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INFLUENCE OF CROP PRICE CHANGES ON CROP AND  
LIVESTOCK PRODUCTION IN KANSAS USING A  
LINEAR PROGRAMMING MODEL

by

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CHAPTER I  
INTRODUCTION

The Kansas Water Resources Board in cooperation with the Kansas Agricultural Experiment Station funded a study of the "comprehensive study of the effects of altering the precipitation pattern on the economy and environment of Kansas." (Project 5-425) A eight region LP-Model of Kansas Agriculture (KAM) is one part of this project. The formulation of KAM (Appendix 1) shows the structure and interdependences of agricultural production among eight regions, its goal is to maximize the net farm income for Kansas.

Testing and primary studies with KAM have been done<sup>1</sup>. The first part of this paper is an application of KAM to test the influence of changes in crop prices on crop and livestock production in the eight regions of Kansas. The underlying LP-problem matrix, to start with, is assumed to be feasible. The general model structure and the changed crop prices will be described, but it is not the scope of this paper to describe the underlying data.

Second part of this report is a description of two computer programs; the Mathematical Programming System Report Generator (MPSRG) and a Program to print MPS-Formal equations. The latter was developed at the Swiss Federal Institute of Technology and both have to be briefly described to enable further use by researchers at Kansas State.

The general outline of this paper is as follows:

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<sup>1</sup>Buller, O. Unpublished work Kansas State University, Department of Economics.



- a) Chapter two gives a general model description of KAM. The complete equation listing will be found in Appendix I.
- b) Chapter three shows the selection process for the underlying crop prices in this report.
- c) Chapter four describes and interprets model results. The reports with the complete listing of the model results are given in Appendix III through VII.
- d) Appendix II and VIII explain the two computer programs.

## CHAPTER II

### MODEL DESCRIPTION

#### GENERAL MODEL DESCRIPTION

Figure 1 shows the general structure of the model. There are five major model parts within each region, they are as follows:

- 1) resources available for land, labor, field-work days, and feed-lot capacity
- 2) production of crops and livestock products
- 3) land, labor, field-work day, feed and capital required
- 4) transportation of feed and livestock among regions
- 5) objective function

For each of the eight regions the hours of labor available is specified for each of the six, 2-month periods. Labor hours available is used for either crop or livestock activities. Another set of 4 equations specify field work hours available during May, June, September and October. Equations for field work hours do not include labor for livestock activities as it is assumed that livestock activities do not compete with crops for field work time.

Crops considered are wheat, grain sorghum, corn, soybeans, alfalfa, silage, and native hay; in the western regions wheat is considered as continuous cropped, fallow or irrigated, grain sorghum is dryland or irrigated; corn, alfalfa and silage are irrigated.

Crop production is either sold for cash or fed to livestock which are sold. The transportation activities allow alfalfa, native hay, corn and grain sorghum to be sold and transported to any region.

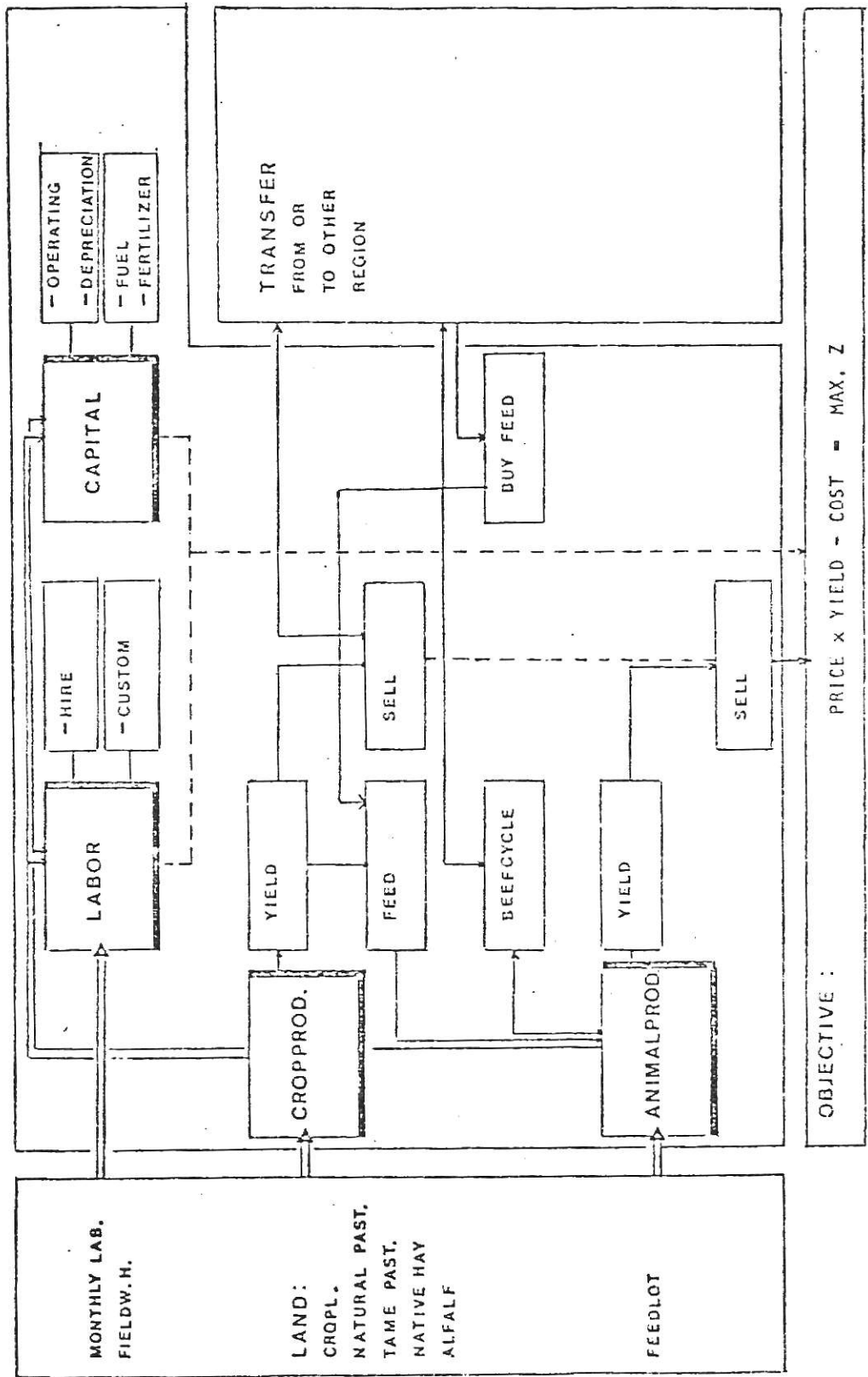


Fig. 1 General Model Structure of KAM for one Region

Livestock production activities are for the systems of beef cow and calf, wintered steer, summer-grazed steer, feeder steers, dairy and hogs. Wintered, grazed and feeder steers can be shipped from any region to all other regions if profitable.

Land, labor hours, field work hours, feed, fuel, fertilizer, depreciation and capital are specified for each crop and livestock activity. In western regions, wheat on fallow requires 2 acres cropland.

The land resource is divided into cropland, native pasture, tame pasture, alfalfa, and native hay. Tame pasture and alfalfa can be planted on cropland, or plowed back into cropland. In western regions, cropland is divided into dryland and irrigated. Irrigation can be developed from dryland cropland.

Operating capital requirements are specified for each crop and livestock enterprise. Livestock capital requirements are specified for each livestock enterprise that involves the purchase of steers. It is assumed that capital required is borrowed and the loan is for six months.

Annual per unit costs of fuel, fertilizer and depreciation are subtracted from income in the objective row by using accounting rows and a transfer column. One common objective function maximizes farm income for all regions.

#### NOMENCLATURE OF ACTIVITIES

All names within a region start with a number referring to the region to which it belongs. For example: 4PHOG means, production of hogs in region four. Transportation activity codes have two numbers, the first refers to the region the activity comes from and the second number refers to the region to which the activity is transferred to. For example:

TABLE 1: ACTIVITY NAMES FOR LIVESTOCK IN DESIGNATED REGION

CODE	DESCRIPTION	IN REGION	UNITS
iPCALF	Beef cow and calf	1, 2, 3, 4, 5, 6, 7, 8	No
iSCALF	Weaning calf sold	1, 2, 3, 4, 5, 6, 7, 8	No
iTWSTR	Weaning calf kept	1, 2, 3, 4, 5, 6, 7, 8	No
iPWSTR	Calves kept thru winter	1, 2, 3, 4, 5, 6, 7, 8	No
iSWSTR	Winter calves sold	1, 2, 3, 4, 5, 6, 7, 8	No
iTGSTR	Winter calves to grass	1, 2, 3, 4, 5, 6, 7, 8	No
iPGSTR	Steers on grass 3 mo.	1, 2, 3, 4, 5, 6, 7, 8	No
iPGSTRFS	Steers on grass 5 mo.	1, 2, 3, 4, 5, 6, 7, 8	No
iSGSTR	Grazing steers sold	1, 2, 3, 4, 5, 6, 7, 8	No
iTFSTR	Grazed steers to feedlot	1, 2, 3, 4, 5, 6, 7, 8	No
iPWFSTR	Wintered calf to feedlot	1, 2, 3, 4, 5, 6, 7, 8	No
iPWGFSTR	Feeder steer	1, 2, 3, 4, 5, 6, 7, 8	No
iBFDSTRA	Feeder steer purchase Nov.	1, 2, 3, 4, 5, 6, 7, 8	No
iBFDSTRB	Feeder steer purchase May	1, 2, 3, 4, 5, 6, 7, 8	No
iPSMILK	Dairy cow	1, 2, 3, 4, 5, 6, 7, 8	No
iPHOG	Sow and two litter	1, 2, 3, 4, 5, 6, 7, 8	No
iFDLOTDE	Develop feedlot	1, 2, 3, 4, 5, 6, 7, 8	No

TABLE 2: ACTIVITY NAMES FOR CROPS IN DESIGNATED REGION

CODE	DESCRIPTION	IN REGION	UNITS
iPWHT	Wheat acres, continuous	3, 4, 6	ac
iPWHTFAL	Wheat acres, fallow	3, 4, 6	ac
iPWHTIRR	Wheat acres, irrigated	3, 4, 6	ac
iSWHT	Wheat bushel sold	1, 2, 3, 4, 5, 6, 7, 8	bu
IPCORN	Corn acres	1, 2, 3, 4, 5, 6, 7, 8	ac
ISCORN	Corn, bushel sold	1, 2, 3, 4, 5, 6, 7, 8	bu
IFCORN	Corn, bushel fed	1, 2, 3, 4, 5, 6, 7, 8	bu
iPGRSOR	Grain sorg., ac dryland	1, 2, 3, 4, 5, 6, 7, 8	ac
iPGSIRR	Grain sorg., ac irrigated	3, 6	ac
iGSIRR	Grain sorg., ac irrigated	4	ac
iSGRSO	Grain sorg., bu sold	1, 2, 3, 4, 5, 6, 7, 8	bu
iFGRSO	Grain sorg., bu fed	1, 2, 3, 4, 5, 6, 7, 8	bu
iPSOY	Soybean, acres	1, 5, 7, 8	ac
iPSIL	Silage, acres dryland	1, 2, 4, 5, 6, 7, 8	ac
iPSILIR	Silage, acres irrigated	3, 4, 6	ac
iPALFH	Alfalf, acres	1, 2, 3, 4, 5, 6, 7, 8	ac
iSALFH	Alfalf, tons sold	1, 2, 3, 4, 5, 6, 7, 8	t
iFALFH	Alfalf, tons fed	1, 2, 3, 4, 5, 6, 7, 8	t
iPNATH	Native hay, acres	1, 2, 5, 7, 8	ac
iFNATH	Native hay, tons fed	1, 2, 5, 7, 8	t
iSNATH	Native hay, tons sold	1, 2, 5, 7, 8	t

TABLE 3: ACTIVITY NAMES FOR OTHER EXPENSES IN DESIGNATED REGION

CODE	DESCRIPTION	IN REGION	UNITS
iHLABFT	Hire full time labor	1, 2, 3, 4, 5, 6, 7, 8	hr
iHLABSU	Hire summer labor	1, 2, 3, 4, 5, 6, 7, 8	hr
ifUELCST	Fuel cost	1, 2, 3, 4, 5, 6, 7, 8	\$
ifFERTCST	Fertilizer cost	1, 2, 3, 4, 5, 6, 7, 8	\$
idePR	Depreciation	1, 2, 3, 4, 5, 6, 7, 8	\$
iOPCAPR	Operating capital reg.	1, 2, 3, 4, 5, 6, 7, 8	\$
iLSKCAPR	Livestock capital reg.	1, 2, 3, 4, 5, 6, 7, 8	\$
ichVWHT	Custom harvest wheat	1, 2, 3, 4, 5, 6, 7, 8	hr
ichVCORN	Custom harvest corn	1, 2, 3, 4, 5, 6, 7, 8	hr
ichVGRSO	Custom harvest gr. sorg.	1, 2, 3, 4, 5, 6, 7, 8	hr
ichVSOY	Custom harvest soybean	1, 5, 7, 8	hr
iBUYFDGR	Feed grains purchased	1, 2, 3, 4, 5, 6, 7, 8	\$
iPFORAGE	Forage acres for feed	3, 4, 6	ac
iIDLECPL	Cropland not used	1, 2, 3, 4, 5, 6, 7, 8	ac
iPLTALF	Plant alfalfa	1, 2, 3, 4, 5, 6, 7, 8	ac
iPLTPAS	Plant tame pasture	1, 2, 3, 4, 5, 6, 7, 8	ac
ideVIRR	Develop irrigation	2, 3, 4, 6	ac

TABLE 4: ACTIVITY NAMES FOR TRANSFER ACTIVITIES IN DESIGNATED REGION

CODE	DESCRIPTION	IN REGION	UNITS
iTPAST	Tame past. sub. for natural pasture	1, 2, 3, 4, 5, 6, 7, 8	ac
iALF>FOR	Alfalfa used as forage	1, 2, 3, 4, 5, 6, 7, 8	t
iTNH>FOR	Native hay used as forage	1, 2, 5, 7, 8	t
iTNH>WPU	Native hay as winter past.	1, 2, 5, 7, 8	ac
iTFWHM>J	May work delayed to June	1, 2, 3, 4, 5, 6, 7, 8	hr
iTFWHJ>M	June work done in May	1, 2, 3, 4, 5, 6, 7, 8	hr

TABLE 5: ACTIVITY NAMES FOR TRANSPORTATION ACTIVITIES IN DESIGNATED REGION

CODE	DESCRIPTION	IN REGION	UNITS
ALFHk-i	Ship alfalfa from k to i	1, 2, 3, 4, 5, 6, 7, 8	t
FDGRk-i	Ship feed grain from k to i	k and i run	bu
kCALFi	Ship calf from k to i	always from	no
kGSTRi	Ship steer to grass from k to i	one through eight except	no
kFDSTi	Ship wintered steer from k to feedlot in region i	for k = 1	no
kFSTRi	Ship grassland steer from k to feedlot in region i		no

## ABBREVIATIONS USED FOR HIRE LABOR ACTIVITIES:

HIRELAB1	Hire full time labor
HIRELAB2	Hire summer labor



7 CALF 3, means 'ship a calf from region 7 to region 3,' correspondingly, the same holds for alfalfa hay: ALFH 7>3.

## GENERAL EQUATIONS

A basic knowledge of the general structure of the KAM (Fig. 1) and the generalized equations is sufficient for an understanding of the following two chapters.

The following is a very general outlay of the model equations. They should give an overview, but the complete list of equations is given in Appendix I. It is always assumed:

$i$  = Subscript for  $i$ -th crop or Subscript for  $i$ -th livestock  
 $j$  = Subscript for region  $j = 1, 2, \dots, 8$

The integers for  $i$  can be found in the equation listing of Appendix I. To find which activities for a certain region have zero value, refer to the table "Nomenclature of the Activities" or see also Appendix I.

The following letters are coefficients of the general equations and defined as:

$a_i$  Yield of activity  $i$  per unit  
 $b_i$  Cost of activity  $i$  per unit  
 $c_i$  Acreage use for one head of livestock  $i$  on native pasture  
 $d_j$  Acreage use for dairy cow on tame pasture  
 $e_i$  Labor hours needed for one unit of livestock  $i$   
 $f_j$  Hired labor available for two month periods  
 $g_i$  Hired labor needed per acre of crop  $i$   
 $h_i$  Field work hours needed per acre of crop  $i$   
 $k_j$  Hired field work hours and/or custom work for two month periods  
 $l_i$  Required feed amount per livestock  
 $m_i$  Operating capital per unit of crops  $i$   
 $n_i$  Operating capital per unit of livestock  $i$   
 $o_i$  Price per unit of livestock  $i$   
 $p_i$  Depreciation per unit livestock  $i$  for buildings and equipment  
 $q_i$  Depreciation per unit crop  $i$  for equipment  
 $r_i$  Gain in depreciation for custom work for crop  $i$   
 $s_i$  Required fuel cost per unit of livestock  $i$   
 $t_i$  Required fuel cost per unit of crop  $i$   
 $u_i$  Fertilizer cost per unit of crop  $i$   
 $y_i$  Yield of crop  $i$   
 $z_i$  Percentages used

## A) OBJECTIVE

1. z : Objective

$$\text{Maximize } Z = \sum_{ij} (A_{ij} \cdot \text{Price}_{ij} - b_{ij}) \text{Units}_{ij} - \sum_{ij} (p_{ij} - \text{LIVESTOCK}_j \\ q_{ij} \cdot \text{Acres}_{ij} + \Delta_{ij} - \text{LIVESTOCK}_j + t_{ij} \cdot \text{Acres}_{ij} + u_{ij} \cdot \text{Acres}_{ij})$$

## B) CAPACITIES

2. jCPLD : Cropland-Total

$$\sum_i 1 * \text{CROPAREA}_{ij} \leq \text{jCPLD}$$

3. jPASTNAT : Natural-Pasture-Area

$$\sum_i c_i * \text{LIVEST}_{ij} - \sum_i 1. * \text{TAMEPASTURE}_{ij} \leq \text{jPASTNAT}$$

4. jPASTTAM : Tame-Pasture-Area

$$d_j * \text{D.COW}_j + .4 * \text{TAMEPAST}_j + 1 * \text{PLTTPAS}_j \leq \text{jPASTTAM}$$

5. jNATHAY : Native-Hay-Area

$$1 * \text{NATIVE HAY}_j \leq \text{jNATHAY}$$

6. jALFHAY : Alfalfa-Hay-Area

$$1 * \text{ALF.AREA}_j - 1 * \text{PLANTALF.AREA}_j \leq \text{jALFHAY}$$

## C) LABOR

7. jLAB-J,F: Labor hours-January, February

$$\sum_i e_{ij} * \text{LIVEST}_{ij} - f_{ij} * \text{HIRELABOR}_{1ij} \leq \text{jLAB-J,F}$$

8. jLAB-M,A: Labor hours-March, April

$$\sum_i e_{ij} * \text{LIVEST}_{ij} + \sum_i g_{ij} * \text{CROP}_{ij} - f_j * \text{HIRELAB}_{1j} - f_j' \\ * \text{HIRELAB}_{2j} - f_j'' * \text{CUSTOMLAB}_j \leq \text{jLAB-M,A}$$

9. jLAB-J,F: Labor hours-May, June

$$\sum_i e_{ij} * \text{LIVEST}_i + \sum_i g_{ij} * \text{CROP}_i - f_j * \text{HIRELAB}_{1j} - f_j' \\ * \text{HIRELAB}_{2j} - f_j'' * \text{CUSTOMLAB}_j \leq \text{jLAB-M,J}$$

10. jLAB-J,A: Labor-July, August

$$\begin{aligned} & \sum_i e_{ij} * LIVEST_{ij} + \sum_i g_{ij} * CROP_{ij} - f_j * HIRELAB1_j - f_j' \\ & * HIRELAB2_j - f_j'' * CUSTOMLAB_j \leq jLAB-M,J \end{aligned}$$

11. jLAB-S,O: Labor hours-September, October

$$\begin{aligned} & \sum_i e_{ij} * LIVEST_{ij} + \sum_i g_{ij} * CROP_{ij} - f_j * HIRELAB1_{ij} \\ & - \sum_i f_{ij}'' * CUSTOMLAB-FOR-CROP_{ij} \leq jLAB-S,O \end{aligned}$$

12. jLAB-N,D: Labor hours-November, December

$$\begin{aligned} & \sum_i e_{ij} * LIVEST_{ij} + \sum_i g_{ij} * CROP_{ij} - f_j * HIRELAB_{ij} \\ & - \sum_i f_{ij}'' * CUSTOMLAB-FOR-CROP_{ij} \leq jLAB-N,D \end{aligned}$$

13. jFWH-MAY: Fieldwork hours-May

$$\begin{aligned} & \sum_i h_{ij} * CROP_{ij} - k_j * HIRELAB1_j + 1 * TRANSFWH>J_j - 1 * \\ & TRANSFWHJ>M \leq jFWH-MAY \end{aligned}$$

14. jFWH-JUN: Fieldwork hours-June

$$\begin{aligned} & \sum_i h_{ij} * CROP_{ij} - k_j * HIRELAB1_j - k_j' * HIRELAB2_j - k_j'' * CUSTOMLAB_j \\ & - 1 * TRANSFWFM>J + 1 * TRANSFWHJ>M \leq jFWH-JUN \end{aligned}$$

15. jFWH-SEP: Fieldwork hours-September

$$\sum_i h_{ij} * CROP_{ij} - k_j * HIRELAB1_j \leq jFWH-SEP$$

16. jFWH-OCT: Fieldwork hours-October

$$\begin{aligned} & \sum_i h_{ij} * CROP_{ij} - k_j * HIRELAB1_j - \sum_i k_{ij}'' * CUSTOMLAB-FOR- \\ & CROP_{ij} \leq jFWH-OCT \end{aligned}$$

## D) CROP PRODUCTION

17. jWHTPD: Wheat Production

$$-y_j * CROP-WHEAT_j + 1 * WHEATSALE_j \leq 0$$

18. jCORNPDP: Corn Production

$$-y_j \cdot \text{CROP-CORN}_j + 1 * \text{CORNSALE}_j + 1 * \text{FEEDCORN}_j \leq 0$$

19. jGRSOPD: Grain Sorghum Production

$$-y_j \cdot \text{CROP-GR.S}_j + 1 * \text{GR.S.SALE}_j + 1 * \text{FEEDGR.S.}_j \leq 0$$

20. jALFPD: Alfalfa Production

$$-y_j \cdot \text{CROP-ALF.}_j + 1 * \text{ALF.SALE}_j + 1 * \text{FEEDALF.}_j \leq 0$$

21. jNATHPD: Natural Hay Production

$$-y_j \cdot \text{CROP-NATH}_j + 1 * \text{NATH.SALE}_j + 1 * \text{FEED.NATH}_j + \\ 1 * \text{THN>FOR}_j \leq 0$$

## E) ANIMAL PRODUCTION AND TRANSFER

22. jB&SCALF: Buy and Sell Weaned Calf

$$-j * \text{SCALF}_j + \sum_i 1 * \text{CALF}_{ij} \leq 0$$

23. jB&SWSTR: Buy and Sell Wintered Calf

$$-1 * \text{SWSTR}_j + \sum_i 1 * \text{GSTR}_{ij} + \sum_i 1 * \text{FDST}_{ij} \leq 0$$

24. jB&SGSTR: Buy and Sell Grazing Steer

$$-1 * \text{SGSTR}_j + \sum_i 1 * \text{FSTR}_{ij} \leq 0$$

25. jTCALF: Transfer Calf

$$-z_j \cdot \text{CALF}_j + 1 * \text{SELLCALF}_j + 1 * \text{KEEP WEANING CALF}_j \leq 0$$

26. jTWSTR: Transfer Weaning Calf to Wintering System (STR = Steers)

$$1 * \text{WINTER-STR.}_j - z_j * \text{KEEP WEANING CALF}_j - \sum_{ij} z'_{ij} \cdot \text{CALF}_{ij} \leq 0$$

27. jWSTR: Winter-steer to Grazing

$$-z_j \cdot \text{WINTER-STR}_j + 1 * \text{SELL-WINTER-STR}_j + 1 * \text{TGSTR}_j \leq 0$$

28. jTGSTR: Transfer Graze Steers to Feedlot  

$$-z_j \cdot TGSTR_j - \sum_i z'_{ij} \cdot GSTR_{ij} + 1 \cdot PGFSTRFS_j + 1 \cdot PGSTR_j \leq 0$$
29. jGSTR: Transfer Graze Steers to Feeder Steers  

$$1 \cdot SGSTR_j + 1 \cdot TFSTR_j - z_j \cdot PGSTR_j \leq 0$$
30. jTFSTR: Transfer Feeder Steer to Feedlot  

$$1 \cdot PWGFSTR_j - z_{ij} \cdot TFSTR_j - \sum_i z_{ij}' \cdot FSTR_{ij} - \sum_i z_{ij}'' \cdot FDST_{ij} \leq 0$$
31. jRCORN: Corn Required by Livestock  

$$\sum_i l_i \cdot LIVEST_j - 1 \cdot FEED-GRAIN - \sum_i l_i \cdot TRANSFER-GRAIN \leq 0$$
32. jRALFH: Alfalfa Required by Livestock  

$$\sum_i l_i \cdot LIVEST_j - 1 \cdot FEEDALFA_{ij} - \sum_i l_i \cdot TRANSFER-ALFA_{ij} \leq 0$$
33. jREFORREQ: Forage Required by Beef Cows  

$$l_j \cdot PCALF_j + l_j \cdot PWSTR - 1 \cdot ALF>FOR \leq 0$$
34. jRWPASTU: Winter Pasture Required by Beef Cow  

$$z_j \cdot PCALF_j + z_j \cdot PWSTR_j - \sum_i l_j \cdot FEED-CROP_{ij} \leq 0$$
- (Equation 35-37 belong to CAPITAL)
35. jOPCAP: Operating Capital Required  

$$\sum_i m_i \cdot CROP_{ij} + \sum_i n_i \cdot LIVEST_j - 1 \cdot OPCAP_j \leq 0$$
36. jLSKCAP: Capital Required to Purchase Livestock  

$$\sum_i o_i \cdot LIVEST_{ij} - 1 \cdot LSKCAP \leq 0$$
37. jDEPREC: Depreciation of Building and Equipment  

$$\sum_i p_i \cdot LIVEST_{ij} + \sum_i g_i \cdot CROP_{ij} - 1 \cdot DEPR - \sum_i r_i \cdot CUSTOMLAB_{ij} \leq 0$$

38. jSFDGRAI: Sell Feed Grain, Transfer Row

$$-\sum_i 1 * \text{SELL-CROP}_{ij} - \sum_i 1 * \text{FEED.GRAIN}_{ij} + 1 * \text{BUY-FEED-GRAIN}_j + \sum_i 1 * \text{FEED-GRAIN}_{i1} \leq 0.$$

39. jSALFH: Sell Alfalfa Hay, Transfer Row

$$-1 * \text{SELL-ALFA}_j - z_j * \text{SELL-NAT-HAY} + \sum_i 1 * \text{ALFH}_{i1} = 0$$

F) CAPITAL (See also 35, 36, 37)

40. jFDLOTCP: Feedlot Capacity (development)

$$\sum_i 1 * \text{LIVEST}_{ij} - 1 * \text{FEEDLOTDEV}_i \leq j\text{FDLOTCP}$$

41. jFUEL: Required Fuel

$$\sum_i s_i * \text{LIVEST}_{ij} + \sum_i t_i * \text{CROP}_{ij} - 1 * \text{FUELCOST} \leq 0$$

42. jFERT: Required Fertilizer

$$\sum_i u_i * \text{CROP}_{ij} - 1 * \text{FERT.COST} \leq 0$$

#### KAM REGIONS

Figure 2 shows the eight regions of KAM. Three factors determined the pattern for the regions, rainfall, general soil differences and county lines. Wherever these three borders came close to each other a certain region was established. The following is an abbreviated item list of characteristics for each region.

Region 1: Cherokee Prairies

(general crop and livestock farming)

Region 2: Central Kansas Sandstone Hills and

Central Loess Plains and

Central Rolling Red Prairies

(little wheat on fallow)

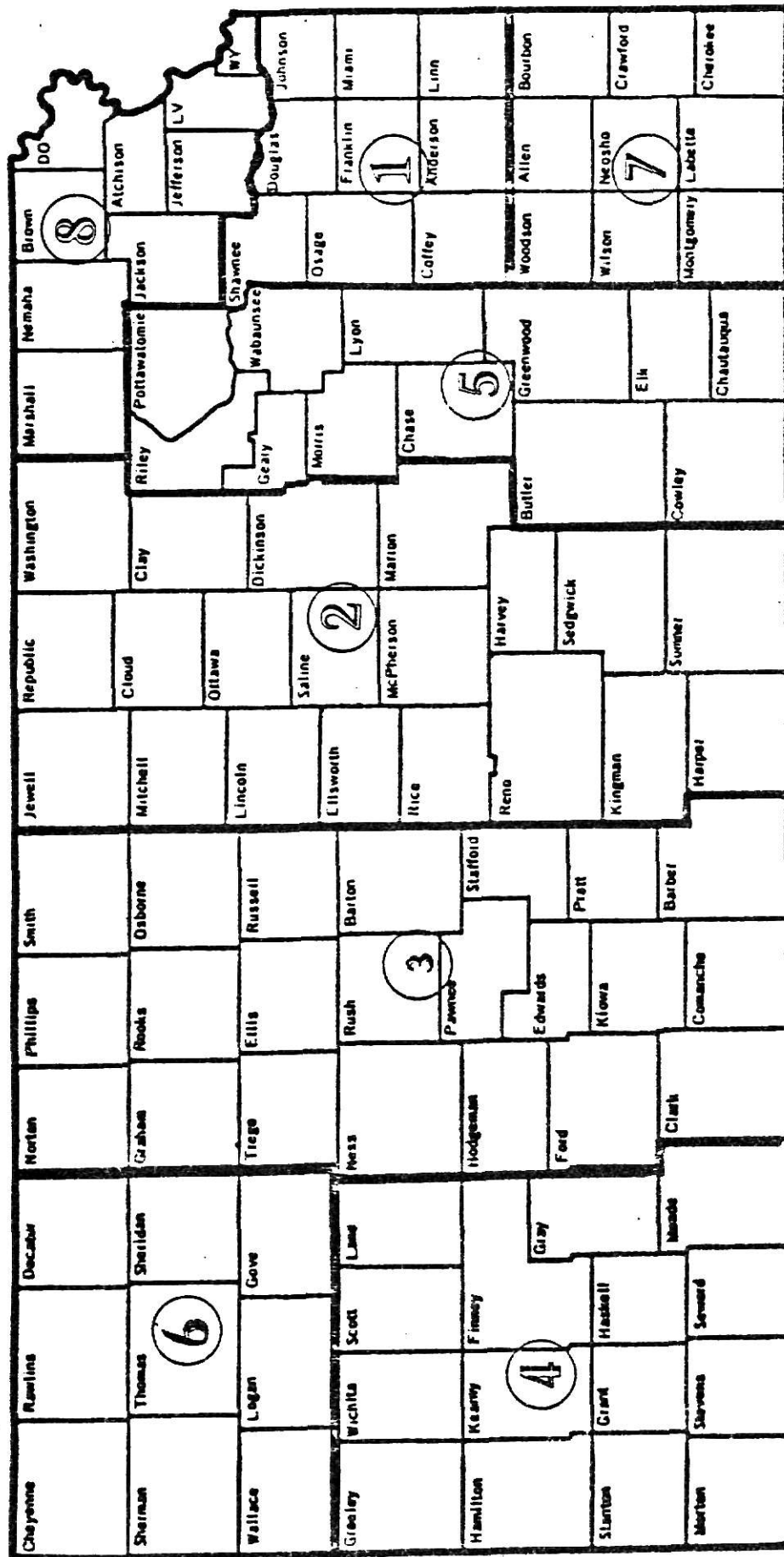


Figure 2: The Eight Regions of KAM

- Region 3: Rolling Plains and Breaks  
Central Rolling Red Plains  
Great Bend Sand Plains  
(transition from continuous wheat to fallow region)
- Region 4: Central High Tableland  
Southern High Plains  
(irrigation region and dryland wheat on fallow)
- Region 5: Bluestem Hills  
(Flint Hills pasture with crops on bottomland)
- Region 6: Central High Table Land  
(80-90% of wheat on fallowing, potential irrigation region)
- Region 7: Cherokee Prairies  
(general crop and livestock farming)
- Region 8: Nebraska and Kansas Loess  
(general crop and livestock farming, also considered as a part of the cornbelt)



CHAPTER III  
SELECTION OF CROP PRICES

A general definition for linear programming would be: "LP is the analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those variables are subject to a number of restraints in the form of linear inequalities" (R. Dorfman et. al.).

The LP- model has utility only to the extent to which crop prices are accurately estimated. Emphasis should be placed on the accurate estimation of prices. Prices too high or too low will distort income estimation. In spite of the lack of accuracy of crop prices over time an approach is needed to estimate the price effect influence on crop and livestock production.

Parametric programming is a method that could be used, which is to vary one of the crop prices for short intervals. But the underlying assumption that all other crop prices are constant is highly unrealistic. It may be a feasible approach for specific questions of a single crop where the influence of a price change for crop B on the supply of crop B has to be examined by assuming the price for crop A remains constant.

This study considered five different price sets for the main crops. The testing and first solutions of KAM were done with Kansas crop prices based on the 1959-75 average relative price relationship. (The 1959-75 average price for all crops and livestock products was divided by the average corn price.) The price ratios were then multiplied by \$2.00, an estimate of the current price of corn. To test further the influence of a change in the price for the three main crops, several extreme price sets

which actually occurred were chosen.

Explanation of the evaluation for the four price sets:

- a) For the years 1971 - 1977 the average monthly Kansas prices of wheat, corn and grain sorghum were plotted. (See Fig. 3-8)
- b) The extreme low price and the extreme high price between 1971 - 1977 was determined for wheat and grain sorghum (marked with a circle in the appropriate Figure)
- c) The prices of all crops during the years when the extremes occurred were selected and used as the price sets.
- d) For each region the specific crop price was calculated, by subtracting the transportation costs, given in Table 1, from the quoted Kansas prices. It is assumed that Kansas City, located in Region one, is the central market.
- e) The four price sets were the basis for four different objective functions:
  - I. ZWH = Objective function with high wheat price
  - II. ZGH = Objective function with high grain sorghum price
  - III. ZWL = Objective function with low wheat price
  - IV. ZGL = Objective function with low grain sorghum price

Table 2 shows the average prices for all regions, the ratio of the wheat price over grain sorghum price and the date the prices occurred.

The 1959-75 average wheat to corn price ratio is 1.38, the grain sorghum to corn price ratio is .85. Using \$2.00 as the estimate of the current corn price, the comparable wheat price is \$2.76, and the comparable grain sorghum price is \$1.70. These price estimates represent long term price relationship at the central market. From the central market price is subtracted the cost of transportation to the central

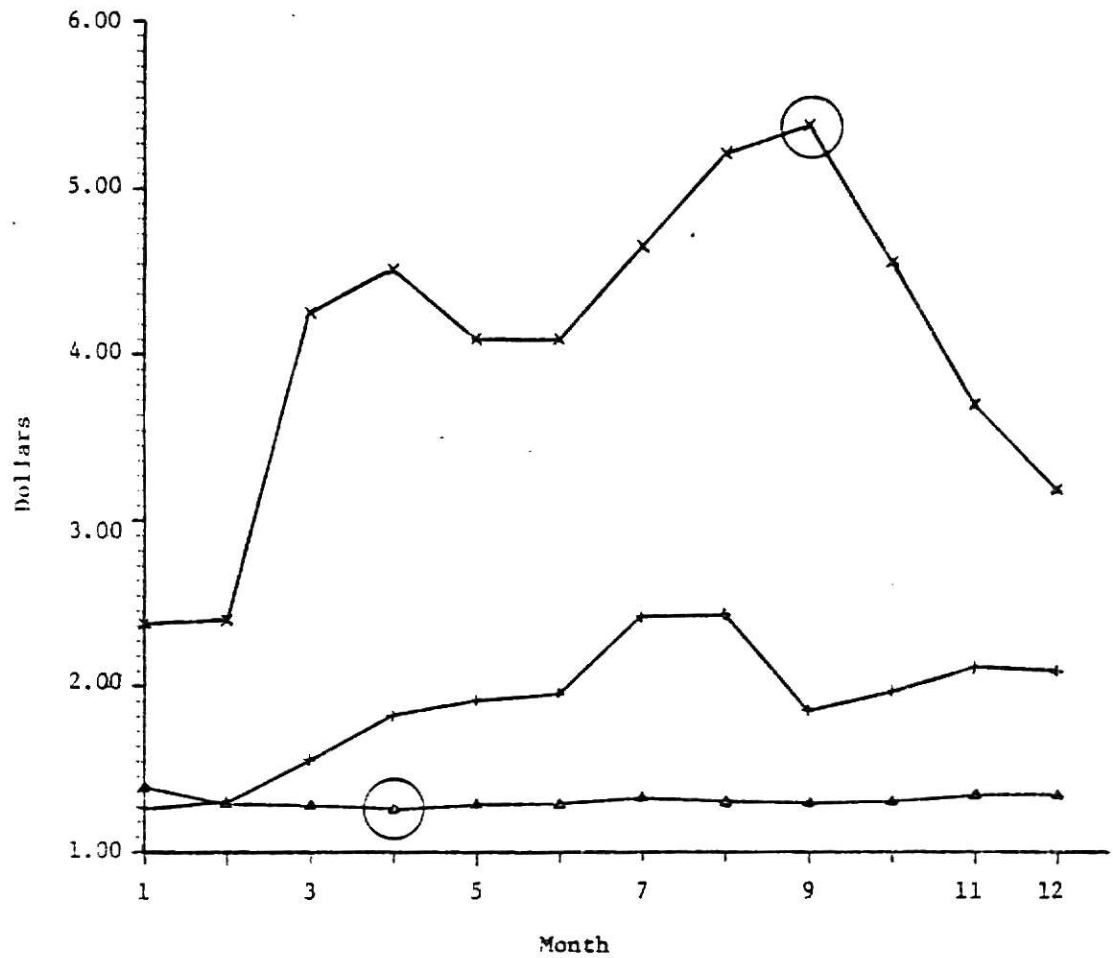


Figure 3: Monthly Kansas Wheat Prices for 1971, 1972 and 1973

- ▲—▲ Wheat Price for 12 months in 1971
- +—+ Wheat Price for 12 months in 1972
- x—x Wheat Price for 12 months in 1973

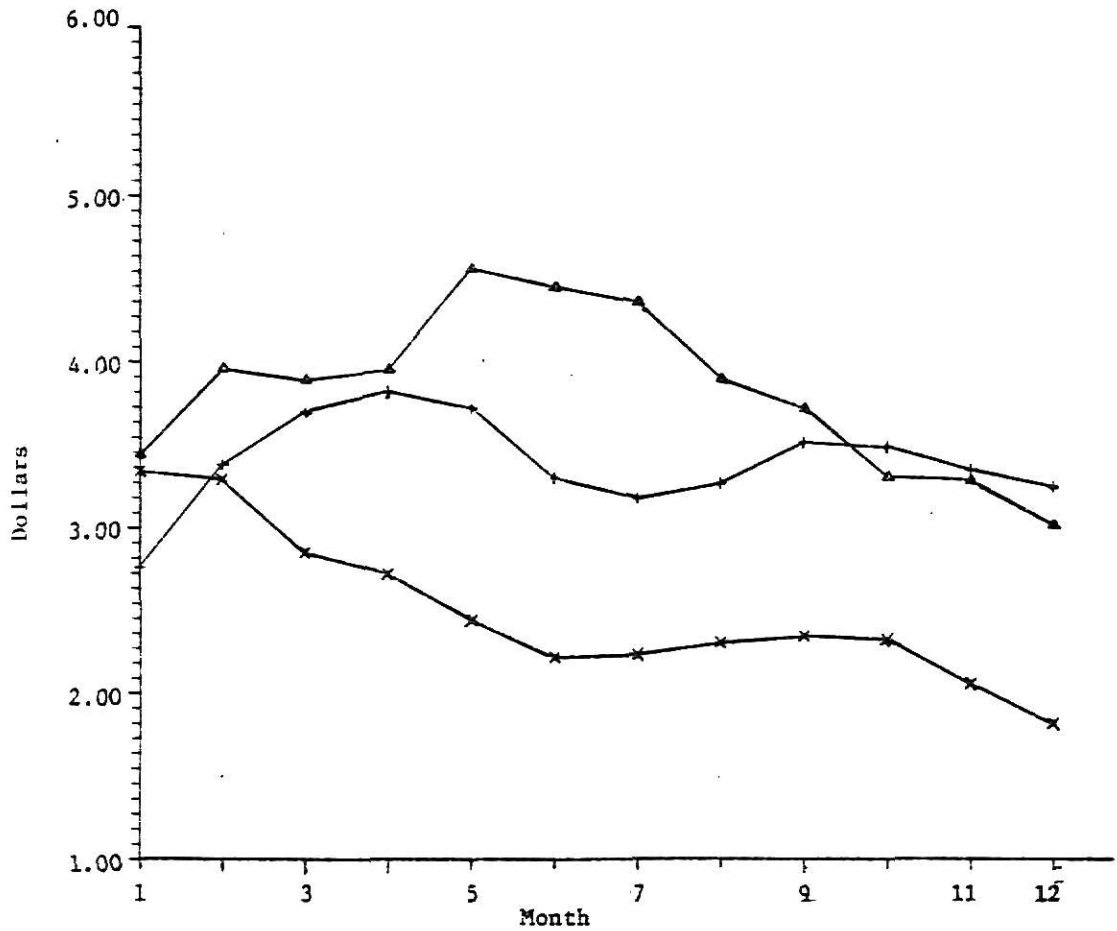


Figure 4: Monthly Kansas Wheat Price for 1974, 1975, and 1976

▲—▲ Wheat Price for 12 months in 1974  
 +—+ Wheat Price for 12 months in 1975  
 x—x Wheat Price for 12 months in 1976

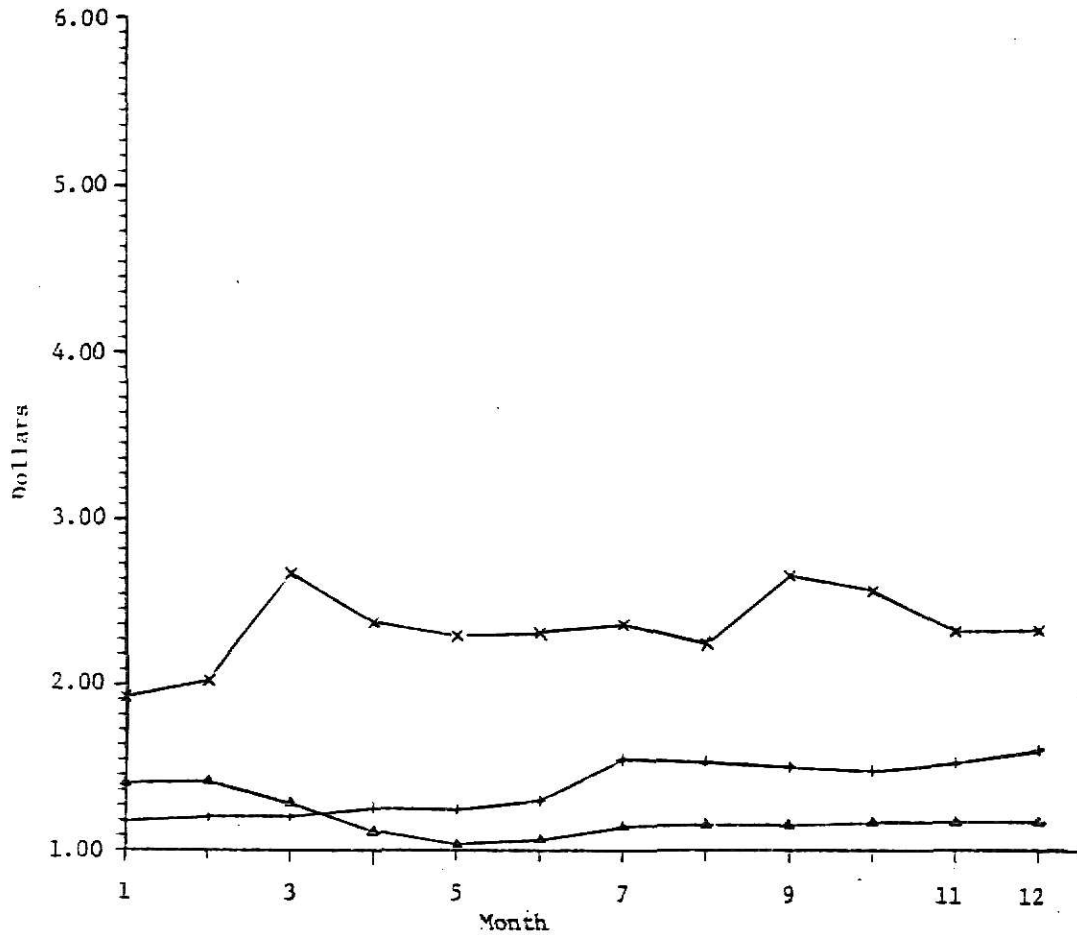


Figure 5: Monthly Kansas Corn Prices for 1971, 1972 and 1973

- ▲—▲ Corn Price for 12 months in 1971
- +—+ Corn Price for 12 months in 1972
- x—x Corn Price for 12 months in 1973

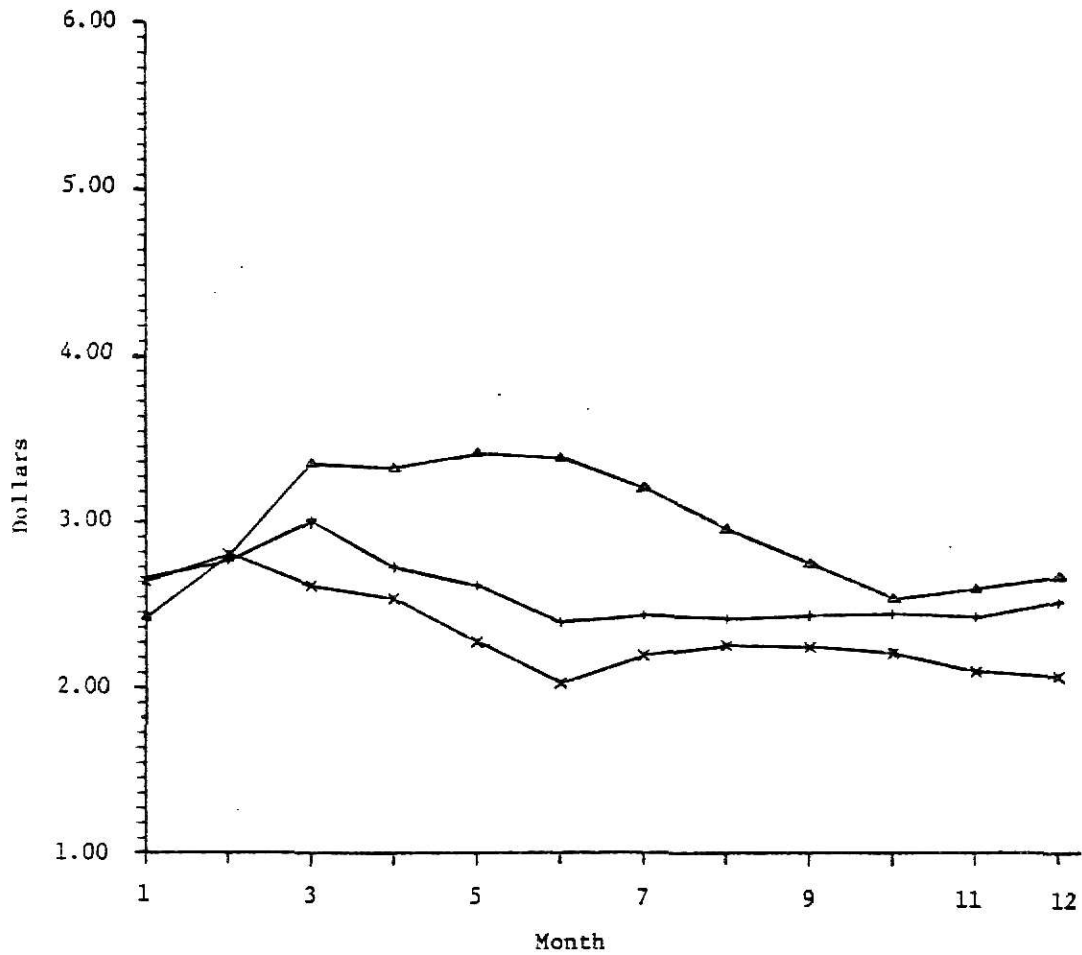


Figure 6: Monthly Kansas Corn Prices for 1974, 1975 and 1976

- ▲—▲ Corn Price for 12 months in 1974
- +—+ Corn Price for 12 months in 1975
- \*—\* Corn Price for 12 months in 1976

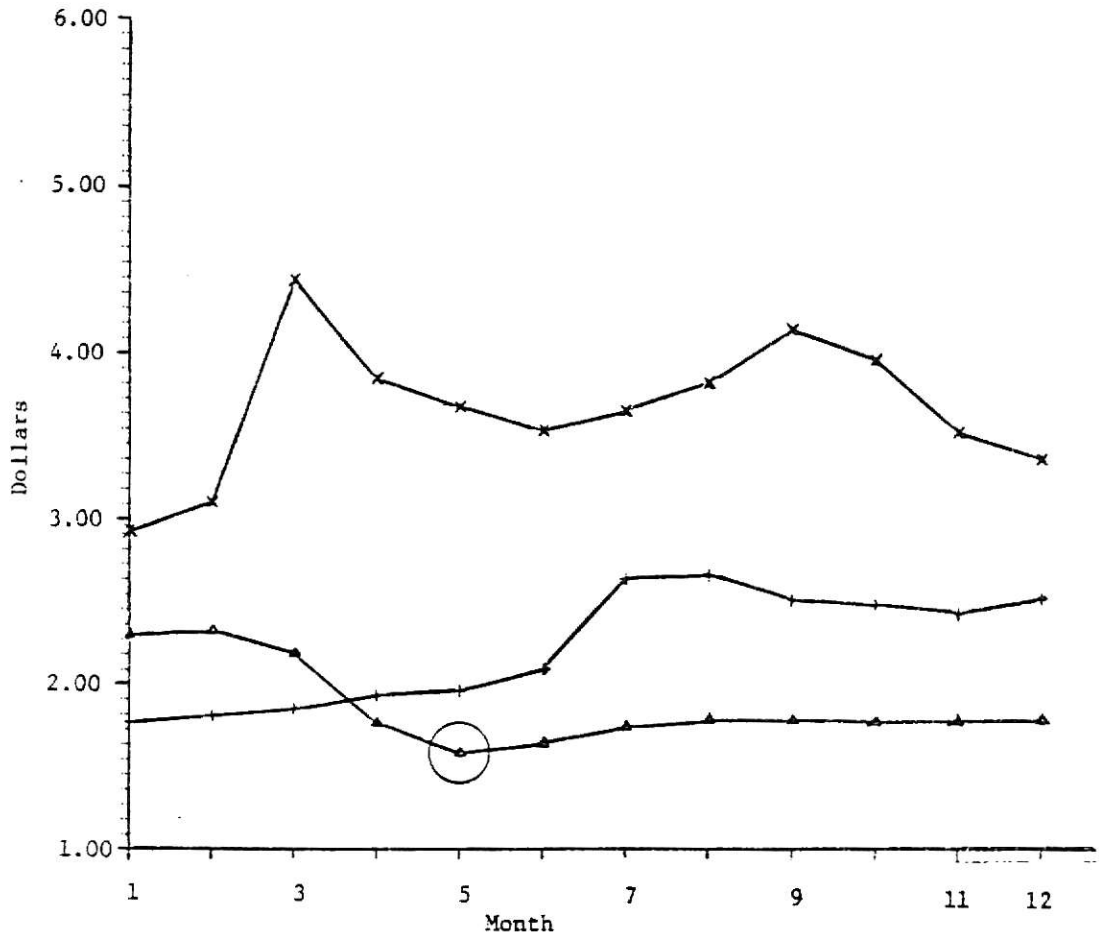


Figure 7: Monthly Kansas Grain Sorghum Prices for 1971, 1972 and 1973

- △—△ Grain Sorghum Price for 12 months in 1971
- +—+ Grain Sorghum Price for 12 months in 1972
- x—x Grain Sorghum Price for 12 months in 1973

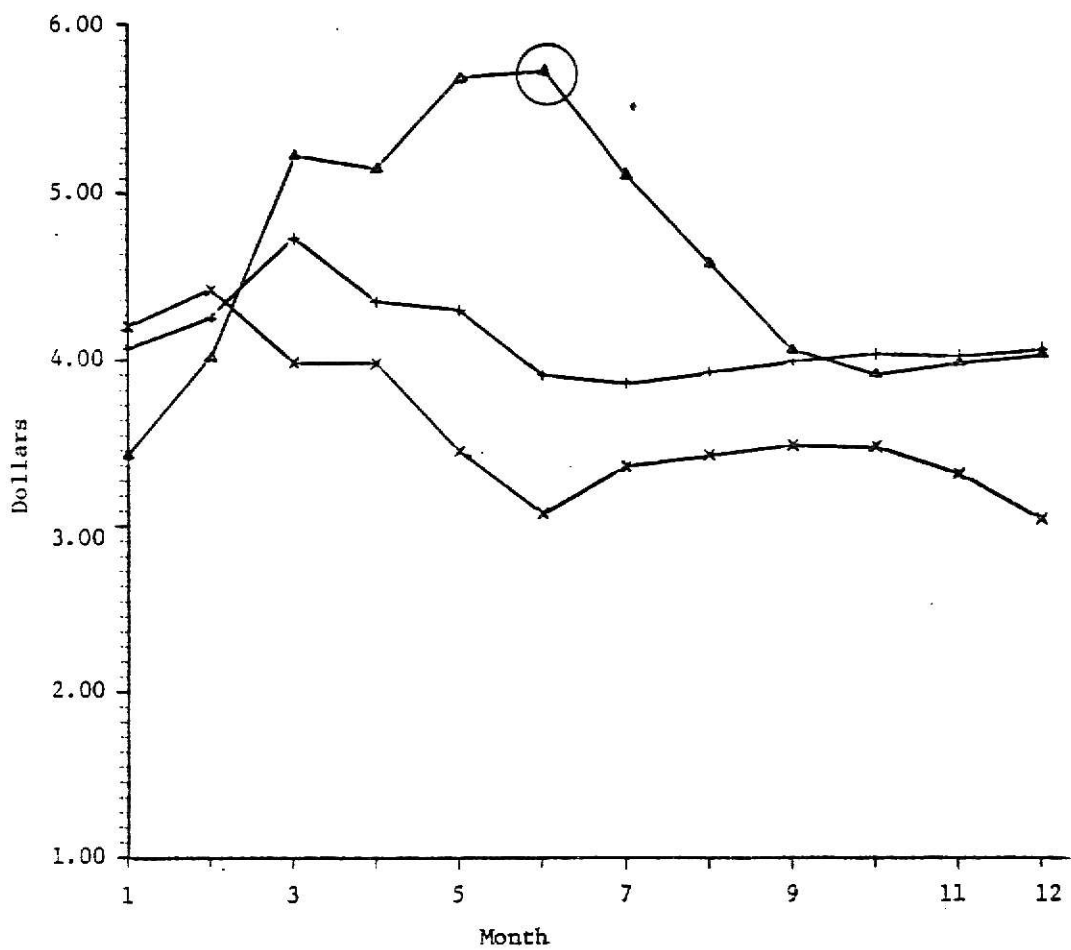


Figure 8: Monthly Kansas Grain Sorghum Prices for 1974, 1975 and 1976

- △ —△ Grain Sorghum Price for 12 months in 1974
- + —+ Grain Sorghum Price for 12 months in 1975
- × —× Grain Sorghum Price for 12 months in 1976



Table 6: Transportation Cost From Specified Regions to the Central Market (Kansas City)

Region i	Transportation Cost for: (\$/Bu.)		
	Wheat	Corn	Gr. So.
1	.00	.00	.00
2	.12	.12	.13
3	.20	.21	.21
4	.29	.30	.30
5	.05	.06	.06
6	.26	.26	.27
7	.06	.07	.07
8	.07	.08	.08

Table 7: Average Crop Prices over all Regions for Different Price Sets, Wheat to Grain Sorghum Price Ratio and Date When Extreme Prices Occurred

Price Set	Crop Price for: \$/Bu.			Price Ratio W/Gr.S.	Date
	Wheat	Corn	Gr. So.		
* NORMAL	2.62	1.86	1.56	1.68	-
I ZWH	5.25	2.52	3.99	1.30	9-73/74
II ZGH	4.30	3.24	5.50	0.78	6-74/75
III ZWL	1.12	0.97	1.62	0.70	4-71/72
IV ZGL	1.16	0.89	1.44	0.80	5-71/72

\* Price was used for the testing of KAM.