	212700
6 1983	8377	11642	11126	17688	14086	2967	220504
7 1984	8683	12068	11533	18336	14602	3075	228579
8 1985	9001	12509	11955	19006	15136	3188	236934

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-3
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

BADULLA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.YEAR	# 8071	# 8072	# 8073	# 8074	# 8075	# 8076
1 1978	0	31297	16461	23947	32405	37092
2 1979	0	31820	16736	24347	32946	37712
3 1980	0	32349	17015	24752	33495	38339
4 1981	0	32860	17283	25143	34023	38944
5 1982	0	33376	17555	25538	34558	39556
6 1983	0	33898	17829	25937	35098	40175
7 1984	0	34426	18107	26342	35645	40801
8 1985	0	34961	18388	26750	36198	41434

BADULLA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.YEAR	# 8077	# 8078	# 8079	# 8080	# 8081	# 8082	TOTAL
1 1978	20912	46410	25920	8965	17696	24363	285468
2 1979	21261	47185	26353	9115	17992	24770	290237
3 1980	21615	47971	26792	9266	18291	25182	295067
4 1981	21956	48727	27214	9413	18580	25580	299723
5 1982	22301	49493	27642	9561	18872	25981	304433
6 1983	22650	50268	28074	9710	19167	26390	309196
7 1984	23003	51051	28512	9861	19465	26800	314013
8 1985	23360	51843	28954	10014	19767	27215	318884

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-4
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

BATTICALOA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8101	# 8102	# 8103	# 8104	# 8105	# 8106	# 8107	# 8108	# 8109	# 8110	# 8111	# 8112
1	1978	15770	32049	24930	22744	0	36181	13374	12145	10975	20442	11087	20928
2	1979	16243	33011	25678	23426	0	37268	13775	12509	11304	21055	11420	21556
3	1980	16730	33999	26447	24128	0	38381	14188	12884	11643	21686	11762	22201
4	1981	17216	34987	27216	24829	0	39499	14600	13258	11981	22316	12103	22847
5	1982	17715	36002	28005	25549	0	40644	15024	13643	12329	22963	12454	23509
6	1983	18228	37044	28815	26288	0	41820	15458	14038	12685	23628	12815	24189
7	1984	18754	38113	29647	27047	0	43026	15904	14443	13052	24310	13185	24888
8	1985	19294	39211	30501	27826	0	44266	16363	14859	13427	25010	13564	25604

BATTICALOA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8113	# 8114	TOTAL
1	1978	6845	7457	234927
2	1979	7050	7681	241576
3	1980	7261	7911	249221
4	1981	7473	8141	256466
5	1982	7689	8377	263903
6	1983	7912	8619	271539
7	1984	8140	8868	279377
8	1985	8375	9123	287423

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-5
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8131	# 8132	# 8133	# 8134	# 8135	# 8136	# 8137	# 8138	# 8139	# 8140	# 8141	# 8142
1 1978	27612	0	0	64876	36250	73125	59543	28259	17308	59967	0	0
2 1979	28165	0	0	66176	36977	74591	60736	28825	17655	61169	0	0
3 1980	28715	0	0	67468	37698	76046	61922	29388	17999	62362	0	0
4 1981	29264	0	0	68757	38418	77499	63105	29949	18343	63554	0	0
5 1982	29821	0	0	70066	39150	78975	64307	30520	18693	64764	0	0
6 1983	30387	0	0	71396	39893	80474	65527	31099	19047	65994	0	0
7 1984	30962	0	0	72746	40648	81996	66766	31687	19408	67242	0	0
8 1985	31545	0	0	74117	41413	83541	68024	32284	19773	68509	0	0

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8143	# 8144	# 8145	# 8146	# 8147	# 8148	# 8149	# 8150	# 8151	# 8152	# 8153	# 8154
1 1978	45797	49795	27026	60645	0	53633	33833	10560	59440	14418	23855	73222
2 1979	46715	50793	27568	61860	0	54708	34511	10772	60631	14707	24333	74690
3 1980	47626	51784	28106	63068	0	55775	35184	10982	61814	14994	24808	76147
4 1981	48536	52774	28643	64273	0	56841	35857	11192	62996	15280	25282	77602
5 1982	49461	53779	29188	65497	0	57924	36540	11405	64195	15571	25763	79080
6 1983	50400	54799	29742	66740	0	59023	37233	11621	65414	15867	26252	80581
7 1984	51353	55836	30305	68002	0	60139	37937	11841	66651	16167	26749	82105
8 1985	52320	56888	30876	69283	0	61272	38652	12064	67906	16472	27253	83652

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

(CONTINUED)

TABLE C-5
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.YEAR	# 8155	# 8156	# 8157	# 8158	# 8159	# 8160	# 8161	# 8162	# 8163	# 8164	# 8165	# 8166
1 1978	55869	18551	29214	44507	20184	34416	20565	44809	12560	15937	61619	10907
2 1979	56989	18923	29800	45399	20589	35106	20977	45707	12812	16256	62854	11126
3 1980	58101	19292	30381	46285	20990	35791	21386	46599	13062	16574	64080	11343
4 1981	59211	19661	30961	47169	21391	36475	21795	47489	13311	16890	65305	11559
5 1982	60339	20035	31551	48068	21799	37169	22210	48394	13565	17212	66549	11780
6 1983	61484	20415	32150	48980	22212	37875	22632	49312	13822	17539	67812	12003
7 1984	62647	20801	32758	49906	22633	38591	23060	50245	14084	17870	69094	12230
8 1985	63827	21193	33375	50846	23059	39318	23494	51192	14349	18207	70396	12461

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.YEAR	# 8167	TOTAL
1 1978	66148	1254450
2 1979	67473	1279593
3 1980	68791	1304561
4 1981	70106	1329488
5 1982	71439	1354809
6 1983	72799	1380524
7 1984	74173	1406632
8 1985	75571	1433132

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-6
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

GALLE
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8171	# 8172	# 8173	# 8174	# 8175	# 8176	# 8177	# 8178	# 8179	# 8180	# 8181	# 8182
1 1978	39400	34789	33633	36260	27786	29568	18952	0	36799	16279	48269	0
2 1979	39951	35275	34103	36767	28174	29981	19217	0	37313	16507	48944	0
3 1980	40471	35735	34547	37245	28541	30372	19467	0	37795	16721	49581	0
4 1981	40963	36169	34967	37698	28888	30741	19704	0	38259	16925	50184	0
5 1982	41453	36606	35390	38154	29238	31113	19942	0	38721	17129	50791	0
6 1983	41957	37047	35816	38613	29589	31487	20182	0	39187	17335	51401	0
7 1984	42459	37490	36244	39075	29943	31863	20423	0	39656	17543	52016	0
8 1985	42964	37936	36675	39540	30299	32242	20666	0	40127	17751	52635	0

GALLE
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8183	# 8184	# 8185	# 8186	# 8187	# 8188	# 8189	# 8190	TOTAL
1 1978	212850	0	16994	24850	59749	14712	20463	34964	706317
2 1979	215825	0	17232	25197	60584	14918	20749	35454	716191
3 1980	218635	0	17456	25525	61373	15112	21019	35915	725514
4 1981	221293	0	17668	25836	62119	15296	21275	36351	734336
5 1982	223969	0	17882	26148	62870	15481	21532	36792	743216
6 1983	226663	0	18097	26463	63626	15667	21791	37232	752153
7 1984	229374	0	18313	26779	64387	15854	22052	37678	761149
8 1985	232101	0	18531	27098	65153	16043	22314	38126	770201

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-7
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

197 -1985

PERIOD NO.	YEAR	HAMBANTOTA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8211	# 8212	# 8213	# 8214	# 8215	# 8216	# 8217	TOTAL
1	1978	60458	37591	28872	91057	31734	25362	29699	304773
2	1979	61858	38462	29541	93166	32469	25949	30388	311833
3	1980	63503	39484	30326	95643	33332	26639	31197	320124
4	1981	64915	40362	31000	97769	34073	27232	31889	327240
5	1982	66354	41257	31687	99936	34829	27835	32595	334493
6	1983	67820	42168	32388	102145	35598	28450	33316	341885
7	1984	69314	43097	33101	104395	36382	29077	34050	349416
8	1985	70836	44044	33828	106688	37181	29716	34797	357090

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-8
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

JAFFNA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8241	# 8242	# 8243	# 8244	# 8245	# 8246	# 8247	# 8248	# 8249	# 8250	# 8251	# 8252
1 1978	8444	15620	3688	5472	2203	19632	7738	16251	14327	17839	9362	19036
2 1979	8554	15823	3736	5543	2232	19837	7839	16462	14513	18071	9484	19283
3 1980	8664	16028	3784	5615	2260	20144	7940	16675	14701	18304	9606	19533
4 1981	8769	16221	3830	5683	2288	20387	8036	16876	14878	18525	9722	19769
5 1982	8874	16416	3876	5751	2315	20632	8132	17079	15057	18748	9839	20006
6 1983	8980	16612	3922	5819	2343	20879	8229	17283	15237	18972	9956	20245
7 1984	9087	16809	3969	5889	2371	21126	8327	17488	15418	19197	10075	20485
8 1985	9194	17007	4016	5958	2399	21376	8425	17695	15600	19424	10194	20727

JAFFNA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8253	# 8254	# 8255	# 8256	# 8257	# 8258	# 8259	# 8260	# 8261	# 8262	# 8263	# 8264
1 1978	22014	24366	21714	32507	30342	18915	9727	21164	21313	83202	12115	25431
2 1979	22300	24683	21996	32929	30736	19161	9853	21439	21590	84283	12272	25767
3 1980	22588	25002	22281	33355	31134	19409	9981	21716	21869	85373	12431	26101
4 1981	22861	25304	22550	33758	31510	19643	10101	21978	22133	86404	12581	26416
5 1982	23136	25607	22820	34163	31888	19879	10223	22242	22399	87441	12732	26733
6 1983	23412	25913	23093	34571	32269	20116	10345	22508	22666	88485	12884	27052
7 1984	23690	26221	23367	34981	32652	20355	10467	22775	22935	89535	13037	27373
8 1985	23969	26530	23643	35394	33037	20595	10591	23044	23206	90593	13191	27697

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

(CONTINUED)

TABLE C-8
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

	JAFFNA MULTIPLE PURPOSE COOPERATIVE SOCIETIES			
PERIOD NO.YEAR	# 8265	# 8266	# 8267	TOTAL
1 1978	10817	14156	10875	498276
2 1979	10950	14340	11016	504750
3 1980	11099	14525	11160	511278
4 1981	11233	14701	11293	517450
5 1982	11368	14877	11430	523663
6 1983	11504	15055	11565	529915
7 1984	11640	15234	11703	536206
8 1985	11778	15413	11841	542537

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-9
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

KALUTARA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8271	# 8272	# 8273	# 8274	# 8275	# 8276	# 8277	# 8278	# 8279	# 8280	# 8281	# 8282
1 1978	0	33528	55427	28241	76479	19770	25792	63847	0	28003	35444	54930
2 1979	0	34001	56208	28639	77557	20049	26156	64747	0	28398	35944	55704
3 1980	0	34478	56997	29041	78645	20330	26523	65655	0	28796	36448	56486
4 1981	0	34932	57748	29423	79681	20598	26872	66520	0	29175	36928	57230
5 1982	0	35390	58505	29809	80725	20868	27224	67392	0	29558	37412	57980
6 1983	0	35851	59267	30198	81778	21140	27579	68271	0	29943	37900	58736
7 1984	0	36316	60036	30589	82839	21414	27937	69156	0	30332	38391	59498
8 1985	0	37018	61197	31181	84440	21828	28477	70493	0	30918	39134	60648

KALUTARA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8283	# 8284	TOTAL
1 1978	20771	39355	481587
2 1979	21064	39909	488376
3 1980	21359	40470	495228
4 1981	21641	41063	501751
5 1982	21924	41540	508327
6 1983	22210	42081	514954
7 1984	22498	42628	521634
8 1985	22933	43451	531718

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-10
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

KANDY
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8301	# 8302	# 8303	# 8304	# 8305	# 8306	# 8307	# 8308	# 8309	# 8310	# 311	# 8312
1 1978	28322	0	18437	8161	27256	17738	0	45406	44216	42115	42275	46327
2 1979	28566	0	18597	8232	27493	17892	0	45800	44600	42481	42642	46729
3 1980	28814	0	18757	8303	27730	18046	0	46195	44984	42847	43010	47132
4 1981	29036	0	18903	8367	27945	18186	0	46554	45334	43180	43344	47498
5 1982	29261	0	19049	8432	28160	18326	0	46912	45683	43512	43677	47864
6 1983	29485	0	19194	8496	28375	18466	0	47270	46031	43844	44011	48229
7 1984	29708	0	19339	8560	28590	18606	0	47628	46379	44176	44343	48594
8 1985	29931	0	19484	8624	28804	18745	0	47985	46727	44507	44676	48958

KANDY
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8313	# 8314	# 8315	# 8316	# 8317	# 8318	# 8319	# 8322	# 8323	# 8324	TOTAL
1 1978	23077	12290	14180	42876	21090	16926	15932	49970	42592	13490	572676
2 1979	23277	12397	14303	43248	21273	17073	16070	50404	42962	13610	577651
3 1980	23478	12504	14426	43621	21456	17220	16209	50838	43332	13726	582628
4 1981	23660	12601	14538	43960	21623	17354	16335	51233	43669	13831	587153
5 1982	23842	12696	14650	44298	21790	17487	16460	51627	44005	13939	591672
6 1983	24024	12795	14762	44636	21956	17621	16586	52021	44341	14044	596187
7 1984	24206	12891	14874	44974	22122	17754	16712	52415	44676	14150	600697
8 1985	24388	12988	14985	45311	22288	17887	16837	52808	45011	14257	605201

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-11
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

	KEGALLE MULTIPLE PURPOSE COOPERATIVE SOCIETIES											
PERIOD NO.YEAR	# 8341	# 8342	# 8343	# 8344	# 8345	# 8346	# 8347	# 8348	# 8349	# 8350	# 8351	TOTAL
1 1978	48302	51454	54273	44924	0	52628	60287	45299	19262	32407	46719	456595
2 1979	48857	52086	54897	45440	0	54244	60980	45820	19483	32780	47257	461844
3 1980	49416	52681	55524	45960	0	54865	61677	46344	19706	33154	47797	467124
4 1981	49938	53236	56112	46446	0	55445	62329	46834	19915	33509	48301	472063
5 1982	50419	53751	56651	46893	0	55978	62929	47284	20106	33827	48766	476604
6 1983	50945	54312	57243	47382	0	56562	63586	47778	20316	34180	49276	481580
7 1984	51474	54875	57837	47874	0	57149	64246	48273	20527	34535	49786	486576
8 1985	52004	55441	58433	48367	0	57738	64908	48771	20738	34891	50301	491592

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-12
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

KURUNEGALA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8371	# 8372	# 8373	# 8374	# 8375	# 8376	# 8377	# 8378	# 8379	# 8380	# 8381	# 9382
1 1978	47458	35197	50016	42636	71651	26922	45029	49802	67917	32670	38127	37632
2 1979	48370	35874	50978	43456	73028	27440	45895	50759	69223	33298	38860	38355
3 1980	49297	36561	51954	44288	74428	27965	46774	51732	70549	33936	39605	39090
4 1981	50199	37230	52905	45099	75790	28477	47630	52679	71840	34557	40329	39806
5 1982	50944	37782	53689	45767	76913	28899	48336	53460	72905	35069	40927	40396
6 1983	52043	38597	54848	46755	78573	29523	49379	54613	74478	35826	41810	41267
7 1984	52985	39296	55840	47601	79995	30057	50273	55601	75826	36474	42567	42014
8 1985	53940	40004	56847	48459	81437	30599	51179	56604	77193	37132	43334	42772

KURUNEGALA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8383	# 8384	# 8385	# 8386	# 8387	# 8388	TOTAL
1 1978	74879	74017	73970	18716	46801	0	833440
2 1979	76318	75440	75392	19076	47701	0	849463
3 1980	77781	76865	76837	19441	48617	0	865740
4 1981	79204	78292	78242	19797	49504	0	881580
5 1982	80378	79453	79403	20091	50240	0	894652
6 1983	82113	81167	81116	20524	51324	0	913956
7 1984	83599	82636	82584	20895	52252	0	930495
8 1985	85106	84126	84073	21272	53195	0	947272

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-13
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO. YEAR	MANNAR MULTIPLE PURPOSE COOPERATIVE SOCIETIES						
	#8411	# 8412	# 8413	# 8414	# 8415	# 8416	TOTAL
1 1978	12144	8197	4683	2600	4016	20908	52548
2 1979	12491	8431	4817	2674	4131	21504	54048
3 1980	12847	8671	4954	2750	4248	22118	55588
4 1981	13201	8911	5091	2826	4366	22728	57123
5 1982	13565	9156	5231	2904	4486	23354	58696
6 1983	13938	9408	5375	2984	4609	23995	60309
7 1984	14320	9665	5522	3066	4735	24654	61962
8 1985	14711	9930	5673	3150	4865	25327	63656

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-14
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

MATALE
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8431	# 8432	# 8433	# 8434	# 8435	# 8436	# 8437	# 8438	# 8439	# 8440	# 8441	TOTAL
1	1978	28547	20166	8432	15787	26587	20495	20493	13963	15726	26847	11028	208071
2	1979	29182	20614	8619	16138	27178	20951	20949	14273	16076	27444	11274	212698
3	1980	29822	21072	8811	16496	27781	21415	21413	14590	16432	28053	11523	217415
4	1981	30464	21521	8998	16847	28373	21872	21869	14901	16782	28650	11770	222047
5	1982	31112	21978	9190	17205	28976	22336	22334	15217	17139	29259	12018	226764
6	1983	31770	22443	9384	17570	29589	22809	22807	15540	17502	29878	12274	231566
7	1984	32441	22917	9582	17940	30214	23291	23288	15868	17871	30509	12532	236453
8	1985	33124	23399	9784	18318	30849	23781	23778	16201	18247	31151	12796	241428

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-15
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO.YEAR	MATARA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8461	# 8462	# 8463	# 8464	# 8465	# 8466	# 8467	# 8468	TOTAL
1 1978	59836	74657	68617	31834	52845	50312	64731	54823	457655
2 1979	60574	75578	69464	32227	53497	50933	65530	55499	463302
3 1980	61318	76506	70316	32622	54154	51558	66334	56182	468990
4 1981	62018	77380	71119	32995	54772	52147	67092	56822	474345
5 1982	62722	78258	71927	33369	55394	52739	67853	57467	479729
6 1983	63430	79141	72738	33746	56019	53334	68619	58116	485143
7 1984	64141	80029	73554	34125	56647	53932	69389	58768	490585
8 1985	64857	80921	74375	34505	57279	54534	70163	59423	496057

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-16
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO. YEAR	MONEREGALA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8491	# 9492	# 8493	# 8494	# 8495	TOTAL
1 1978	35550	32832	26369	16917	27527	139195
2 1979	37120	34282	27533	17664	28742	145341
3 1980	38756	35793	28747	18443	30009	151748
4 1981	40430	37339	29989	19239	31307	158304
5 1982	42174	38950	31282	20069	32657	165132
6 1983	43990	40627	32630	20933	34063	172243
7 1984	45882	42374	34032	21833	35527	179648
8 1985	47851	44193	35493	22771	37052	187360

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE 18
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO. YEAR	NUWARA-ELIYA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8521	# 8522	# 8523	# 8524	# 8525	# 8526	# 8527	# 8528	# 8529	TOTAL
1 1978	6624	13860	12934	68166	31565	17012	22381	22230	7945	202717
2 1979	6700	14020	13083	68951	31929	17208	22639	22486	8037	205053
3 1980	6777	14180	13233	69742	32295	17405	22898	22744	8129	207403
4 1981	6849	14331	13373	70481	32637	17590	23141	22985	8214	209601
5 1982	6921	14482	13514	71224	32981	17775	23385	23227	8301	211810
6 [illegible]	6994	14633	13656	71969	33326	17961	23630	23470	8388	214027
7 [illegible]	7066	14786	13798	72718	33673	18148	23876	23714	8475	216254
8 [illegible]	7139	14938	13940	73469	34021	18336	24122	23960	8564	218489

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-18
PROJ[illegible]D NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

	POLONNARUWA MULTIPLE PURPOSE COOPERATIVE SOCIETIES									
PERIOD NO.YEAR	# 8541	# 8542	# 8543	# 8544	# 8545	# 8546	# 8547	# 8548	# 8549	TOTAL
1 1978	8151	10785	13981	6697	4982	14716	14426	17544	4100	95382
2 1979	8494	11238	14569	6978	5191	15335	15032	18281	4273	99391
3 1980	8850	11710	15180	7271	5409	15978	15663	19049	4453	103553
4 1981	9214	12191	15804	7570	5632	16635	16307	19831	4634	107818
5 1982	9592	12691	16452	7881	5863	17317	16976	20645	4824	112241
6 1983	9985	13211	17126	8203	6103	18026	17671	21490	5023	116838
7 1984	10393	13751	17826	8539	6352	18763	18393	22369	5228	121614
8 1985	10817	14312	18554	8887	6611	19529	19144	23282	5442	126578

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-19
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO.	YEAR	PUTTALAM MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8571	# 8572	# 8573	# 8574	# 8575	# 8576	# 8577	TOTAL
1	1978	55612	33068	43981	28991	54261	29027	58883	303823
2	1979	56959	33869	45046	29693	55575	29730	60308	311180
3	1980	58334	34687	46134	30410	56917	30448	61765	318695
4	1981	59692	35494	47208	31118	58242	31157	62204	326115
5	1982	61078	36318	48304	31841	59594	31880	64671	333686
6	1983	62492	37159	49422	32577	60974	32618	66167	341409
7	1984	63934	38016	50563	33329	62381	33371	67695	349289
8	1985	65405	38891	51726	34096	63816	34139	69254	357327

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-20
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

RATNAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8601	# 8602	# 8603	# 8604	# 8605	# 8606	# 8607	# 8608	# 8609	# 8610	# 8611	# 8612
1 1978	38665	27609	89580	26918	21084	40455	25101	25252	69357	69357	41293	43980
2 1979	39442	28164	91381	27459	21508	41272	25606	25760	70751	70751	42123	44864
3 1980	40233	28728	93212	28009	21939	42099	26119	26276	72165	72165	42967	45763
4 1981	41004	29279	94999	28546	22359	42906	26619	26780	73552	73552	43791	46640
5 1982	41787	29838	96814	29092	22787	43726	27128	27291	74958	74958	44627	47531
6 1983	42583	30407	98657	29646	23220	44559	27644	27811	76385	76385	45477	48436
7 1984	43391	30983	100529	30208	23661	45404	28169	28338	77834	77834	46340	49355
8 1985	44211	31569	102429	30779	24108	46262	28701	28874	79305	79305	47216	50288

RATNAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8613	TOTAL
1 1978	19755	538410
2 1979	20152	549233
3 1980	20556	560239
4 1981	20952	570979
5 1982	21350	581887
6 1983	21756	592966
7 1984	22170	604216
8 1985	22590	615637

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-21
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO. YEAR	TRINCOMALEE MULTIPLE PURPOSE COOPERATIVE SOCIETIES										
	# 8631	# 8632	# 8633	# 8634	# 8635	# 8636	# 8637	# 8638	# 8639	# 8640	TOTAL
1 1978	7023	10546	12343	22852	28494	4744	3209	23497	0	2564	115272
2 1979	7268	10914	12773	23649	29488	4909	3321	24316	0	2654	119292
3 1980	7521	11294	13218	24472	30514	5080	3436	25163	0	2745	123443
4 1981	7776	11677	13666	25302	31549	5253	3553	26016	0	2838	127630
5 1982	8039	12072	14129	26158	32617	5430	3673	26897	0	2936	131951
6 1983	8311	12480	14606	27042	33719	5614	3797	27806	0	3034	136409
7 1984	8591	12901	15099	27954	34856	5803	3925	28743	0	3136	141008
8 1985	8880	13335	15607	28895	36029	5998	4058	29710	0	3241	145753

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

TABLE C-22
PROJECTED NUMBER OF RICE RATION RECIPIENTS BY MPCS

1978-1985

PERIOD NO.	YEAR	VAVUNIYA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8661	# 8662	# 8663	# 8664	# 8665	# 8666	TOTAL
1	1978	3078	18873	24420	3512	11473	2664	64020
2	1979	3185	19531	25271	3634	11873	2758	66252
3	1980	3296	20211	26151	3761	12286	2853	68558
4	1981	3408	20896	27038	3889	12703	2950	70884
5	1982	3523	21604	27954	4020	13133	3050	73284
6	1983	3642	22334	28898	4156	13577	3153	75760
7	1984	3765	23087	29872	4296	14035	3259	78314
8	1985	3892	23864	30878	4441	14507	3368	80950

SOURCE:
BASED ON 1963 AND 1971 CENSUS DATA, DEPARTMENT OF CENSUS AND STATISTICS, SRI LANKA.
TABLE 11,12,AND 13, FOOD AND FEED GRAIN INSTITUTE STUDY, REPORT #70

APPENDIX D

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS BY MULTIPLE PURPOSE COOPERATIVE SOCIETY STORE

TABLE D-1

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

AMPARAI MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8001	# 8002	# 8003	# 8004	# 8005	# 8006	# 8007	# 8008	# 8009	# 8010	# 8011	# 8012
1 1978	719	648	492	2814	3242	599	2518	3034	1645	1216	1197	1257
2 1979	739	666	505	2893	3332	615	2586	3119	1691	1249	1230	1292
3 1980	760	684	519	2973	3425	632	2660	3206	1738	1284	1265	1329
4 1981	780	703	533	3053	3518	649	2732	3293	1785	1319	1299	1364
5 1982	801	722	548	3136	3612	667	2805	3381	1833	1354	1334	1401
6 1983	823	741	562	3220	3709	685	2881	3472	1882	1391	1370	1439
7 1984	845	761	578	3306	3809	703	2958	3565	1933	1428	1406	1477
8 1985	867	781	593	3395	3910	722	3037	3660	1985	1466	1444	1517

AMPARAI MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8013	# 8014	# 8015	TOTAL
1 1978	889	605	830	21705
2 1979	915	623	854	22311
3 1980	940	640	878	22933
4 1981	965	657	901	23551
5 1982	991	675	926	24186
6 1983	1018	692	950	24835
7 1984	1045	711	975	25500
8 1985	1073	730	1002	26182

SOURCE:

CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-2

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

ANARADHAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8026	# 8027	# 8028	# 8029	# 8030	# 8031	# 8032	# 8033	# 8034	# 8035	# 8036	# 8037
1 1978	224	582	457	279	755	360	0	883	2452	2912	753	331
2 1979	232	604	475	290	784	373	0	916	2545	3022	781	344
3 1980	241	627	493	300	813	387	0	951	2641	3136	811	357
4 1981	250	650	511	312	843	402	0	986	2738	3251	840	370
5 1982	259	674	529	323	874	416	0	1022	2839	3371	871	384
6 1983	268	698	[illegible]	335	906	432	0	1060	2943	3494	903	398
7 1984	278	724	569	347	940	447	0	1099	3051	3622	936	412
8 1985	288	751	590	360	974	463	0	1138	3162	3755	971	427

ANARADHAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8038	# 8039	# 8040	# 8041	# 8042	# 8043
1 1978	557	331	378	179	335	196
2 1979	578	343	393	186	347	204
3 1980	600	356	407	193	360	212
4 1981	622	369	422	200	374	219
5 1982	645	383	438	207	387	227
6 1983	668	397	454	215	402	236
7 1984	693	412	471	222	416	244
8 1985	718	427	488	231	432	253

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

(CONTINUED)

TABLE D-2

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO.	YEAR	ANARADHAPURA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8044	# 8045	# 8046	# 8047	# 8049	# 8050	TOTAL
1	1978	648	901	861	1369	1090	229	17062
2	1979	673	934	893	1420	1131	238	17706
3	1980	698	970	927	1474	1173	247	18374
4	1981	724	1006	961	1528	1216	256	19050
5	1982	750	1043	997	1584	1262	266	19751
6	1983	778	1081	1033	1642	1308	275	20475
7	1984	806	1121	1071	1703	1356	286	21226
8	1985	836	1161	1110	1764	1405	296	22000

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-3

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	BADULLA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8071	# 8072	# 8073	# 8074	# 8075	# 8076
1 1978	0	2906	1529	2224	3009	3444
2 1979	0	2955	1554	2261	3059	3502
3 1980	0	3004	1580	2298	3110	3560
4 1981	0	3051	1605	2335	3159	3616
5 1982	0	3099	1630	2371	3209	3673
6 1983	0	3148	1656	2408	3259	3731
7 1984	0	3197	1681	2446	3310	3789
8 1985	0	3246	1707	2484	3361	3847

PERIOD NO. YEAR	BADULLA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8077	# 8078	# 8079	# 8080	# 8081	# 8082	TOTAL
1 1978	1942	4310	2407	832	1643	2262	26508
2 1979	1974	4381	2447	846	1671	2301	26951
3 1980	2007	4454	2488	860	1699	2339	27399
4 1981	2039	4525	2527	874	1725	2375	27831
5 1982	2071	4596	2567	888	1752	2413	28269
6 1983	2103	4668	2607	902	1779	2450	28711
7 1984	2136	4740	2648	916	1807	2488	29158
8 1985	2169	4814	2689	930	1836	2528	29611

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-4

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

BATTICALOA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8101	# 8102	# 8103	# 8104	# 8105	# 8106	# 8107	# 8108	# 8109	# 8110	# 8111	# 8112
1 1978	1464	2976	2315	2112	0	3360	1242	1128	1019	1898	1030	1943
2 1979	1508	3065	2384	2175	0	3461	1279	1162	1050	1955	1060	2002
3 1980	1554	3157	2456	2240	0	3564	1317	1196	1081	2014	1092	2062
4 1981	1599	3249	2527	2306	0	3668	1356	1231	1113	2072	1124	2122
5 1982	1645	3343	2600	2372	0	3774	1395	1267	1145	2132	1157	2183
6 1983	1693	3440	2676	2441	0	3883	1435	1304	1178	2194	1190	2246
7 1984	1741	3539	2753	2512	0	3995	1477	1341	1212	2257	1224	2311
8 1985	1792	3641	2832	2584	0	4110	1519	1380	1247	2322	1260	2378

BATTICALOA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8113	# 8114	TOTAL
1 1978	636	692	21815
2 1979	655	713	22469
3 1980	674	735	23142
4 1981	693	755	23815
5 1982	714	778	24505
6 1983	734	800	25214
7 1984	756	823	25941
8 1985	777	847	26689

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-5

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8131	# 8132	# 8133	# 8134	# 8135	# 8136	# 8137	# 8138	# 8139	# 8140	# 8141	# 8142
1 1978	2564	0	0	6024	3366	6790	5529	2624	1607	5568	0	0
2 1979	2615	0	0	6145	3434	6926	5640	2677	1639	5680	0	0
3 1980	2666	0	0	6265	3501	7061	5750	2729	1671	5791	0	0
4 1981	2717	0	0	6385	3567	7196	5860	2781	1704	5901	0	0
5 1982	2769	0	0	6506	3635	7333	5974	2833	1736	6014	0	0
6 1983	2822	0	0	6630	3704	7473	6085	2888	1769	6128	0	0
7 1984	2875	0	0	6755	3774	7614	6200	2942	1802	6244	0	0
8 1985	2929	0	0	6882	3845	7757	6317	2998	1836	6362	0	0

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8143	# 8144	# 8145	# 8146	# 8147	# 8148	# 8149	# 8150	# 8151	# 8152	# 8153	# 8154
1 1978	4253	4624	2510	5631	0	4980	3142	981	5519	1339	2215	6799
2 1979	4338	4716	2560	5744	0	5080	3205	1000	5630	1366	2259	6936
3 1980	4422	4809	2610	5856	0	5179	3267	1020	5740	1392	2304	7071
4 1981	4507	4900	2660	5968	0	5278	3330	1039	5850	1419	2348	7206
5 1982	4593	4994	2710	6082	0	5379	3393	1059	5961	1446	2392	7343
6 1983	4680	5088	2762	6197	0	5481	3457	1079	6074	1473	2438	7483
7 1984	4768	5185	2814	6314	0	5584	3523	1100	6189	1501	2484	7624
8 1985	4858	5282	2867	6433	0	5690	3589	1120	6306	1530	2531	7768

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-5 (CONTINUED)

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8155	# 8156	# 8157	# 8158	# 8159	# 8160	# 8161	# 8162	# 8163	# 8164	# 8165	# 6166
1 1978	5188	1723	2713	4133	1874	3196	1910	4161	1166	1480	5722	1013
2 1979	5292	1757	2767	4216	1912	3260	1948	4244	1190	1509	5836	1033
3 1980	5395	1791	2821	4298	1949	3323	1986	4327	1213	1539	5950	1054
4 1981	5498	1826	2875	4380	1986	3387	2024	4410	1236	1568	6064	1073
5 1982	5603	1860	2930	4464	2024	3451	2062	4494	1260	1598	6180	1094
6 1983	5709	1896	2985	4548	2063	3517	2102	4579	1283	1629	6297	1114
7 1984	5817	1932	3042	4634	2102	3583	2141	4666	1308	1659	6416	1136
8 1985	5927	1968	3099	4721	2141	3651	2182	4754	1332	1691	6537	1157

COLOMBO
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8167	TOTAL
1 1978	6143	116487
2 1979	6265	118819
3 1980	6388	121138
4 1981	6509	123452
5 1982	6634	125806
6 1983	6759	128192
7 1984	6888	130616
8 1985	7017	133077

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-6

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

GALLE
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8171	# 8172	# 8173	# 8174	# 8175	# 8176	# 8177	# 8178	# 8179	# 8180	# 8181	# 8182
1 1978	3659	3230	3123	3367	2580	2746	1760	0	3417	1512	4482	0
2 1979	3710	3276	3167	3414	2616	2784	1784	0	3465	1533	4545	0
3 1980	3758	3318	3208	3458	2650	2820	1808	0	3510	1553	4604	0
4 1981	3804	3359	3247	3501	2682	2855	1830	0	3553	1572	4660	0
5 1982	3850	3399	3286	3543	2715	2889	1852	0	3596	1591	4716	0
6 1983	3896	3440	3326	3585	2748	2924	1874	0	3639	1610	4773	0
7 1984	3943	3481	3366	3628	2780	2959	1896	0	3682	1629	4830	0
8 1985	3990	3523	3406	3672	2813	2994	1919	0	3726	1648	4888	0

GALLE
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8183	# 8184	# 8185	# 8186	# 8187	# 8188	# 8189	# 8190	TOTAL
1 1978	19765	0	1578	2308	5548	1366	1900	3246	65587
2 1979	20041	0	1600	2340	5625	1385	1926	3292	66503
3 1980	20302	0	1621	2370	5699	1403	1952	3335	67369
4 1981	20548	0	1640	2399	5768	1420	1975	3375	68188
5 1982	20797	0	1660	2428	5838	1438	1999	3416	69013
6 1983	21047	0	1680	2457	5908	1455	2023	3458	69843
7 1984	21299	0	1700	2487	5979	1472	2048	3499	70678
8 1985	21552	0	1721	2516	6050	1489	2072	3540	71519

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-7

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO.	YEAR	HAMBANTOTA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8211	# 8212	# 8213	# 8214	# 8215	# 8216	# 8217	TOTAL
1	1978	5614	3491	2681	8455	2947	2355	2757	28300
2	1979	5744	3571	2743	8651	3015	2410	2822	28956
3	1980	5897	3666	2816	8881	3095	2474	2897	29726
4	1981	6028	3748	2879	9079	3164	2528	2961	30387
5	1982	6161	3831	2942	9280	3234	2585	3027	31060
6	1983	6298	3916	3007	9485	3305	2641	3094	31746
7	1984	6436	4002	3074	9694	3378	2700	3162	32446
8	1985	6578	4090	3141	9907	3452	2759	3231	33158

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE Q-8

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

JAFFNA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8241	# 8242	# 8243	# 8244	# 8245	# 8246	# 8247	# 8248	# 8249	# 8250	# 8251	# 8252
1 1978	784	1450	342	508	205	1823	719	1509	1330	1656	869	1768
2 1979	794	1469	347	515	207	1847	728	1529	1348	1678	881	1791
3 1980	805	1488	351	521	210	1871	737	1548	1365	1700	892	1814
4 1981	814	1506	356	528	212	1893	746	1567	1382	1720	903	1836
5 1982	824	1524	360	534	215	1916	755	1586	1398	1741	914	1858
6 1983	834	1543	364	540	218	1939	764	1605	1415	1762	924	1880
7 1984	844	1561	369	547	220	1962	773	1624	1432	1783	936	1902
8 1985	854	1579	373	553	223	1985	782	1643	1449	1804	947	1925

JAFFNA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8253	# 8254	# 8255	# 8256	# 8257	# 8258	# 8259	# 8260	# 8261	# 8262	# 8263	# 8264
1 1978	2044	2263	2016	3019	2817	1756	903	1965	1979	7726	1125	2362
2 1979	2071	2292	2042	3058	2854	1779	915	1991	2005	7826	1140	2393
3 1980	2097	2322	2069	3097	2891	1802	927	2016	2031	7927	1154	2424
4 1981	2123	2350	2094	3135	2926	1824	938	2041	2055	8023	1168	2453
5 1982	2148	2378	2119	3172	2961	1846	949	2065	2080	8120	1182	2482
6 1983	2174	2406	2144	3210	2996	1868	961	2090	2105	8216	1196	2512
7 1984	2200	2435	2169	3248	3032	1890	972	2115	2130	8314	1211	2542
8 1985	2226	2464	2195	3287	3068	1912	983	2140	2155	8412	1225	2571

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

(CONTINUED)

TABLE D-8

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO.	YEAR	JAFFNA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8265	# 8266	# 8267	TOTAL
1	1978	1005	1315	1010	46268
2	1979	1017	1331	1022	46870
3	1980	1031	1349	1037	47476
4	1981	1043	1365	1048	48049
5	1982	1056	1381	1062	48626
6	1983	1068	1398	1074	49206
7	1984	1080	1414	1086	49791
8	1985	1093	1431	1099	50378

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-9

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

KALUTARA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8271	# 8272	# 8273	# 8274	# 8275	# 8276	# 8277	# 8278	# 8279	# 8280	# 8281	# 8282
1 1978	0	3113	5147	2622	7102	1836	2395	5929	0	2600	3291	5101
2 1979	0	3157	5219	2659	7202	1862	2429	6012	0	2637	3338	5173
3 1980	0	3202	5293	2697	7303	1888	2463	6096	0	2674	3384	5245
4 1981	0	3244	5362	2732	7399	1913	2495	6177	0	2709	3429	5314
5 1982	0	3286	5433	2767	7496	1938	2528	6258	0	2745	3474	5384
6 1983	0	3329	5503	2804	7594	1963	2561	6339	0	2780	3519	5454
7 1984	0	3372	5575	2840	7692	1988	2594	6422	0	2817	3565	5525
8 1985	0	3437	5683	2895	7841	2027	2644	6546	0	2871	3634	5632

KALUTARA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8283	# 8284	TOTAL
1 1978	1929	3654	44719
2 1979	1956	3705	45349
3 1980	1983	3757	45985
4 1981	2010	3607	46591
5 1982	2035	3857	47201
6 1983	2063	3908	47817
7 1984	2089	3958	48437
8 1985	2129	4035	49374

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-10

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

KANDY
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8301	# 8302	# 8303	# 8304	# 8305	# 8306	# 8307	# 8308	# 8309	# 8310	# 8311	# 8312
1 1978	2630	0	1712	758	2531	1647	0	4216	4106	3911	3926	4302
2 1979	2653	0	1727	764	2553	1661	0	4253	4141	3945	3960	4339
3 1980	2676	0	1742	771	2575	1676	0	4290	4177	3979	3994	4377
4 1981	2696	0	1755	777	2595	1689	0	4323	4210	4010	4025	4411
5 1982	2717	0	1769	783	2615	1702	0	4356	4242	4040	4056	4445
6 1983	2738	0	1782	789	2635	1715	0	4389	4274	4071	4087	4478
7 1984	2759	0	1796	795	2655	1728	0	4423	4307	4102	4118	4512
8 1985	2779	0	1809	801	2675	1741	0	4456	4339	4133	4148	4546

KANDY
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8313	# 8314	# 8315	# 8316	# 8317	# 8318	# 8319	# 8322	# 8323	# 8324	TOTAL
1 1978	2143	1141	1317	3981	1958	1572	1479	4640	3954	1253	53177
2 1979	2161	1151	1328	4016	1975	1585	1493	4681	3989	1264	53639
3 1980	2180	1161	1340	4051	1992	1598	1505	4720	4023	1274	54101
4 1981	2197	1170	1350	4082	2008	1611	1517	4757	4055	1284	54522
5 1982	2214	1179	1360	4113	2023	1624	1528	4794	4086	1295	54941
6 1983	2231	1188	1371	4145	2039	1636	1540	4831	4117	1305	55361
7 1984	2248	1197	1381	4176	2054	1649	1551	4867	4148	1313	55779
8 1985	2265	1206	1391	4207	2070	1661	1563	4904	4180	1323	56197

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-11

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	KEGALLE MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8341	# 8342	# 8343	# 8344	# 8345	# 8346	# 8347	# 8348	# 8349	# 8350	# 8351	TOTAL
1 1978	4485	4782	5040	4172	0	4980	5598	4206	1788	3009	4338	42398
2 1979	4537	4837	5098	4219	0	5037	5662	4255	1809	3044	4388	42886
3 1980	4589	4892	5156	4268	0	5095	5727	4303	1829	3079	4438	43376
4 1981	4637	4944	5210	4313	0	5148	5788	4349	1849	3111	4485	43834
5 1982	4682	4991	5260	4354	0	5198	5843	4391	1867	3141	4529	44256
6 1983	4731	5043	5315	4400	0	5252	5904	4437	1886	3174	4576	44718
7 1984	4780	5096	5371	4445	0	5307	5965	4482	1906	3207	4623	45182
8 1985	4829	5148	5426	4491	0	5361	6027	4529	1926	3240	4671	45648

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-12

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

KURUNEGALA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8371	# 8372	# 8373	# 8374	# 8375	# 8376	# 8377	# 8378	# 8379	# 8380	# 8381	# 8382
1 1978	4407	3268	4644	3959	6653	2500	4161	4624	6307	3034	3540	3494
2 1979	4492	3331	4734	4035	6781	2548	4262	4713	6428	3092	3608	3562
3 1980	4578	3395	4824	4112	6911	2597	4343	4804	6551	3151	3678	3630
4 1981	4661	3457	4913	4188	7037	2644	4423	4892	6671	3209	3745	3696
5 1982	4731	3508	4985	4250	7142	2683	4488	4964	6770	3256	3800	3751
6 1983	4833	3584	5093	4342	7296	2741	4585	5071	6916	3327	3882	3832
7 1984	4920	3649	5185	4420	7428	2791	4668	5163	7041	3387	3953	3901
8 1985	5009	3715	5279	4500	7562	2841	4752	5256	7168	3448	4023	3971

KURUNEGALA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO. YEAR	# 8383	# 8384	# 8385	# 8386	# 8387	# 8388	TOTAL
1 1978	6954	6873	6869	1738	4346	0	77391
2 1979	7087	[illegible]05	7001	1771	4429	0	78879
3 1980	7223	7139	7135	1805	4514	0	80390
4 1981	7355	7270	7265	1838	4596	0	81860
5 1982	7464	7378	7373	1866	4666	0	83075
6 1983	7625	7537	7532	1906	4765	0	84867
7 1984	7763	7673	7669	1940	4852	0	86403
8 1985	7903	7812	7807	1975	4940	0	87961

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-13

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	MANNAR MULTIPLE PURPOSE COOPERATIVE SOCIETIES						
	#8411	# 8412	# 8413	# 8414	# 8415	# 8416	TOTAL
1 1978	1128	761	435	241	373	1941	4879
2 1979	1160	783	447	248	384	1997	5019
3 1980	1193	805	460	256	394	2054	5162
4 1981	1226	828	473	262	405	2110	5304
5 1982	1260	850	485	269	417	2169	5450
6 1983	1294	874	499	277	428	2228	5600
7 1984	1330	897	513	285	440	2289	5754
8 1985	1366	922	526	293	452	2352	5911

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS; FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-14

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

	MATALE MULTIPLE PURPOSE COOPERATIVE SOCIETIES											
PERIOD NO.-YEAR	# 8431	# 8432	# 8433	# 8434	# 8435	# 8436	# 8437	# 8438	# 8439	# 8440	# 8441	TOTAL
1 1978	2651	873	783	1466	2469	1903	1903	1296	1460	2493	1024	19321
2 1979	2710	914	800	1499	2524	1945	1945	1325	1493	2549	1047	19751
3 1980	2770	[illegible]57	818	1532	2580	1988	1988	1355	1526	2605	1070	20189
4 1981	2829	1998	836	1564	2635	2031	2031	1384	1558	2660	1093	20619
5 1982	2889	2041	853	1595	2691	2074	2074	1413	1591	2717	1116	21057
6 1983	2950	2084	871	1632	2748	2118	2118	1443	1625	2774	1140	21503
7 1984	3012	2128	890	1666	2806	2162	2162	1474	1659	2833	1164	21956
8 1985	3076	2173	908	1701	2865	2208	2208	1504	1694	2893	1188	22418

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS; FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-15

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	MATARA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8461	# 8462	# 8463	# 8464	# 8465	# 8466	# 8467	# 8468	TOTAL
1 1978	5556	6932	6372	2956	4907	4672	6011	5091	42497
2 1979	5625	7018	6450	2993	4968	4729	6085	5153	43021
3 1980	5694	7104	6529	3029	5029	4788	6160	5216	43549
4 1981	5759	7185	6604	3064	5086	4842	6230	5276	44046
5 1982	5824	7267	6679	3099	5144	4897	6300	5336	44546
6 1983	5890	7349	6754	3134	5202	4952	6372	5396	45049
7 1984	5956	7431	6830	3169	5260	5008	6443	5457	45554
8 1985	6022	7514	6906	3204	5319	5064	6515	5518	46062

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-16
PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO.YEAR	MONEREGALA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8491	# 9492	# 8493	# 8494	# 8495	TOTAL
1 1978	3301	3049	2449	1570	2556	12925
2 1979	3447	3183	2557	1640	2669	13496
3 1980	3599	3324	2669	1712	2787	14091
4 1981	3754	3467	2785	1787	2907	14700
5 1982	3916	3617	2905	1864	3032	15334
6 1983	4085	3773	3030	1943	3163	15994
7 1984	4260	3935	3160	2028	3299	16682
8 1985	4443	4104	3296	2114	3441	17398

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-17

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	NUWARA-ELIYA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8521	# 8522	# 8523	# 8524	# 8525	# 8526	# 8527	# 8528	# 8529	TOTAL
1 1978	615	1287	1201	6330	2931	1580	2078	2064	736	18824
2 1979	622	1302	1215	6403	2965	1598	2102	2088	746	19041
3 1980	629	1317	1229	6476	2999	1616	2126	2112	755	19259
4 1981	636	1331	1242	6545	3031	1633	2148	2134	763	19463
5 1982	643	1345	1255	6614	3063	1651	2171	2156	770	19668
6 1983	649	1359	1268	6683	3094	1668	2194	2179	779	19873
7 1984	656	1373	1281	6752	3127	1685	2217	2201	787	20079
8 1985	663	1387	1294	6822	3159	1703	2240	2225	795	20288

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-18

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO.	YEAR	POLONNARUWA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8541	# 8542	# 8543	# 8544	# 8545	# 8546	# 8547	# 8548	# 8549	TOTAL
1	1978	757	1001	1298	622	463	1366	1340	1629	381	8857
2	1979	789	1044	1353	648	482	1424	1396	1697	396	9229
3	1980	822	1087	1410	675	502	1484	1454	1769	414	9617
4	1981	856	1132	1468	703	523	1545	1514	1841	430	10012
5	1982	891	1178	1528	732	544	1608	1576	1917	448	10422
6	1983	927	1227	1590	762	567	1674	1641	1995	466	10849
7	1984	965	1277	1655	793	590	1742	1708	2078	485	11293
8	1985	1004	1329	1723	825	614	1813	1778	2162	506	11754

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-19

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	PUTTALAM MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8571	# 8572	# 8573	# 8574	# 8575	# 8576	# 8577	TOTAL
1 1978	5164	3071	4084	2692	5039	2695	5467	28212
2 1979	5289	3145	4183	2757	5161	2760	5600	28895
3 1980	5417	3221	4284	2824	5285	2827	5735	29593
4 1981	5543	3296	4384	2890	5408	2893	5868	30282
5 1982	5672	3372	4485	2957	5534	2960	6005	30985
6 1983	5803	3450	4589	3025	5662	3029	6144	31702
7 1984	5937	3530	4695	3095	5793	3099	6285	32434
8 1985	6073	3611	4803	3166	5926	3170	6431	33180

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-20
PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

RATNAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8601	# 8602	# 8603	# 8604	# 8605	# 8606	# 8607	# 8608	# 8609	# 8610	# 8611	# 8612
1	1978	3590	2564	8318	2500	1958	3757	2331	2345	6440	6440	3834	4084
2	1979	3662	2615	8485	2550	1997	3832	2378	2392	6570	6570	3911	4166
3	1980	3736	2668	8655	2601	2037	3909	2426	2440	6701	6701	3990	4249
4	1981	3808	2719	8821	2651	2076	3984	2472	2487	6829	6829	4066	4331
5	1982	3880	2771	8990	2701	2116	4060	2519	2534	6960	6960	4144	4414
6	1983	3954	2824	9161	2753	2156	4138	2567	2582	7093	7093	4223	4497
7	1984	4029	2877	9335	2805	2197	4216	2616	2632	7227	7227	4303	4583
8	1985	4105	2931	9511	2858	2239	4296	2665	2681	7364	7364	4384	4670

RATNAPURA
MULTIPLE PURPOSE COOPERATIVE SOCIETIES

PERIOD NO.	YEAR	# 8613	TOTAL
1	1978	1834	49995
2	1979	1872	51000
3	1980	1909	52022
4	1981	1946	53019
5	1982	1983	54032
6	1983	2020	55061
7	1984	2059	56106
8	1985	2098	57166

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-21

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	TRINCOMALEE MULTIPLE PURPOSE COOPERATIVE SOCIETIES										
	# 8631	# 8632	# 8633	# 8634	# 8635	# 8636	# 8637	# 8638	# 8639	# 8640	TOTAL
1 1978	652	979	1146	2122	2646	441	298	2182	0	238	10704
2 1979	675	1013	1186	2196	2738	456	308	2258	0	247	11077
3 1980	698	1049	1227	2272	2834	472	319	2337	0	255	11463
4 1981	722	1084	1269	2349	2930	488	330	2416	0	263	11851
5 1982	746	1121	1312	2429	3029	504	341	2498	0	273	12253
6 1993	772	1159	1356	2511	3131	521	353	2582	0	282	12667
7 1984	798	1198	1402	2596	3237	539	364	2669	0	291	13094
8 1985	825	1238	1449	2683	3346	557	377	2759	0	300	13534

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS; FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

TABLE D-22

PROJECTED VOLUME OF RATION RICE TO BE DISTRIBUTED TO RICE RATION RECIPIENTS IN TONS

1978-1985

PERIOD NO. YEAR	VAVUNIYA MULTIPLE PURPOSE COOPERATIVE SOCIETIES # 8661	# 8662	# 8663	# 8664	# 8665	# 8666	TOTAL
1 1978	286	1752	2268	326	1065	248	5945
2 1979	296	1814	2347	337	1102	256	6152
3 1980	306	1877	2428	349	1141	265	6366
4 1981	316	1940	2511	361	1180	274	6582
5 1982	327	2006	2596	373	1219	284	6805
6 1983	338	2074	2683	386	1261	293	7035
7 1984	350	2144	2774	399	1303	302	7272
8 1985	361	2216	2867	412	1348	313	7517

SOURCE:
CALCULATIONS BASED ON AUGUST 1978 LIST OF RATION CARD HOLDERS, FOOD COMISSIONER. ASSUMED CURRENT POLICY TO CONTINUE, WITH INCREASE IN RATION LIST IN PROPORTION TO DISTRICT POPULATION GROWTH. LIST MULTIPLIED BY STANDARD RATION ALLOTMENT.

APPENDIX E

MILLED DOMESTIC RICE AVAILABLE FOR RICE RATION SYSTEM BY DISTRICT AND RICE MILL

TABLE 1

YEAR #	TONS	NAME	
			AMPARAI
19856001	5412	HINGURANA	
19856002	10825	UHANA	
19856003	2700	SAMANTHURAI	
19856004	9472	AMPARAI	
19856005	1353	LAHUGALA	
19856006	4059	DAMANA	
19856007	6089	POTTUVIL	
19856008	4287	KALMUNAI	
19856009	7640	AKKARAIPATTU	
19856010	7267	BAKKIELLA	
19856011	1353	INGINIYAGALA	
19856012	1353	EPAPGAMA	
19856013	4173	KARATIVU	
19856014	1353	WEERAGODA	
19856015	8955	ADDALACHAVAI	
19856016	1353	NINTAVUR	
19856017	10262	CHAVALAKADA-PMB	
19856018	6082	INGINIYAGALA-PMB	
19856019	7602	SAMANTHURAI-AID	
19856020	7602	SAGAMA	
19856021	4561	MAHA OYA	
			ANARADHAPURA
19856041	2699	MEDAWACHCHIYA	
19856042	3774	ANURADHAPURA	
19856043	667	HIDCGAMA	
19856044	4508	TAYAWA	
19856045	997	SRAVASTIPURA	
19856046	8082	KEKIRAWA	
19856047	1349	KAHATGASDIGILIYA	
19856048	1349	MANKADEWELA	
19856049	1334	HORPWPOTHANA	
19856050	2699	MARADANKADAWALA	
19856051	2699	MACATUGAMA	
19856052	1349	VIJITHAPURA	
19856053	2699	MIHINTALE	
19856054	2362	PULIYANKULAMA	
19856055	7497	ANARADHAPURA-PMB	
19856056	0	MEDWACHCHIYA-PMB	
19856057	0	KALAWEWA-PMB	
19856058	7497	PADAVIYA-PMB	
19856059	7497	RAPAWALA-PMB-AID	
19856060	7497	RAJANGANA-PMBAID	
19856061	7497	KEKIRAWA-PMB-AID	
19856062	7497	KERITHIGOLLEMA	
19856063	7497	MOCHCHIYAGAMA	
			BADULLA
19856081	7509	HALI-ELA	
19856082	1316	BADULLA	

(CONTINUED)

19856083	1269	KEPPETIPOLA
19856084	1978	MAHIYANGANA
19856085	1316	MEEGAHAKIVULA

BATTICALOA

19856101	15222	KATTANKUDI
19856102	3488	CHENKALADAI
19856103	806	KARAVEDDI
19856104	1306	PALAMUNAI
19856105	1308	MURUKOTTACHENAI
19856106	0	ERAVUR
19856107	0	BATTICALOA
19856108	6615	BATTICALOA-PMB
19856109	4899	ERAVUR-PMB-AID

COLOMBO

19856131	226	KELANIYA
19856132	466	WATTALA
19856133	162250	COLOMBO

GALLE

19856141	2266	UNAWATUNA
19856142	1158	BENTOTA
19856143	837	URUGASMANHANDIYA
19856144	86125	GALLE

HAMBANTOTA

19856161	12447	AMPALANTOTA
19856162	2182	TANGALLE
19856163	2971	BELLATTA
19856164	4950	TISSAMAHARAMA
19856165	2021	MARMADELA
19856166	1303	VALGSMULLA
19856167	1064	HAMBANTOTA
19856169	0	HUNGAMA
19856170	646	WEERAKETIYA
19856171	8077	AMPALANTOTA-PMB
19856173	9566	KACHCHIGALE-PMG

JAFFNA

19856191	1291	KARAVEDDI
19856192	581	MUSALAI
19856193	694	KILLINOCHCHI
19856194	940	KONDAVIL
19856195	702	VELANAI
19856196	1447	CHUNAKAM
19856197	2641	MANIPAE
19856198	1393	PARANTHAN
19856199	594	KARAVANAI-SOUTH
19856200	1397	POONALAI-KADUVAN
19856201	4268	KOKKUVIL
19856202	0	SUTHUMALAI
19856203	694	ELALAI
19856204	694	JAFFNA
19856205	195	KARAINGGAR
19856206	562	VADUKODDAI
19856207	354	KANKESANTHURAI

(CONTINUED)

19856208	523	KAITHADY	
19856209	507	CHANKANGI	
19856210	0	UDUPPIDY	
19856211	0	CHUNNAKAM-PMB	
			KALUTARA
19856231	2100	KALUTARA	
19856232	1350	ALUTHAAMA	
19856233	781	MORONTHUDUWA	
			KANDY
19856251	5633	KANDY	
19856252	5800	AMBATENNE	
19856253	0	GAMPOLA	
19856254	2999	WATTEGAMA	
19856255	1035	AKURANA	
19856256	481	KUNDASALGE	
19856257	1499	HASALAKE	
19856258	0	VERAGANTOTA	
19856259	962	MENIKHINNA	
19856260	962	POOJAPITIYA	
19856261	216	MURUTHALAWA	
19856262	962	VERALLAGAMA	
19856263	440	KATUGASTOTA	
19856264	0	TELDENIYA	
19856266	481	MINIPAE	
19856267	0	KADUGANNAWA	
19856269	0	GALAGEDERA	
19856271	567	PALLEWATTE-PMB	
19856272	2702	HASALAKA-PMB	
19856273	324	DENUWARA-PMB	
19856274	202	GANNARUWA-PMB	
			KEGALLE
19856291	1347	KEGALLE	
19856292	0	WARAKAPOLA	
19856293	0	THULHIRIYA	
19856296	0	MAWANELLA	
19856297	1893	RAMBUKKANA	
			KURUNEGALA
19856321	5343	NIKAWERATIYA	
19856322	4114	HOROMBARWA	
19856324	2702	KURUNEGALA	
19856325	1108	PANNALA	
19856327	812	NIKADALUPOTHA	
19856328	0	PANNALA	
19856329	0	DAMPADENIYA	
19856330	645	KULIYAPITIYA	
19856331	1351	POLGANAWELA	
19856332	0	MALLAWAPITIYA	
19856333	0	IBBAGAMUWA	
19856334	0	KATUPOTHA	
19856335	357	WARIYAPOLA	
19856336	1380	POTHUHERA	
19856337	0	MAHO-PMB	

(CONTINUED)

19856338		ONTKAWERATIYA-PMB	
19856339	7590	GALGAMUWA-PMB	
19856340	3795	MAHO	
			MANNAR
19856361	796	MANNAR	
19856362	5193	ADAMPAN	
19856363	796	PALIYANKULAM	
19856364	796	UILANKULAM	
19856365	805	MURUNKAN	
19856366	805	SILLAVATTURAI	
19856367	1656	THIRUKETHISWARA	
19856368	0	NANATTAN-PMB	
			MATALE
19856391	1334	GALEWELA	
19856392	5660	DAMBULLA	
19856393	0	MATALE	
19856395	0	MAHAWELA	
19856396	0	ALUBIHARA	
19856397	0	DEVAHUWA	
19856398	1446	KONAGAHAWELA	
19856399	1664	KARNKU-PALALLA	
19856400	0	KANDALAMA-PMB	
19856401	0	NAULA-PMB	
19856402	1873	HETTIPOLA	
			MATARA
19856421	1270	MATARA	
19856422	1270	DEVINUWALA	
19856423	0	WELIGAMA	
19856424	516	KAMBURUGAMUWA	
19856425	234	KAMBURUPITIYA	
19856426	0	DIKWELLA	
19856427	800	WALASGALA	
19856428	0	RATMALAE	
19856429	1618	HAKMANA	
19856430	247	DIYAGAHA	
19856431	719	YATIYANA	
19856432	741	THIHAGODA	
			MONEREGALA
19856451	5841	MONERAGALA	
19856452	1546	BIBILE	
19856453	0	TANAMALVILA	
19856454	1546	SIBIGALA	
19856455	0	MONERAGALA-PMB	
19856456	1546	WELLAWAYA	
			NUWARA-ELIYA
19856460	5609	WELLAWAYA	
			POLONNARUWA
19856501	23696	POLONNARUWA	
19856502	3868	MANAMPITIYA	
19856503	967	KALAHAGALA	
19856504	10638	KADURUWELA	

(CONTINUED)

19856505	3868	ELAHERA
19856506	967	KAUDULLA
19856507	9195	GIRITALAE
19856508	27088	
19856509	967	PALASTIGAMA
19856510	967	HINGURAKGODD
19856511	5011	POLONNARUWA-PMB
19856512	727	HINGURAKGODA-PMG
19856513	1303	BAKAMUNA-PMB
19856514	5011	MINERIYA-PMB-AID

PUTTALAM

19856531	1380	PUTTALAM
19856532	1380	MADAMPAE
19856533	0	RAJAKADALUWA
19856534	1364	ANAMADUWA
19856535	767	TARBOWA

RATNAPURA

19856551	1308	OPANAIKE
19856552	654	PELMADULLA
19856553	654	BALANGODA
19856554	5230	PADALANGALA
19856555	3703	EMBILIPITIYA
19856556	5877	MORAKETIYA

TRINCOMALEE

19856581	2013	KINNIYA
19856582	1477	KANTALAI
19856583	2074	GANTALARWA
19856584	1186	UPPUVELI
19856585	1033	PANKULAM
19856586	5900	TRINCOMALEE
19856587	4086	SAMBALATIVU
19856588	742	NELAVELI
19856589	0	KANTALAI-PMB
19856590	15305	KANTALE COMP-PMB
19856591	0	MUTTUR I-PMB
19856592	0	MUTTUR II-PMB
19856593	7652	KALLOR
19856594	5357	KILIPEDDI
19856595	7652	THOPPUR

VAVUNIYA

19856611	2038	OMANTAI
19856612	5693	VAVUNIYA
19856613	2440	MANKULAM
19856614	2440	MULLIAVELAI
19856615	813	NEDUNKERNI
19856616	1627	ODDU-SUDDAN
19856617	4566	VAVUNIYA-PMB-AID

APPENDIX F

ADJUSTMENTS OF RAIL TRANSPORTATION COST FUNCTIONS TO LACK OF SIDINGS AT SHIPPING AND/OR RECEIVING POINTS

1. Lack of siding at shipping or receiving points only

The cost of transporting rice by truck for one mile between shipping point and the railroad station or siding or from the station or siding to the final destination point is added to the second railroad transportation cost function as follows:

Second railroad transportation cost function:	$Y = 36.36 + 0.30x$
Plus transportation cost of one mile by truck:	$Y = 13.731$
Adjusted railroad transportation cost function:	$Y = 50.091 + 0.30x$

However, since no additional handling is involved at either the shipping point or the destination point, the additional handling costs not incurred at either point must be subtracted. These extra handling costs amount to Rs. 9.00 per ton {(36.36 - 18.36) + 2}.

Therefore, the rail cost function reflecting one mile truck transport at shipping or destination is:

$$Y = 41.091 + 0.30x$$

2. Lack of sidings at both shipping and destination

In this case, the extra cost of transporting rice by truck for one mile between the shipping point and the railroad station or siding and again at the end of the trip between the railroad station or siding and the destination point is added to the second railroad transportation cost function as follows:

Second railroad transportation cost function:	$Y = 36.36 + 0.30x$
Plus transportation cost of two miles by truck:	$Y = 27.462$
Adjusted railroad transportation cost function to reflect the lack of rail station or siding a both shipping and receiving points:	$Y = 63.822 + 0.30x$

Finally, these railroad transportation cost functions were used to

obtain the least-cost railroad network file with mode identification via a special Network Conversion Program which separates those shipping or receiving points having railroad siding from those not having any and applying corresponding cost function.

APPENDIX G

OPTIMUM NUMBER, LOCATION, AND THROUGHPUT OF RATION RICE BY SUPPLY STATIONS UNCONSTRAINED SOLUTIONS

TABLE 1

DISTRIBUTION ANALYSIS - UNCONSTRAINED SOLUTIONS

		Unconstrained FC Warehouse Demand Quantity	Unconstrained FC Warehouse Supply Quantity
7001	Amparai	45823.00	5178.00
7002	Chavalakadae	23231.00	6881.00
7003	Naipattimunai	40099.00	15776.00
7004	Batti Transit	0.00	0.00
7026	Anuradhapura	1349.00	2651.00
7027	Sravastipura	73978.00	23883.00
7041	Badulla	10141.00	10126.00
7042	Bandarawela	0.00	10941.00
7043	Haputale	0.00	2528.00
7061	Batticaloa	36901.00	25036.00
7076	Colombo	147242.00	66795.00
7077	Wharf	694.00	63426.00
7101	Galle	103399.00	40333.00
7102	Boosa	0.00	7996.00
7131	Hambantota	38419.00	6372.00
7132	Werrawila	4950.00	2759.00
7133	Kahandawa	16668.00	24027.00
7171	Jaffna	9612.00	14086.00
7172	Point Pedro	1985.00	3670.00
7173	Kankasannturai	2495.00	8751.00
7174	Kayts	2294.00	4664.00
7175	Navatkuli	1104.00	9132.00
7176	Delft	0.00	0.00
7177	Palali	0.00	5121.00
7211	Katugastota	24311.00	53861.00
7212	Gampola	324.00	14917.00
7213	Wattegama	2999.00	4546.00
7214	Nawalapitiya	0.00	4829.00
7215	Kundasale	13317.00	24128.00
7251	Kegalle	5699.00	31628.00
7252	Warakapola	0.00	40109.00
7253	Karawanella	0.00	13272.00
7281	Kurunegala	10342.00	29626.00
7282	Maho	9495.00	19139.00
7311	Mannar	8443.00	2804.00
7312	Murunkan	2406.00	3107.00
7341	Matale	7344.00	19342.00
7371	Matara	6145.00	31642.00
7372	Welligama	1270.00	20470.00
7401	Moneregala	11832.00	17398.00
7431	Nuwara-Fliya	1269.00	13188.00
7461	Polonaruwa	49830.00	5928.00
7462	Hingurakgoda	45889.00	5826.00
7491	Puttalam	3511.00	10876.00
7492	Madampe	2025.00	39994.00

TABLE 1 (Continued)

		Unconstrained FC Warehouse Demand Quantity	Unconstrained FC Warehouse Supply Quantity
7521	Ratnapura	0.00	12320.00
7522	Kahawatta	654.00	19540.00
7523	Opanaike	1962.00	7036.00
7524	Eheliyagoda	0.00	20351.00
7525	Dela	0.00	11735.00
7551	Trincomalee	12947.00	934.00
7552	Kinniya	41530.00	8954.00
7553	Clappenburg	0.00	3646.00
7581	Vavuniya	33688.00	7901.00
7582	Mullaitivu	3253.00	2577.00
7583	Mankulam	6154.00	5267.00

APPENDIX H

OPTIMUM NUMBER, LOCATION, AND THROUGHPUT OF RATION RICE BY SUPPLY STATION BASE CASE AND MODIFIED SOLUTIONS

TABLE 1

OPTIMUM THROUGHPUT OF RATION RICE FOR 54 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-0	7001	Amparai	12723
	7002	Chavalakadae	6831
	7003	Naipattimunai	15776
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	14911
	7042	Bandarawela	10941
	7043	Haputale	9691
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	87288
	7102	Boosa	7996
	7131	Hambantota	6372
	7132	Werrawilla	2759
	7133	Kahandawa	36096
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasannturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	14912
	7213	Wattegama	6935
	7214	Nawalapitiya	4829
	7215	Kundasale	14416
	7251	Kegalle	26349
	7252	Warakapola	21446
	7253	Karawanella	3240
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	1707
	7372	Welligama	5708
	7401	Moneregala	8099
	7431	Nuwara Eliya	1269
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	2881
	7522	Kanawatta	31093
	7523	Opaniake	654
	7524	Eheliyagoda	6371
	7525	Dela	1962
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 2

OPTIMUM THROUGHPUT OF RATION RICE FOR 53 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-1	7001	Amparai	12723
	7002	Chavalakadae	6881
	7003	Naipattimunai	15776
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	14911
	7042	Bandarawela	10941
	7043	Haputale	9691
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	87288
	7102	Boosa	7996
	7131	Hambantota	6372
	7132	Werrawilla	2759
	7133	Kahandawa	36096
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasanturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	14912
	7213	Wattegama	6935
	7214	Nawalapitiya	4829
	7215	Kundasale	14416
	7251	Kegalle	26349
	7252	Warakapola	21446
	7253	Karawanella	3240
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	1707
	7372	Welligama	5708
	7401	Moneregala	8099
	7431	Nuwara Eliya	1269
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	9252
	7522	Kanawatta	31093
	7523	Opaniake	654
	7524	Eheliyagoda	0
	7525	Dela	1962
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 3

OPTIMUM THROUGHPUT OF RATION RICE FOR 52 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-2	7001	Amparai	12723
	7002	Chavalakadae	6881
	7003	Naipattimunai	15776
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	14911
	7042	Bandarawela	10941
	7043	Haputale	9691
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	87288
	7102	Boosa	7996
	7131	Hambantota	6372
	7132	Werrawilla	2759
	7133	Kahandawa	36096
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasannturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	14912
	7213	Wattegama	6935
	7214	Nawalapitiya	4829
	7215	Kundasale	14416
	7251	Kegalle	26349
	7252	Warakapola	21446
	7253	Karawanella	3240
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	1707
	7372	Welligama	5708
	7401	Moneregala	8099
	7431	Nuwara Eliya	1269
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	40345
	7523	Opaniake	654
	7524	Eheliyagoda	0
	7525	Dela	1962
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 4

OPTIMUM THROUGHPUT OF RATION RICE FOR 49 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.F. F-3	7001	Amparai	12723
	7002	Chavalakadae	6881
	7003	Naipattimunai	15776
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	14911
	7042	Bandarawela	10941
	7043	Haputale	9691
	7051	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	87288
	7102	Boosa	7996
	7131	Hambantota	6372
	7132	Werrawilla	2759
	7133	Kahandawa	36096
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasanturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	14912
	7213	Wattegama	6935
	7214	Nawalapitiya	4829
	7215	Kumasale	14416
	7251	Kegalle	26349
	7252	Warakapola	24686
	7253	Karawanella	0
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	1707
	7372	Welligama	5708
	7401	Moneregala	8099
	7431	Nuwara Eliya	1269
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opanlake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 5

OPTIMUM THROUGHPUT OF RATION RICE FOR 45 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-4	7001	Amparai	12723
	7002	Chavalakadae	6881
	7003	Naipattimunai	15776
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	87288
	7102	Boosa	7996
	7131	Hambantota	6372
	7132	Werrawilla	2759
	7133	Kahandawa	36096
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasannturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	19741
	7213	Wattegama	6935
	7214	Nawalapitiya	0
	7215	Kundasale	14416
	7251	Kegalle	26349
	7252	Warakapola	24686
	7253	Karawanella	0
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	1707
	7372	Welligama	5708
	7401	Moneregala	8099
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 6

OPTIMUM THROUGHPUT OF RATION RICE FOR 40 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-5	7001	Amparai	12723
	7002	Chavalakadae	0
	7003	Naipattimunai	22657
	7026	Anuradnapura	7097
	7027	Sravastipura	20973
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasanturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	19741
	7213	Wattegama	6935
	7214	Nawalapitiya	0
	7215	Kundasale	14416
	7251	Kegalle	26349
	7252	Warakapola	24686
	7253	Karawanella	0
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	14821
	7371	Matara	0
	7372	Welligama	7415
	7401	Moneregala	8099
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	17705
	7462	Hingurakgoda	5826
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	934
	7552	Kinniya	8954
	7553	Clappenburg	3646
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 7

OPTIMUM THROUGHPUT OF RATION RICE FOR 35 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-6	7001	Amparai	12723
	7002	Chavalakadae	0
	7003	Naipattimunai	22657
	7026	Anuradnapura	0
	7027	Sravastipura	28070
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa 45227	45227
	7171	Jaffna	14086
	7172	Point Pedro	3670
	7173	Kankasannturai	8751
	7174	Kayts	4664
	7175	Navatkuli	6424
	7177	Palali	5121
	7211	Katugastota	48273
	7212	Gampola	19741
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	17415
	7251	Kegalle	26349
	7252	Warakapola	24686
	7253	Karawanella	0
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	18754
	7371	Matara	0
	7372	Welligama	7415
	7401	Moneregala	8099
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	16374
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Deraniyagala	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 8

OPTIMUM THROUGHPUT OF RATION RICE FOR 30 SU LY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-7	7001	Amparai	12723
	7002	Chavalakadae	0
	7003	Naipattimunai	22657
	7026	Anuradnapura	0
	7027	Sravastipura	28070
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasanturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	48273
	7212	Gampola	19741
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	17415
	7251	Kegalle	26349
	7252	Warakapola	24686
	7253	Karawanella	0
	7281	Kurunegala	46492
	7282	Maho	27042
	7311	Mannar	6038
	7312	Murunkan	2288
	7341	Matale	18757
	7371	Matara	0
	7372	Welligama	7415
	7401	Moneregala	8099
	7431	Nuwara iya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	16574
	7492	Madampe	16806
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	6658
	7582	Mullaitvu	2577
	7583	Mankulam	5267

TABLE 9

OPTIMUM THROUGHPUT OF RATION RICE FOR 25 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-8	7001	Amparai	12723
	7002	Chavalakadae	0
	7003	Naipattimunai	22657
	7026	Anuradnapura	0
	7027	Sravastipura	28070
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	99518
	7077	Wharf	63426
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	49015
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	36414
	7251	Kegalle	51035
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	59787
	7282	Maho	27042
	7311	Mannar	8326
	7312	Murunkan	0
	7341	Matale	18757
	7371	Matara	0
	7372	Welligama	7415
	7401	Moneregala	8099
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	19885
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	6658
	7582	Mullaitvu	0
	7583	Mankulam	7844

TABLE 10

OPTIMUM THROUGHPUT OF RATION RICE FOR 20 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-9	7001	Amparai	0
	7002	Chavalakadae	0
	7003	Naipattimunai	35380
	7026	Anuradnapura	0
	7027	Sravastipura	28070
	7041	Badulla	36812
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	162944
	7077	Wharf	0
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	85429
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	0
	7251	Kegalle	51035
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	86829
	7282	Maho	0
	7311	Mannar	8326
	7312	Murunkan	0
	7341	Matale	18757
	7371	Matara	7415
	7372	Welligama	0
	7401	Moneregala	8099
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Put lam	19885
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	14502
	7582	Mullaitvu	0
	7583	Mankulam	0

TABLE 11

OPTIMUM THROUGHPUT OF RATION RICE FOR 18 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-10	7001	Amparai	0
	7002	Chavalakadae	0
	7003	Naipattimunai	40790
	7026	Anuradnapura	0
	7027	Sravastipura	28070
	7041	Badulla	39501
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	162944
	7077	Wharf	0
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	104186
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	0
	7251	Kegalle	51035
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	86829
	7282	Maho	0
	7311	Mannar	8326
	7312	Murunkan	0
	7341	Matale	0
	7371	Matara	7415
	7372	Welligama	0
	7401	Moneregala	0
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	19885
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	14502
	7582	Mullaitvu	0
	7583	Mankulam	0

TABLE 12

OPTIMUM THROUGHPUT OF RATION RICE FOR 16 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-11	7001	Amparai	0
	7002	Chavalakadae	0
	7003	Naipattimunai	40790
	7026	Anuradnapura	0
	7027	Sravastipura	43446
	7041	Badulla	39501
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	162944
	7077	Wharf	0
	7101	Galle	95284
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	45227
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	146227
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	0
	7251	Kegalle	0
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	100332
	7282	Maho	0
	7311	Mannar	8326
	7312	Murunkan	0
	7341	Matale	0
	7371	Matara	7415
	7372	Welligama	0
	7401	Moneregala	0
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	0
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	14502
	7582	Mullaitvu	0
	7583	Mankulam	0

TABLE 13

OPTIMUM THROUGHPUT OF RATION RICE FOR 14 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-12	7001	Amparai	0
	7002	Chavalakadae	0
	7003	Naipattimunai	40790
	7026	Anuradnapura	0
	7027	Sravastipura	43446
	7041	Badulla	39501
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	162944
	7077	Wharf	0
	7101	Galle	99011
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	48915
	7171	Jaffna	42716
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	146227
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	0
	7251	Kegalle	0
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	100332
	7282	Maho	0
	7311	Mannar	0
	7312	Murunkan	0
	7341	Matale	0
	7371	Matara	0
	7372	Welligama	0
	7401	Moneregala	0
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	0
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Embiliyagoda	0
	7525	Deraa	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	22828
	7582	Mullaitvu	0
	7583	Mankulam	0

TABLE 14

OPTIMUM THROUGHPUT OF RATION RICE FOR 13 SUPPLY STATION IN TONS
1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. F-13	7001	Amparai	0
	7002	Chavalakadae	0
	7003	Naipattimunai	40790
	7026	Anuradnapura	0
	7027	Sravastipura	43446
	7041	Badulla	39501
	7042	Bandarawela	0
	7043	Haputale	0
	7061	Batticaloa	40287
	7076	Colombo	162944
	7077	Wharf	0
	7101	Galle	99011
	7102	Boosa	0
	7131	Hambantota	0
	7132	Werrawilla	0
	7133	Kahandawa	48915
	7171	Jaffna	0
	7172	Point Pedro	0
	7173	Kankasannturai	0
	7174	Kayts	0
	7175	Navatkuli	0
	7177	Palali	0
	7211	Katugastota	146227
	7212	Gampola	0
	7213	Wattegama	0
	7214	Nawalapitiya	0
	7215	Kundasale	0
	7251	Kegalle	0
	7252	Warakapola	0
	7253	Karawanella	0
	7281	Kurunegala	100332
	7282	Maho	0
	7311	Mannar	0
	7312	Murunkan	0
	7341	Matale	0
	7371	Matara	0
	7372	Welligama	0
	7401	Moneregala	0
	7431	Nuwara Eliya	0
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	0
	7491	Puttalam	0
	7492	Madampe	0
	7521	Ratnapura	0
	7522	Kanawatta	42961
	7523	Opaniake	0
	7524	Eheliyagoda	0
	7525	Dela	0
	7551	Trincomalee	0
	7552	Kinniya	13534
	7553	Clappenburg	0
	7581	Vavuniya	65544
	7582	Mullaitvu	0
	7583	Mankulam	0

APPENDIX I

OPTIMUM THROUGHPUT OF RATION RICE BY SUPPLY STATION SUGGESTED ALTERNATIVE

TABLE 1

OPTIMUM THROUGHPUT OF RATION RICE FOR 13 PRESELECTED SUPPLY STATION IN TONS 1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. 0-B	7001	Amparai	40284
	7002	Chavalakadae	
	7003	Naipattimunai	
	7026	Anuradnapura	41952
	7027	Sravastipura	
	7041	Badulla	70251
	7042	Bandarawela	
	7043	Haputale	
	7061	Batticaloa	26689
	7076	Colombo	165825
	7077	Wharf	
	7101	Galle	96643
	7102	Boosa	
	7131	Hambantota	52555
	7132	Werrawilla	
	7133	Kahandawa	
	7171	Jaffna	
	7172	Point Pedro	
	7173	Kankasannturai	
	7174	Kayts	
	7175	Navatkuli	
	7177	Palali	
	7211	Katugastota	
	7212	Gampola	
	7213	Wattegama	
	7214	Nawalapitiya	
	7215	Kundasale	180000
	7251	Kegalle	
	7252	Warakapola	
	7253	Karawanella	
	7281	Kurunegala	
	7282	Maho	
	7311	Mannar	87568
	7312	Murunkan	
	7341	Matale	
	7371	Matara	
	7372	Welligama	
	7401	Moneregala	
	7431	Nuwara Eliya	
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	
	7491	Puttalam	
	7492	Madampe	
	7521	Ratnapura	11644
	7522	Kanawatta	
	7523	Opaniake	
	7524	Eheliyagoda	
	7525	Dela	
	7551	Trincomalee	13534
	7552	Kinniya	
	7553	Clappenburg	
	7581	Vavuniya	
	7582	Mullaitvu	
	7583	Mankulam	56547

TABLE 2

OPTIMUM THROUGHPUT OF RATION RICE FOR 13 PRESELECTED AND 3 ADDITIONAL SUPPLY STATION IN TONS 1985

REFERENCE NUMBER	CODE NUMBER OF SUPPLY STATION	LOCATION	OPTIMUM THROUGHPUT
T.L.P. VIII-B	7001	Amparai	40284
	7002	Chavalakadae	
	7003	Naipattimunai	
	7026	Anuradnapura	36041
	7027	Sravastipura	
	7041	Badulla	70251
	7042	Bandarawela	
	7043	Haputale	
	7061	Batticaloa	26689
	7076	Colombo	165825
	7077	Wharf	
	7101	Galle	89228
	7102	Boosa	
	7131	Hambantota	52555
	7132	Werrawilla	
	7133	Kahandawa	
	7171	Jaffna	42716*
	7172	Point Pedro	
	7173	Kankasannturai	
	7174	Kayts	
	7175	Navatkuli	
	7177	Palali	
	7211	Katugastota	
	7212	Gampola	
	7213	Wattegama	
	7214	Nawalapitiya	
	7215	Kundasale	180000
	7251	Kegalle	
	7252	Warakapola	
	7253	Karawanella	
	7281	Kurunegala	
	7282	Maho	87568
	7311	Mannar	5911*
	7312	Murunkan	
	7341	Matale	
	7371	Matara	7415*
	7372	Welligama	
	7401	Moneregala	
	7431	Nuwara Eliya	
	7461	Polonnaruwa	23531
	7462	Hingurakgoda	
	7491	Puttalam	
	7492	Madampe	
	7521	Ratnapura	
	7522	Kanawatta	11644
	7523	Opaniake	
	7524	Eheliyagoda	
	7525	Dela	
	7551	Trincomalee	13534
	7552	Kinniya	
	7553	Clappenburg	
	7581	Vavuniya	13821
	7582	Mullaitvu	
	7583	Mankulam	

* Additional storage facilities

BIBLIOGRAPHY

Books

Dantzig, George B., Linear Programming and Extension, Princeton, N.J., Princeton University Press, 1963.

Gass, Saul I., Linear Programming: Methods and Applications, New York, McGraw-Hill, Third Edition, 1969.

Kuenne, Robert E., The Theory of General Economic Equilibrium, Princeton, N.J., Princeton University Press, 1963.

Periodicals

Baumel, Phillip C., John J. Miller, and Thomas P. Drinka, "The Economics of Upgrading Seventy-one Branch Rail Lines in Iowa," American Journal of Agricultural Economics, Vol. 57, (February, 1977), pp. 61-70.

Bobst, B. W., and M. W. Waananen, "Cost and Price Effects of Concentration Restriction in the Plant Location Problem," American Journal of Agricultural Economics, Vol. 50, (August, 1968), pp. 676-686.

Candler, Wilfred, James C. Snyder, and William Faught, "Concave Programming Applied to Rice Mill Location," American Journal of Agricultural Economics, Vol. 45, (February, 1972), pp. 126-130.

Chern, Wen-Shyong, and Leo Polopolus, "Discontinuous Plant Cost Functions and a Modification of the Stollsteimer Location Model," American Journal of Agricultural Economics, Vol. 52, (November, 1970), pp. 581-586.

Fuller, Stephen W., Paul Randolph, and Darwin Klingman, "Optimizing Subindustry Marketing Organizations: A Network Analysis Approach," American Journal of Agricultural Economics, Vol. 58, (August, 1976), pp. 425-436.

Geoffrion A. M., and G. W. Groves, "Multicommodity Distribution System Design by Binders Decomposition," Management Science, Vol. 20, (January, 1974), pp. 822-844.

Hilger, Donald A., Bruce A. McCarl, and William J. Uhrig, "Facilities Location: The Case of Grain Subterminals," American Journal of Agricultural Economics, Vol. 59, (November, 1977), pp. 674-682.

King, Gordon A., and Samuel H. Logan, "Optimum Location, Number and Size of Processing Plants with Raw Product and Final Product Shipments," Journal of Farm Economics, Vol. 46, (February, 1964), pp. 94-108.

Kloth, Donald W., and Leo W. Blahley, "Optimum Dairy Plant Location with Economies of Size and Market-Share Restrictions," American Journal of Agricultural Economics, Vol. 53, (August, 1971), pp. 461-466.

Ladd, George W., and Patrick M. Haloorson, "Parametric Solutions to the Stollsteimer Model," American Journal of Agricultural Economics, Vol. 52, (November, 1970), pp. 578-580.

Ladd, George W., and Deuvis R. Lifferth, "The Analysis of Alternative Grain Distribution System," American Journal of Agricultural Economics, Vol. 57, (August, 1975), pp. 420-430.

Larson, Donald W., and Michael D. Kane, "Effects of Rail Abandonment on Grain Marketing and Transportation Costs in Central and Southwestern Ohio," North Central Journal of Agricultural Economics, Vol. 1, (July, 1979), pp. 105-113.

Polopolus, Leo, "Optimum Plant Numbers and Locations for Multiple Product Processing," Journal of Farm Economics, Vol. 47, (May, 1965), pp. 287-295.

Toft, H. I., P. A. Cassidy, and W. O. McCarthy, "Sensitivity Testing and Plant Location Problems," American Journal of Agricultural Economics, Vol. 52, (August, 1970), pp. 403-410.

Tyrchniewicz, Edward W., and Robert J. Tosterud, "A Model for Rationalizing the Canadian Grain Transportation and Handling System on a Regional Basis," American Journal of Agricultural Economics, Vol. 55, (December, 1973), pp. 805-813. "Sri Lanka Ending Flour Subsidies," Milling and Baking News, Vol. 59, (March, 1980), p. 51.

Stollsteimer, John F., "A Working Model for Plant Numbers and Locations," Journal of Farm Economics, Vol. 45, (August, 1963), pp. 631-645.

Warrack, Allan A., and Lehman B. Fletcher, "Plant-location Model Suboptimization for Large Problems," American Journal of Agricultural Economics, Vol. 52, (November, 1970), pp. 587-590.

Wright, Charles L., Richard L. Meyer, and Francis E. Walker, "Modeling Transportation and Storage Systems in Developing Areas as Capacitated Networks," American Journal of Agricultural Economics, Vol. 58, (December, 1976), (abstract).

Reports

Borsdorf, Roe, Relevant Issues and Guidelines for Assessment of Issues Related to Phase II Development Projects within the Paddy and Rice Marketing Sectors of Sri Lanka, Food and Feed Grain Institute, January 1978.

Borsdorf, Roe, Outline for Sri Lanka Paddy and Rice Transportation Analysis, Food and Feed Grain Institute, April, 1978.

Borsdorf, Roe, and Cornelius Hugo, Sri Lanka Transport and Locational Analysis Study, A working paper prepared for USAID/Colombo, Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, 1978.

Borsdorf, Roe, and Cornelius Hugo, Interim Report #1. Sri Lanka Transport and Locational Analysis, Food and Feed Grain Institute, June, 1978.

Borsdorf, Roe, and Cornelius Hugo, Future Supply Potentials and Facility Requirements, Government Sector of the Sri Lanka Rice Industry, Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas, 1978.

Borsdorf, Roe, Dale Anderson, and Don Anderson, Grain Policy Development and Implementation in Sri Lanka, Food and Feed Grain Institute, Kansas State University, March, 1979.

Edirisinghe, Neville, and Thomas T. Poleman, Implications of Government Intervention in the Rice Economy of Sri Lanka, Department of Agricultural Economics, Cornell University, New York, 1976.

Hussain, S. M., ed, Sectorial Analysis of Paddy Production, Marketing, and Processing in Sri Lanka, Ministry of Planning and Economic Affairs, Development Planning Unit, Colombo, Sri Lanka, 1977.

Paddy Marketing Board, Statistical Bulletin, Colombo, Sri Lanka, 1978.

Pevera, H. E. M., ed, Survey of Re-Processing of Ration Rice In Sri Lanka, Paddy Marketing Board, Colombo, Sri Lanka, 1975.

Phillips, Richard, Leonard W. Schruben, and Joe M. Tiao, User's Guide to Computerized System for Feasible Agribusiness Development, Food and Feed Grain Institute, Kansas State University, May, 1975.

Trimac, Consulting Services LTD, Sri Lanka Railway Assessment Study. Prepared for CIDA. Canada, 1976.

Yoshimura, H., ed, Some Aspects of Paddy and Rice Marketing in Sri Lanka. Agrarian Research and Training Institute, Colombo, Sri Lanka, 1975.