AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

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Batch #31

1. SUBJECT CLASSIFICATION	A. PRIMARY Agriculture	AE10-0000-0000
	B. SECONDARY Agricultural economics	

2. TITLE AND SUBTITLE

Economic and computational processing of the recursive linear programming component; consulting report based on a field trip to Korea,1974

3. AUTHOR(S)

Bauersachs,Friedrich

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1974	31p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Mich.State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER PN-AAB-763	11. PRICE OF DOCUMENT
12. DESCRIPTORS Korea Rep. Linear programming	13. PROJECT NUMBER
	14. CONTRACT NUMBER CSD-2975 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

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CONSULTING REPORT

ON

ECONOMIC AND COMPUTATIONAL PROCESSING OF THE RECURSIVE LINEAR PROGRAMMING COMPONENT

Based on a Field Trip to Seoul, Korea

May 25 - July 22, 1974

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Korean Agricultural Sector Simulation Project

(USAID Contract No. AID/csd-2975)

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July 1974

Contents

Introduction

This report gives a survey of my activities in the Korean Agricultural Sector Study (KASS) team from May 25 to July 22, 1974.

First of all, some topical economic and computational problems are described and some appropriate solutions recommended which may support the future work of the KASS project. Additionally, some general remarks are enclosed on the operationality of models for policy analysis. These general notes may be useful to progress in the operationalization and generalization of the present empirical approach for quantitative sector analysis of agriculture in growing economics[1/].

1. Objectives and Job Definition

A pressing objective of the Korean Agricultural Sector Study (KASS) project at present is to demonstrate the ability of the KASS approach to support agricultural planning activities in Korea in the short and long run.

In the first period of the KASS project (1971-1972) a computerized simulation model was implemented and empirically used to analyze the agricultural development in Korea under different assumptions for the period from 1971 to 1985[2/].

1/ In this general part I refer to my own plans and current work as a member of the Central Coordination and Computing group in an interdepartmental economic research project in West Germany. Within the project "Interregional Competition of Agricultural Locations" (sponsored by the German Research Foundation (DFG)) an interregional and intertemporal large scale model is being established on different aggregative levels. It is designed for future use as an operational and permanent information system for scientific and practical analysis of the agricultural sector.

2/ The theoretical and empirical background and the most important results of this research phase are reported in Rossmiller et al., Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, Agricultural Economics Research Institute, Ministry of Agriculture and Forestry, Seoul, and Department of Agricultural Economics, Michigan State University, East Lansing, 1972.

In the present phase a series of model extensions and refinements have been developed and are now being implemented to generalize the empirical approach. In the second half of this phase the general status of the central operationalized KASS model can be described as follows distinguishing four different model components:[1/]

(i) The Basic Korean Agricultural Simulation Model (KASM).

The computerized version of this basic model is the quantitative component for the KASS recommendations in the report of the first research phase (see Rossmiller et al., 1972).

A programming version of this model consists of a series of computer programs which are technically and empirically linked. This package is designed for UNIVAC 1100 computers and described in detail in an extensive user's manual (Manetsch, T.J. and Carroll, T.W., 1973).

(ii) The Recursive Linear Programming Component (RLP).

An additional developed component contains an interregional recursive linear programming model. This model and its feedback with KASM (see iii) were theoretically and empirically designed by H. deHaen. The early computer version used the exogenously defined prices of KASM. The final version is designed for the direct feedback with KASM and for the simultaneous price determination in a special subprogram (see iv).

The theoretical model (de Haen, H. and Lee, J.H., 1972) and the computerized version (de Haen, 1973) have been described in detail.

(iii) The Feedback KASM.RLP.

A modified version of the original KASM includes feedback linkages to the newly developed RLP component (see ii). The special programming modifications to enable a feedback between the two referred components are described in the RLP User's Manual (de Haen, 1973, pp. 33).

1/ Besides the central KASM the described components were previously designed to be methodically and technically incorporated in the original simulation model. Some additional components (grain management, livestock, etc.) are compiled with regard to the contents of the theoretical KASS concept but are technically separated presently from the central computer model. Therefore they are excluded from this report.

(iv) The Simultaneous Equation Annual Price Adjustment Component (SEAPA).

A second additionally developed component is concerned with the simultaneous price adjustment of agricultural commodities within the KASS project. L.D. Teigen developed a theoretical approach using a simultaneous equation system. The computerized version of SEAPA has been programmed and empirically tested separately from the central KASM in the initial phase. SEAPA will be included in a slightly modified version of the existing DEMAND routine of KASM without changes to the feedback facilities (see iii). The theoretical model has been described in detail by L. D. Teigen, 1973 and 1974.

In the view of this initial situation the general purpose of my participation in the KASS team for the last two months was:

Firstly, to make operational a technically and empirically linked version of the central model including simultaneously the KASM, RLP and SEAPA components.

Secondly, to analyse and initiate further economic and computational development of the integrated model as an useful tool for quantitative analysis of agricultural policy strategies emphasizing the RLP model.

Certainly the execution of the first field can not be separated from a series of simultaneous investigations into the second field to keep the model integrated.

2. General Aspects of the Incorporation of Additional Model Components

The incorporation of any additional model component to the existing and implemented model version of KASS has to be generally considered under the following viewpoints:

- the additional economic improvement of the analytical model
- the data demand
- the technical and personal capabilities for the implementation
- the economic and technical impact on other model components and the integrated model being the central basis of operationality

- the impact on the flexibility and clearness of the model structure including the use of existing literature and manuals

2.1 Economic and Computational Considerations

2.11 Economic and Computational Interrelations in Quantitative Analysis

An evaluation of the economic and computational interrelations in quantitative economic analysis has to favour the economic positions beyond dispute. However, at present quantitative economic analysis using comprehensive models is combined with computer techniques. Economics and computer techniques should keep a balance between empirical objectives, available data, model structure and computational facilities to produce economic results efficiently.

The most pretentious economic model is not useful for any practical policy analysis if it is:

- inflexible in the empirical structure and numerical content due to unexpected changing policy parameters and problems
- unavailable within a proper time period which is in policy making more often too short for conventional scientific analysis in quantitative terms.

On the other hand any computerized model can only be accepted by practical policy decision makers and their consultants, if there is:

- a fundamental theoretical structure of the economic model and
- a founded data basis for empirical investigations and comparisons.

If one of these conditions is absent or unreliable, the policy-economic problems are insufficiently treated in this view.

2.12 Significance of the RLP and SEAPA Components for the KASS Project

Implementing the RLP and SEAPA models in the KASS situation can be evaluated under the following viewpoints:

(i) In connection with SEAPA the RLP represents important and necessary economic improvement of the KASS project. The additional endogenous determination of economic variables becomes possible by means of these components. In particular the interregional and intertemporal factor allocation in the agricultural sector can be analyzed due to:

- factor capacities (acreage, capital, labor),
- production functions (natural resources and production techniques),
- product and factor prices on the national and local market;
- agricultural policy measures and
- farmers and consumers behavior.

In this way endogenous quantities and values can additionally be derived to described e.g., changing income situations or physical balances for products and factors 1/.

(ii) Under the computational viewpoint the RLP component introduces new dimensions into the original design of the computerized KASS model. Necessary model generation routines, feedback linkages, extended overlay techniques, optimization algorithms and additional output routines are technically and empirically enlarging the model structure to extraordinary complexity.

Therefore the incorporation of the RLP model into the existing KASS model takes necessary again an elementary analysis of the operational consequences.

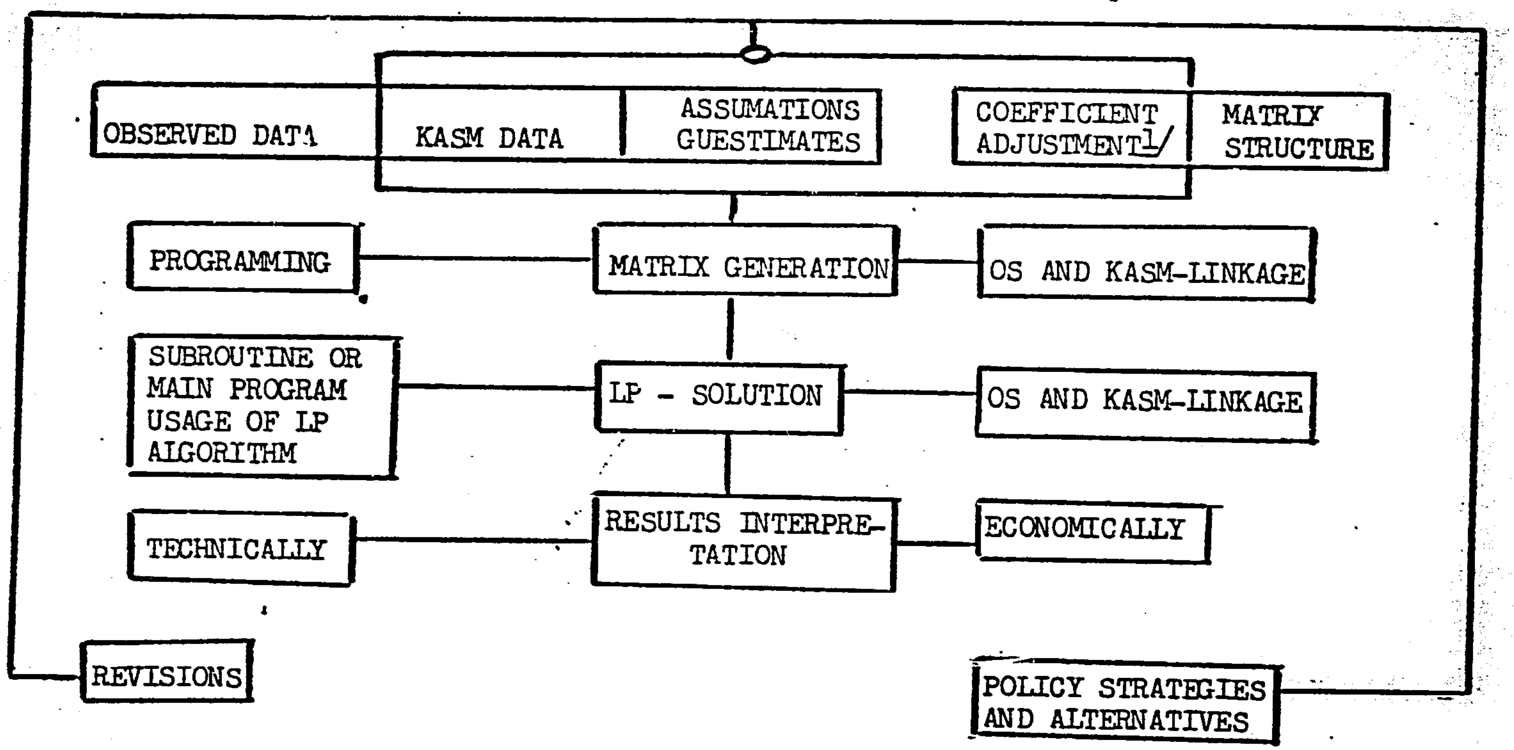
2.2 Elementary Activities for the Implementation and the Refinement of the RLP Component

2.21 Summarizing Survey

The empirical and theoretical problems concerning the RLP component are pointed out in figure 1. There are two different problem fields:

1/ For detailed description see: deHaen, H. and Lee, J.H. (1973); Teigen, L.D. (1974); and the literature referenced therein.

Figure 1: Survey of General Problems of the RLP Component



1/ Including price adjustments.

- The basic data field. It includes directly observed data as well as data produced by the KASM routines needed by the RLP model for each period t_i.

- The coefficient adjustment and matrix structure fields. It includes consistency check of input-output ratios as well as the problems of adequate aggregation level. Furthermore it includes economic problems of formulating relevant and complete agricultural farm activities and endogenous price response due to supply change.

A series of computational problems corresponds to these empirical and methodical problems:

- The generation of a complete and appropriate formatted matrix including unavoidable programming and linkage problems.

- The problem of the mathematical solving of the RLP model. It includes the choice of the most appropriate LP algorithm being available either usable as a subroutine within the KASM overlay system or as a main program forcing an additional iterative computation via operating system linkages and external storage of preprocessed information.

- Finally it is important to provide technical interpretation routines to analyse the RLP results economically in an efficient way. From the technical viewpoint appropriate routines like plotting and tabularizing etc. should be developed. From the decisive economic viewpoint the interpretation of the results has to be considered primarily as a matter of producing additional information for checking data, model structure, matrix generation and solving tricks. Depending on the actual quality of the model the results can be used as preliminary or definite output to evaluate policy strategies.

2.22 Characteristics of LP-Packages

Some systemizing information on the practicability of different LP packages is compiled in figure 2. The test and the selection of the appropriate LP packages are the most important computational problems to be solved implementing the RLP component. However, in many cases the

Figure 2: Some Characteristics of Different Categories of LP-Packages for KASS Usage

	LP-Packages Usage as				
	SUBROUTINE		MAIN-PROGRAM		
	DULPDX[1]	APEX I	OPTIMA	LP 08	OTHERS
1. present availability and compatibility	all FORTRAN V compilers	only CDC computers	only CDC computers	company restricted	only 1100 Univac computers
2. time consumption	high	low	low	low	low
3. max. matrix-size in rows	150	1500	4094	under OS[2]	up to 16000
4. implementation into KASM	easy	easy	under OS[2] control	under OS[2] control	under OS[2] control
5. utilities (input, output)	restricted	sufficient	many	many	many
6. presumed math. level (solving accuracy)	(low)	high	relatively low but sufficient	very high	like Optima
7. evaluation under long run aspects	good, but to company and model size restricted		without company support	very flexible but company restricted	

1/ DULPX = Single precision version, no special experience except accuracy problems with starting models.

2/ OS = Operating system of the computer.

decision on this question is predetermined by the given conditions of computer type and software availability. In view of this fact it is useful in the present phase to show the important characteristics of different LP systems which can be applied in the KASS project.

In general the problem packages for the mathematical solving of linear programming problems can be classified into two main categories. It depends on the character of the LP packages to be suited for the use as a callable subroutine within a user oriented program system or as separate main routine with external information reference.

The most interesting characteristics of the LP packages have been summarized in figure 2. The result shows that the variety of the package quality is very high. Therefore any decision has to be considered under the special aspects of available time, computer staff capacity and the empirical problem definition. Additionally, figure 2 shows that the LP-packages does not have to be an important restriction for the empirical work if the elementary qualities of the different packages are known and the appropriate adaption will be taken into account starting the empirical work.

3. Special Aspects of the Initial Status of RLP and SEAPA

3.1 Economic Status and Operational Conditions

The basic computational conditions have been the most important reasons for an evidently inflexible initial status of the operational KASS model. As I evaluate the situation the following reasons should be mentioned:

(i) Insufficient and incompleted clean-up of the original version of the KASS model.

Although intensive clean-up actions improved the KASS package technically in the last year, no break-through was achieved towards enlarged operational flexibility.

(ii) Numerous organizational and technical problems on the KASS project.

The general shortage and the foreseeable replacement of a programmer as well as the restricted access to computer and basic programming facilities (terminal, key-punch) may be reasons that a new basic concept could not be initialized and realized. Especially the casual access to the UNIVAC computer at the National Computer Center (NCC) may not have encouraged the elementary reorganization of the model.

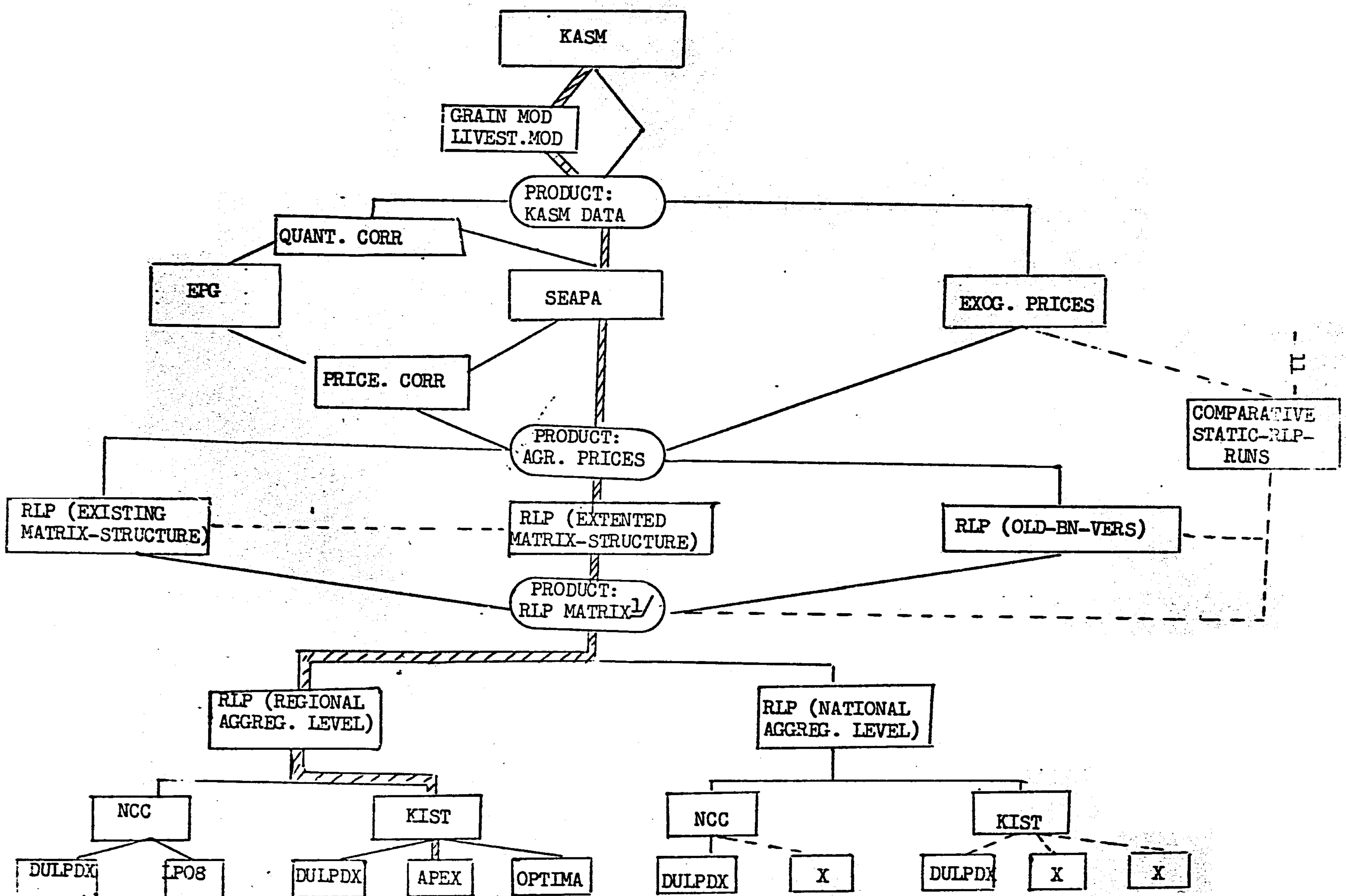
In view of these computational conditions, the economic status of the operational KASS model stagnated because of the computational and economic imbalance (see section 2.11).

In detail, at the end of May 74, it was not even possible to get a complete run of the KASM.RLP version with exogenous prices because of computational difficulties. Furthermore, the core capacity of the computer at NCC was totally exhausted. The SEAPA-model was theoretically designed and programmed but the empirical tests separately done besides the central KASM.RLP model were unsatisfactory because of numerical problems and gaps in the empirical model.

Under these conditions it seemed to be more efficient to try different alternatives in order to restart running the implemented model version and to initiate some basis activities towards enlarged operational flexibility. This operational flexibility is the most important stipulatior to realize economic concepts.

In the initial phase of my work with KASS a series of technical and methodical conditions were uncertain. Therefore, a broad approach of

Figure 3: KASM and RLP - Linkage and Application Alternatives Under the Given Condition



1/ Flexible aggregation version.

these objectives should not be achieved completely but alternatively to minimize the risk of a dilemma. An explanation is given in the next section.

3.2 Linkage and Application Alternatives

The programming level of the KASS package is different at the two accessable computers at NCC and KIST[1/]. Therefore, the alternatives planned for the short run most consider this fact. Figure 3 shows logic alternatives regarding the current status of the KASS package at the end of May 1974. It also shows in detail the branches which could lead alternatively to a satisfactory solution of the empirical problems. It is not to be necessary to discuss in detail the work alternatives shown in figure 3. In any case the desired line runs from the start to the end in the feedback KASM version using the basic information and routines of KASM as well as the complete RLP model which has access to simultaneously adjusted prices of agricultural products.

Figure 3 shows that the way to the final phase can presently be reached via different alternatives which have some remarkable characteristics. In accordance with the balance of computational and economical aspects mentioned in section 2.11; all alternatives have different comparative advantages in regard to the current situation and realized working phase.

1/ The National Computer Center (NCC) uses a UNIVAC 1106 computer. The Korean Institute for Science and Technology (KIST) uses a CDC Cyber 70. The access to the NCC computer is restricted to one time a day but not charged. The access to the KIST computer is free but charged.

In particular some special points have to be explained.

The operational model is producing intermediate results on three levels:

(i) On the first level a series of KASM and RLP generated data are calculated to generate the basic information for SEAPA.

(ii) On the second level the simultaneously adjusted prices for agricultural commodities are produced as the final results of the price adjustment routines.

(iii) On the third level the complete RLP matrix is generated and prepared for the mathematical solution. The definite results of the total KASM.RLP component can be produced there. On this stage two empirical steps can be distinguished additionally: Firstly, the step which uses the existing matrix structure and secondly, the step in which the presently designed matrix structure will be extended.

The main problems in the empirical work are therefore the price adjustment mechanism, the RLP matrix extension and the efficient solving of the RLP model without restricting the operational and economic flexibility of other components.

The price adjustment complex: To guarantee a short run empirical solution of the simultaneous price adjustment, two different approaches are available: the SEAPA model and a special subroutine (EPG) which is methodically designed and programmed by H. deHaen. The SEAPA and the EPG routine have been in the test phase and have been expected to produce faultless adjusted prices for the use in the RLP model. Special flexible linkages must be provided to admit the alternative use in different test runs, which are necessary because of the preliminary character of this routines in the early phase. Furthermore, specific features have been provided to control exogenously the flow of quantities (QUANT.CORR.) and prices (PRICE.CORR.) in order to avoid extreme and unreasonable (for example negative prices) values during the test phase with preliminary elasticity coefficients and give the opportunity to close the gaps of both models regarding unrealistic price response because of insufficient consideration of substitution effects and political control in extreme cases. The pressing theoretical and empirical problems are analyzed in the papers of L.D. Teigen and H. deHaen on simulatneous price adjustment.

<u>The matrix coefficient and structure complex</u>: The current RLP model was designed by H. deHaen under the restrictions given by computer core limitations and data lack. It is useful to extend the current approach especially in the fields of capital, labor hiring and migration (depending of opportunity costs), factor input refinement (fertilizer application and yield response, fuel use) and improved activity aggregation. The implementation of these structural refinements is only possible on the basis of a given technical flexibility. For details see 3.

<u>The LP solving complex</u>: The callable subroutine DULPDX is applied as LP package to solve the RLP model. This subroutine is very intensive in its core requirements because of the double precision storage of the RLP matrix in the internal core of the computer. The higher flexibility which is absolutely necessary to emphasize the economic

analysis can be achieved by subroutitution to another appropriate LP-package or the compression to the remaining KASM and RLP routines. The definite decision in this field is depending on the computer type. Figure 3 shows the alternatives given in this field presently at KIST and NCC.

3.3 Special Work Plan for the RLP Component

A survey on special activities concerning the economic refinement of the RLP component is given in figure 4. There has been pointed out in which way the preliminary results of test runs can efficiently be used for the different questions. The combination in this way permits an intensive use of current results.

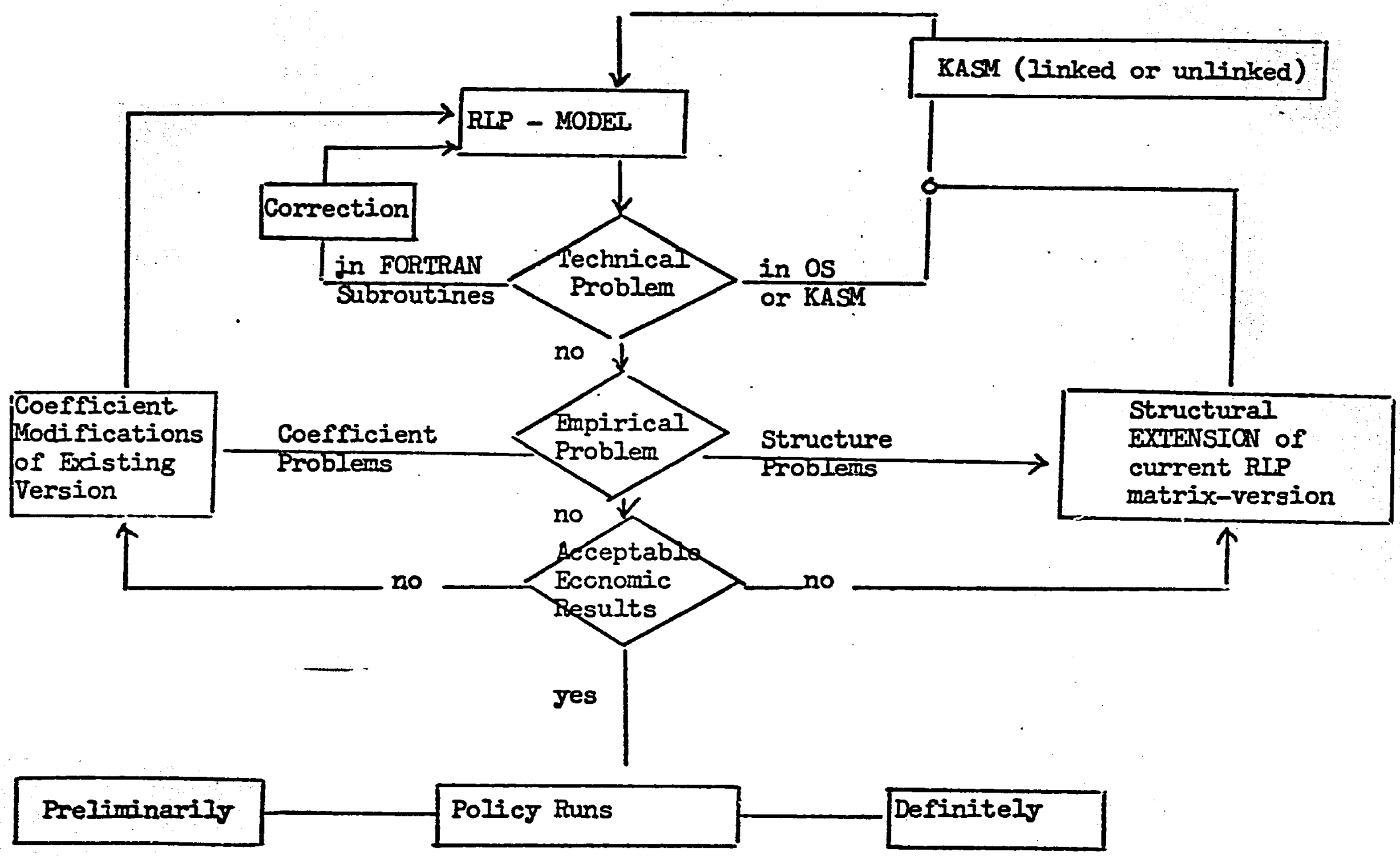
In detail the following fields should be considered in the structural matrix extension complex:

- capital
- fertilizer yield relations
- labor (seasonal workers, economically induced migration)
- mechanization
- activity and restraint aggregation

H. deHaen has made some detailed suggestions to this complex in his last consulting report from March 1974.

As this questions are concerned with the empirical structure of the matrix, additional concepts should be developed to prepare a better and detailed preparation of the results. In particular it is necessary to operationalize the production cost analysis using exogenous and endogenous results of the RLP model.

Figure 4: Special Working Plan for Handling the RLP Component



An exemplified model on the national level should be formulated in order to facilitate the empirical test of different matrix structures.

Finally special provisions should be made to have the opportunity for consistency checks of the total matrix or submatrices.

4. Present and Future Aspects on Implementing and Refining of the KASM.RLP

4.1 The NCC version of KASM.RLP

After being sure of the unavailability of APEX and the incompleteness of the transferred model to the KIST computer emphasis has been put on the NCC version of KASM.RLP. In spite of the organizational and operational disadvantages, the NCC version of KASM.RLP is the most developed one. This version is now in the state of being prepared for complete runs of KASM linked with RLP and the price adjusting routines. Unfortunately the both available routines SEAPA and EPG didn't start to work satisfactorily in connection with the RLP. There are a few sources of weakness:

Firstly, the SEAPA and EPG routine are showing problems due to the numerical values of the used elasticity coefficients. Furthermore they are not empirically tested within a system of price elastic supply. Therefore the work with KASM.RLP using SEAPA or EPG alternatively could not be satisfactorily finished up to July 74.

Secondly, the cleaned-up version of the RLP showed numerical inconsistencies compared with statistical and KASS results for 1971. Different mistakes could be found and corrected. It can be supposed that changes are necessary in the case of great differences in the results (see figure 5).

Figure 5: Data Comparisons between KASS, RLP and Published Statistics

	KASS 1971						RLP 71			Stat. Yearbook 1971			IBRD 1971
	TDSUP	RDM	Farm Loss	Gross Output	Acreage	Yield	Gross Output	Acreage	Yield	Gross Output	Acreage	Yield1/	Gross Output
Rice	1,343.0	1,746.0	713.6	3,961.0	1,231.0	3.218	4.105	1,275.0	3.219	3.998	1,200.0	3.333	3.998
Barley	434.2	1,381.0	247.5	2,063.0	954.0	2.162	1.811	833.8	2.172	1.857	839.4	2.212	1.857
Wheat	-136.1	476.2	37.8*	377.9	170.5	2.217	310.8	140.2	2.217	322	143.4	2.252	322
O. grain	34.6	88.9	13.7	137.2	137.2	1.000	107.0	107.0	1.000	127			
Fruits	322.5	95.2	73.7	491.5	64.4	7.637	191.5	56.4	8.719	404	55.3	7.305	
Pulses	164.8	111.1	14.5	290.5	374.4	.776	246.5	317.7	.776	262			
Veget.	1,370.0	825.4	387.5	2.583	247.4	10.70	2,823.0	263.8	10.700	2.998?	257.2	11.656?	
Potato	478.5	285.7	84.9	849.2	205.5	4.133	772.2	186.9	4.133	589*	164.6	3.528	
Tobacco	62.6	0	1.9	064.5	41.0	1.574	76.7	48.8	1.574	63	41.0	1.537	
Forage	0	0	0	0	0	0	0	0	0	0	0	0	
Mulberry	23.0	0	.2	23.3	101.4	.229	18.7	81.4	.229	24.7	81.3	.304	
Ind.	82.1	0	2.5	184.6	88.0	.962	78.8	82.0	.962	81	90.6	.890	
Beef	37.3	3.2	0	40.4			50.8						39.5
Milk	42.3	6.3	2.6	51.2			79.0	18.5	4.270	65.3	30.1		65.3
Pork	60.9	23.8	0	84.7			145.1	265.1	.547				89.6
Chicken	46.2	8.6	0	54.8			20.7	25.002	83				50.0
Eggs	103.1	34.1	7.2	144.4			116.1	16.855	688				139.5
Fish	542.3	158.7	0	683.0			683.0						–
Res. agr.	150.5	79.4	7.1	237.0			237.0						–

* Unhulled
1/ Calculated.

For example, the livestock production activities should be analyzed carefully. Probably the loss rates or the yields differ with the statistical data. Unfortunately comparable statistical data didn't exist in the appropriate aggregation level to complete these checks. Appropriate data collections and aggregations have been initiated.

Thirdly, the present structure of the RLP matrix includes flexibility constraints for almost all products except a lower limit for rice. The preliminary results of the NCC version of KASM.RLP showed that a lower restriction for rice production is useful, too. Furthermore unused paddy-land should be available for the production of other commodities in low price situations of rice.

These examples of weak points in the NCC version are not exhaustive but indicate where additional refinements can be introduced in order to obtain more operational flexibility.

In the case of proper use the flexibility constraints can replace the QUANT.CORR section in the price adjusting routines, of course. Certainly, in the present test version the handling of QUANT.CORR may operationally be easier.

The current KASM.RLP version has been modified in different sections.

Firstly, evident programming and logical mistakes have been corrected if they impaired the processing. The corrections have been documented in the listing folder of the NCC version.

Secondly, an additional improvement of the output analyzing routine of the RLP has been implemented to aggregate the regional results to improve the solution analysis.

Thirdly, the SEAPA and EPG has been implemented. EPG had to be modified for use in the feedback system of KASM.RLP. The original version sent from Bonn in designed for separate use and cannot directly be implemented in any other feedback system.

Summarizing the state of the NCC version of the KASM.RLP, the conclusion is that this version integrates economically and technically the important components for long run analysis. The NCC version will bound minimal programmer capacity and allow some efficient improvements than the KIST version, strengthening the initiated effort to save core by excluding second-rate routines and/or testing the single precision DULPX as solving algorithm. The organizational conditions at NCC being more complex than at KIST, there are not relevant disadvantages under this viewpoint.

4.2 The KIST Version of KASM.RLP

The NCC version of the KASM.RLP has been transferred to KIST in card form. Unfortunately the transferred version is out-of-date and only partially implemented up to now. Especially the RLP component is in an useless status. Tests could not be made with the linked KASM.RLP version.

Using the efficient organization at the KIST computer center some concepts are developed to initiate additional implementing and refinement activities in future under generalized viewpoints.

4.3 Using of the OPTIMA LP Package in the Current KASM.RLP Version

OPTIMA could not be empirically tested as LP solving package in view of the nonoperational KASM.RLP version for the KIST computer. A program has been prepared (LPRUN.OPTIMA) and can be implemented in the sburoutine LPRUN before the CALL DULPDX statement to produce a OPTIMA formatted matrix. Additional activities are necessary on different levels:

- the MAIN routine of KASM.RLP has to be separated in different main routines which can be called after any optimization step. The interruption of the old MAIN routine has to be made at the call of LPRUN.
- according to the reorganization of the MAIN routine the subroutine LPRUN has to be divided into two parts. The first part runs up to the CALL DULPDX statement. It will be the last section of MAIN 1. The program section behind the CALL DULPDX statement will become the first part of MAIN 2. MAIN 2 will separately be called after the first optimization period in KASM.RLP.
- the split of the MAIN and LPRUN routine requires an external information transfer between the two parts of KASM.RLP which enclose in each period the OPTIMA routine.
- an example of appropriate control cards to implement OPTIMA in this way is given in the program example OPTIMA.-GLEMPS (see 4.41). In this routine also is exemplified how OPTIMA generated information can be transferred to the KASM.RLP routines establishing the feed-back.

4.4 Additional Concepts

4.41 Integration of FORTRAN Generated Information and OPTIMA Feedback (OPTIMA.GLEMPS)

An integrated program package has been exemplified to integrate

- matrix generation with a FORTRAN routine[1/]
- utility routines of OPTIMA
- BASIS insertion
- optimization
- output analysis of OPTIMA runs for feedback purposes and separate direct economic cost analysis

The complete package exists in card form using a very simple LP example for demonstration. The structure of this program is so uncomplicated that an application can be made to any LP problem with a few problem specific extensions

4.42 Aggregated National LP Model

An aggregated LP model for the Korean agricultural sector has been prepared.

In a first attempt a national version of the RLP matrix of KASM.RLP was aggregated by individual procedures from the TTY. Keith Olson used the initial data sets of the RLP to generate the matrix. As it is known the first period matrix of the RLP component is a direct extract of data files. The aggregation functions are very simple in this case: weighted averages of the regional objective function values, addition of the regional constraint vectors and direct transfer of the matrix having the same structure in all regions.

This version of the national matrix could not be solved with DULPDX at KIST. Tests with the modification of tolerances have been not successful up to the end of my stay.

1/ The implemented matrix generation routine is not very efficient because of the core use is directly dependent of the matrix size. General systems like GLEMPS don't have this restriction.

A card version in OPTIMA format was developed on the basis of the mentioned version to evade the problems mentioned above. This version has been extended by additional matrix sections in the labor section. A product balance section with import and export activities was has been added. Unfortunately this version could not be brought in a final form because of the urgent problems on other fields. Nevertheless special problems of agricultural policy can be analyzed in a comparative static way with this model. It is very easy to transfer the coefficients of this model into the OPTIMA.GLEMPS to have a more efficient handling of input and output (see 4.41). This model can also be prepared for the integration with SEAPA or EPG to simulate price elastic supply response. The transfer of all RLP functions is not necessary in the first step. Single feedbacks (prices) are sufficient for testing. In this way a lot of programming input can be saved in the initial phase. A successive extension is the best. In addition to this applications the national version can be used to design and test a reorganized operational version of KASM.RLP.

4.43 <u>The Interregional Programming (IPM) Model</u>

Besides my negotiation with KASS I worked together with a team of the Production Economics Division of NAERI. This team has established an interregional competition model of the agricultural sector in Korea.

In two memorandum the problems have been analyzed and recommendations have finally been given[1].

The IPM team has handling problems at present. On the contrary the model is highly disaggregated and uses detailed information of production

1/ Memo dated June 5, 1974 to KASS staff; memo dated July 20, 1974 to Dr. Dong Hi Kim.

techniques which can be used for refinement of the numerical content of the RLP. It is useful for KASS and IPM to cooperate more intensively at least in collecting and establishing a data base and operational handling of the model. Detailed evaluation can be taken from the memorandums mentioned above.

5. Summary of Recommendations

(1) Basic interrelations in quantitative economic analysis: Quantitative economic analysis using comprehensive models has to consider the interdependencies of empirical objectives of the study, operationality of the model and the data basis. In the face of existing empirical objectives of KASS the following statements and recommendations can be given.

(1.1) General Operationality: The present status of the operational KASS model shows an imbalance between the computational and economic fields disfavouring the economic evolution towards the empirical objectives of KASS.

(1.11) Flexibility: The present design of the operational KASM.RLP model is more complex than necessary in the view of its economic results. Therefore economic improvements and enlargements are negatively impaired by insufficient operational flexibility.

(1.12) Generalization: Future efforts have to be made to enlarge the flexibility of the operational model. Flexibility can be achieved by generalization of the operational model. Future programming efforts

should be combined with an elementary new design of the used operational packages. The most important objective of this task should be to range the different main - and subcomponents due to their significance for the final objectives of the analysis.
In the concrete case it should be distinguished clearly between routines which are economic submodels and routines which are nothing more than neutral information handling subprograms. The present mixture including data definition is unsatisfactorily and prohibiting the current handling and development towards a generalized approach.

(1.2) Data basis: A urgent problem in the KASS work is the existence and the management of a founded data basis: It is necessary to extract the current data used in the models and put them into a separate data bank. In this way the operationalization of the economic approach can be generalized. Furthermore the flexibility of the program package can be improved. Finally an explicit data basis can be used for separate data analysis to investigate special problems, checking and interpreting model results, and last but not least to be improved quantitatively and qualitatively.

(2) Processing of the NCC Version of KASM.RLP. The NCC version of the KASM.RLP model has some technical and economical weakness in its present status. Expecially, the simultaneous price adjustment components doesn't work. Nevertheless, the NCC version is the only one integrating the most

components. Therefore, this version should be maintained as long as no technical version is available having at least the same standard.

(2.1) Core requirements: The NCC version exhausts the core capacity of the UNIVAC 1106 computer. Temporary elimination of some unimportant routines of the KASM is one way towards more flexibility. Furthermore a separate generation of information using no feedback information of RLP should be provided. Additionally, the replacement of the DULPDX routine based on double precision storage should be initialized. The implementation of the single precision version DULPX instead of DULPDX should be tested. In the face of the enormous advantages it is recommended to contact immediately the UWCC in Wisconsing for support instead of arbitrary tests of different tolerance parameters.
Finally, the overlay structure of KASM.RLP should be improved expecially in the B and C branches. Eventually, some uncomplicated reorganizations of programs used there will enlarged the capacity to empirical economic modifications.

(2.2) Output organization: The formal shape of the most output routines producing the model results for economic interpretation is extremely complex and unsystematic. The interpretation of the results for technical and economic analysis taxes most of the patience and energy of analysts to collect relevant information in regional and temporary order. A generalized output generator can reduce the quantitative extend of the KASM.RLP enormously without impact to the economic quality of the model.

(2.3) Operationaly in the test phase: A general problem is the question of unavoidable use of the total KASS model including KASM and RLP for all empirical test purposes. I recommend a uniform program set on a basic storage level to avoid more risky and time consuming program modifications. But I recommend to establish a series of different main routines, which should be designed for different purposes.

(2.4) Data basis: The existence of a founded data basis is an elementary condition of quantitative economic analysis. The data basis should have following characteristics: comprehensive, aggregatable, documented, operational, reliable, reformable.
The KASM.RLP is based on the data collected for the original KASM. These data should be checked and reorganized.

(2.5) Economic refinements of the RLP structure: The most important modifications concerning the structure of the RLP are described by H. deHaen. Some suggestions should be added concerning the structure of the matrix.
In the case of enlarged operational flexibility all matrix activities should be restricted by formal flexibility constraints. Decisions on the numerical values of the flexibility constraints should be dependent of the concrete empirical objective (consistency analysis, test of the price adjustment routines, long run analysis). So far, the numerical value of the flexibility constraints has to be controlled exogenously in a flexible way.

Besides the present handling of flexibility constraints it has to be considered a ranking of the maximum and minimum levels of the activity levels. It is useful to formulate flexibility constraints for aggregates with subrestrictions to give more economic freedom degrees for the quantitative analysis in special cases. By these aggregated restraints activities can be restricted only so far as no internal substitutions within the aggregate are possible (for example the aggregate grain constraint is restricting the activities wheat, barley and other grains or cattle enclosing dairy cows, beef and draft cattle etc.).
The conditions representing the rotation of crops should be reformulated. In the view of production techniques a more flexible substitution is possible within crop production than formulated in the present model by summer and winter upland. Furthermore the paddy land must, be included in this acreage substitution mechanism.
From the numerical point of view the input-output relations have to be checked to be certain that correct quantities are transferred into the simultaneous price adjustment program. This price adjusting submodel transfers the present RLP model from a open system of supply and prices into a closed system in which economic equilibrium exists of supply, demand and prices for all commodies. Under the conditions of this generalized equilibrium the consistency of the coefficients is important for the market model as well as for the production model.

(3) <u>Processing of KASM.RLP at the KIST computer</u>: The transfer of the operational KASM.RLP model from NCC to KIST is not possible without

comprehensive programming input. Therefore the transfer of the total package should be done with low priority. In face of the status of the NCC version short run improvements can be done at NCC considering the suggestions made above. The main activities at KIST should be concentrated on testing new and reorganized components avoiding the weakness of the old NCC version.

(3.1) National LP model: Using a card version of a national aggregated LP model a flexible generated national LP model should be built. It can be used for comparative static economic analysis as well as for matrix structure tests and testing SEAPA or EPG. It is recommended to use OPTIMA as LP package.

(3.2) OPTIMA implementation: When reorganizing the KASM.RLP at KIST, the implementation of OPTIMA as a LP package should be considered. The examplified system OPTIMA.GLEMPS shows how this can be done.

(3.3) Cooperation with the Interregional Programming Model (IPM) team: Cooperation with the IPM team should be intensified. The KASS team can give support to the IPM team to handle the comprehensive regional model. The IPM team can support the KASM.RLP by giving informations on production conditions and other data.