APPENDIX: PROGRAM LISTING

```
*     AGRICULTURE SECTOR WITH EXOGENOUS INPUTS
NOTE
NOTE  LOOP 1: FOOD FROM INVESTMENT IN LAND DEVELOPMENT
NOTE
84    A     LPC.K=AL.K/PALT
      C     PALT=3.2E9
85    L     AL.K=AL.J+(DT)(LDR.JK-LER.JK-LRUI.JK)
      N     AL=ALI
      C     ALI=.9E9
86    L     PAL.K=PAL.J+(DT)(-LDR.JK)
      N     PAL=PALI
      C     PALI=2.3E9
87    A     F.K=LY.K*AL.K*LFH*(1-PL)
      C     LFH=.7
      C     PL=.1
88    A     FPC.K=F.K/POP.K
89    A     IFPC.K=CLIP(IFPC2.K,IFPC1.K,TIME.K,PYEAR)
90    A     IFPC1.K=TABHL(IFPC1T,IOPC.K,0,1600,200)
      T     IFPC1T=230/480/690/850/970/1070/1150/1210/1250
91    A     IFPC2.K=TABHL(IFPC2T,IOPC.K,0,1600,200)
      T     IFPC2T=230/480/690/850/970/1070/1150/1210/1250
92    A     TAI.K=10.K*FIOAA.K
93    A     FIOAA.K=CLIP(FIOAA2.K,FIOAA1.K,TIME.K,PYEAR)
94    A     FIOAA1.K=TABHL(FIOAA1T,FPC.K/IFPC.K,0,2.5,.5)
      T     FIOAA1T=.4/.2/.1/.025/0/0
95    A     FIOAA2.K=TABHL(FIOAA2T,FPC.K/IFPC.K,0,2.5,.5)
      T     FIOAA2T=.4/.2/.1/.025/0/0
96    R     LDR.KL=TAI.K*FIALD.K/DCPH.K
97    A     DCPH.K=TABHL(DCPHT,PAL.K/PALT,0,1,.1)
      T     DCPHT=1E5/7400/5200/3500/2400/1500/750/300/150/75/50
NOTE
NOTE  LOOP 2: FOOD FROM INVESTMENT IN AGRICULTURAL INPUTS
NOTE
98    A     CAI.K=TAI.K*(1-FIALD.K)
99    A     AI.K=SMOOTH(CAI.K,ALAI.K)
      N     AI=5E9
      A     ALAI.K=CLIP(ALAI2,ALAI1,TIME.K,PYEAR)
100   C     ALAI1=2
      C     ALAI2=3
101   A     AIPH.K=AI.K*(1-FALM.K)/AL.K
102   A     LYMC.K=TABHL(LYMCT,AIPH.K,0,1000,40)
      T     LYMCT=1/2/3.8/4.4*4.9/5.4/5.7/6/6.1/6.6/6.9/7.2/7.4
      X     /7.6/7.8/8/8.2/8.4/8.6/8.8/9/9.2/9.4/9.6/9.8/10
103   A     LY.K=LYF.K*LFERT.K*LYMC.K*LYMAP.K
104   A     LYF.K=CLIP(LYF2,LYF1,TIME.K,PYEAR)
      C     LYF1=1
      C     LYF2=1
105   A     LYMAP.K=CLIP(LYMAP2.K,LYMAP1.K,TIME.K,PYEAR)
106   A     LYMAP1.K=TABHL(LYMAP1T,IO.K/IO70,0,30,10)
      T     LYMAP1T=1/1/.7/.4
107   A     LYMAP2.K=TABHL(LYMAP2T,IO.K/IO70,0,30,10)
      T     LYMAP2T=1/1/.7/.4
      C     IO70=7.9E11
NOTE
NOTE  LOOPS 1 & 2: THE INVESTMENT ALLOCATION DECISION
NOTE
108   A     FIALD.K=TABHL(FIALDT,(MPLD.K/MPAI.K),0,2,.25)
      T     FIALDT=0/.05/.15/.30/.50/.70/.85/.95/1
109   A     MPLD.K=LY.K/(DCPH.K*SD)
      C     SD=.07
110   A     MPAI.K=ALAI.K*LY.K*YLYMC.K/LYMC.K
      A     YLYMC.K=TABHL(MLYMCT,AIPH.K,0,600,40)
111   T     MLYMCT=.975/.93/.915/.911/.909/.908/.907/.906/
      X     .905/.905/.905/.905/.905/.905/.905/.905
NOTE
NOTE  LOOP 3: LAND EROSION AND URBAN-INDUSTRIAL USE
NOTE
112   A     ALL.K=ALLI*LLMY.K
```



```
      C     ALLN=6000
113   A     LLMY.K=CLIP(LLMY2.K,LLMY1.K,TIME.K,PYEAR)
114   A     LLMY1.K=TABHL(LLMY1T,LY.K/LY.K*1PT,0,9,1)
      T     LLMY1T=1.2/1/.63/.36/.16/.055/.04/.025/.015/.01
115   A     LLMY2.K=TABHL(LLMY2T,LY.K/LY.K*1PT,0,9,1)
      T     LLMY2T=1.2/1.63/.36/.16/.055/.04/.025/.015/.01
116   R     LER.KL=AL.K/ALL.K
117   A     UILPC.K=TABHL(UILPCT,IOPC.K,0,1600,200)
      T     UILPCT=.995/.998/.915/.84/.655/.47/.26/.09
118   A     UILR.K=UILPC.K*POP.K
119   R     LRUI.KL=MAX(0,(UILR.K-UIL.K)/UILDT)
      C     UILDT=10
120   L     UIL.K=UIL.J+(DT)(LRUI.JK)
      N     UIL=UILI
      C     UILI=8.2E6
NOTE
NOTE  LOOP 4: LAND FERTILITY DEGRADATION
NOTE
121   L     LFERT.K=LFERT.J+(DT)(LFR.JK-LFD.JK)
      N     LFERT=LFERTI
      C     LFERTI=600
122   A     LFDR.K=TABHL(LFDRT,PPOLX.K,0,30,10)
      T     LFDRT=.8/1./.5
123   R     LFD.KL=LFERT.K*LFDR.K
NOTE
NOTE  LOOP 5: LAND FERTILITY REGENERATION
NOTE
124   R     LFR.KL=(ILF-LFERT.K)/LFRT.K
      C     ILF=600
125   A     LFRT.K=TABHL(LFRTT,FALM.K,0,.10,.02)
      T     LFRTT=20/13/8/4/2/2
NOTE
NOTE  LOOP 6: DISCONTINUING LAND MAINTENANCE
NOTE
126   A     FALM.K=TABHL(FALMT,PFR.K,0,4,1)
      C     FALMT=0/.04/.07/.09/.1
127   A     FR.K=PFC.K/SFPC
      C     SFPC=230
128   A     PFR.K=SMOOTH(FR.K,FSPD)
      N     PFR=1
      C     FSPD=2
NOTE
NOTE  EXOGENOUS INPUTS TO THE AGRICULTURE SECTOR
NOTE
NOTE  POPULATION GROWS EXPONENTIALLY AT 1.2% PER YEAR
NOTE
      A     POP.K=CLIP(POP2.K,POP1.K,TIME.K,EYEAR)
      C     EYEAR=2500
      A     POP1.K=POPI*EXP(.012*(TIME.K-1900))
      A     POP2.K=POPI*EXP(.012*(EYEAR-1900))
      C     POPI=1.65E9
NOTE
NOTE  INDUSTRIAL OUTPUT GROWS EXPONENTIALLY AT 3.6% PER YEAR
NOTE
      A     IO.K=CLIP(IO2.K,IO1.K,TIME.K,EYEAR)
      A     IO1.K=IOI*EXP(.036*(TIME.K-1900))
      A     IO2.K=IOI*EXP(.036*(EYEAR-1900))
      C     IOI=.67E11
      A     IOPC.K=IO.K/POP.K
NOTE
NOTE  PERSISTENT POLLUTION GROWS EXPONENTIALLY AT 3% PER YEAR
NOTE
      A     PPOLX.K=CLIP(PPOLX2.K,PPOLX1.K,TIME.K,EYEAR)
      A     PPOLX1.K=PPOLXI*EXP(.03*(TIME.K-1900))
      A     PPOLX2.K=PPOLXI*EXP(.03*(EYEAR-1900))
      C     PPOLXI=.12
NOTE
NOTE  CONTROL CARDS
NOTE
      C     PYEAR=1975
      N     TIME=TIMEN
      C     TIMEN=1900
SPEC  DT=.25/LENGTH=2100/PLTPER=5/PRTPER=0
PLOT  F=B(0,12E12)/PPC=P(0,1000)/LY=Y(0,8E3)/
X     LFERT=T(0,600)/AIPH=S(0,1000)
PLOT  AL=L,PAL=P(0,4E9)/LER=E,LDR=D,
4     LRUI=U(0,4E7)/DCPH=S(0,1E4)
RUN   STANDARD
```