MULTILEVEL COMPUTER MODEL OF
WORLD DEVELOPMENT SYSTEM
User Oriented Descriptions

A SERIES: PART II. THE FOOD ANALYSIS MODEL

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THE FOOD ANALYSIS SUBMODEL

ABSTRACT

The Food Analysis Submodel is intended to provide an estimation of the food situation for the next 50 years. It consists of a population, an economic, a land use and a food production submodel as well as a pricing mechanism. By choosing appropriate scenarios it is possible to analyze the effects of population policies and investment shifts to the agricultural sector.

I. MATHEMATICS OF THE MODEL

The M.P. Food Model uses an extensive list of variables and parameters which is given below:

A. Notation

1. Population Submodel

POP : Population number
AP(I), \( I = 1, \ldots, 86 \) : Age group of the I - year-olds
FERTO : Initial fertility coefficient
FERT : Fertility coefficient
KONTR : Start of equilibrium birth control
INT : Transition period to reach equilibrium fertility coefficient
FERTE : Fertility coefficient that leads to population equilibrium
EO : Sensitivity of babies to protein deficiency
EU : Sensitivity of old people to protein deficiency
EA : Time constant that indicates the years that pass until \( E(a) - EU \) drops to 37% of \( EO - EU \) (see model equations)
XO : Minimum daily protein consumption per capita below which there is no survival
TL : Time delay in the effect of protein deficiency
PPCSAV(I),
I = 1,...,15 : Array used to compute lagged daily per capita protein consumption
PRONOR : Level of daily per capita protein consumption below which starvation occurs
PROPCI : Daily per capita protein consumption
PTPCR : Protein per capita produced regionally
PRODST : Protein distribution factor
PROPCN : Lagged daily per capita protein consumption
PROFAC : Factor indicating food supply situation
AMPFO : Mortality multiplier for babies
AMPF(I),
I = 1,...,86 : Mortality multiplier, by age category
BAB : Number of babies
TOT : Number of deaths
AMORT : Mortality coefficient
AMO : Normalized probability that a baby dies
AM(I),
I = 1,...,86 : Normalized age-specific probability to die, by age category
TOT15 : Accumulative sum of children that died
CBR : Crude birth rate
CGR : Population growth rate
CDR : Crude death rate

2. Economic Submodel

A(I,J),
I,J = 1,2 : Input-Output matrix
AINV(I,J)
I,J = 1,2 : Inverse of (I - A), I denoting the 2 • 2 identity matrix
CNA : Capital stock, non-agricultural sector
QNA : Capital per output ratio, non-agricultural sector
YNA : Gross regional product, non-agricultural sector
CA : Capital stock, agricultural sector
QA : Capital per output ratio, agricultural sector
YA : Agricultural production (dollar value)
YAX : Agricultural production (dollar value) computed within the economic model
SYSYNA : Ratio of Y to YNA
Z(I), I = 1,2 : Gross output, by sector
U(I), I = 1,2 : Intermediate demand, by sector
UA : Intermediate demand, from agriculture
UAFK : Coefficient relating UA to expenditures on fertilizers etc.
UAF : Expenditures on fertilizer and related productive factors
SUAF : Increased expenditures on fertilizer etc.
I : Total investment
GI : Investment coefficient
IAS : Additional investment shifted to the agricultural sector
IAKS : Shift of investment to the agricultural sector, coefficient
IAK : Investment in agricultural sector, coefficient
IA : Investment in agricultural sector
KL : Fraction of additional investment to agricultural capital stock
INA : Investment in non-agricultural sector
IR : Regional investment
IRK : Regional investment, coefficient
IMN : Imports of investment capital needed
IAP : Investment in non-land agricultural capital stock
IAPK : Investment in agricultural production, coefficient
IALV : Investment in livestock development
IALVK : Investment in livestock development, coefficient
IALD : Investment in land development
C : Consumption
GC : Consumption, coefficient
G : Governmental expenditures
GG : Governmental expenditures, coefficient
M : Imports
GM : Imports, coefficient
MA : Imports, agricultural
MAK : Agricultural imports, coefficient
MI : Imports, investment
MC : Imports for consumption

3. Land Use Model
CLGR : Cultivated grain land
CLNG : Cultivated non-grain land
TA : Intercept of linear equation relating grain land to non-grain land
TB : Slope of linear equation relating grain land to non-grain land
CLWR : Ratio of maximum cultivable land to maximum total land
CLM : Maximum cultivable land
TLM : Maximum total land
CL : Cultivated land
CLW : Total cultivable land withdrawn
TLW : Total land withdrawn for urbanization etc.
GLM : Maximum grazing land
CLR : Cultivable land remaining that is not yet cultivated
TLWR : Ratio of withdrawn land to maximum total land
TLWM : Land withdrawal multiplier
TLAW : Annual withdrawal of land for urbanization etc.
TLWPCB : Per capita land withdrawal
CLAW : Annual withdrawal of cultivable land for urbanization etc.
GLW : Grazing land withdrawn
GL : Grazing land
TLLS : Total land for livestock support
FCLR : Ratio of remaining cultivable land to total cultivable land
CLD : Cultivated land developed
CLDGR : Development of grain land
CLDNG : Development of non-grain land
CLWGR : Annual grain land withdrawn

4. Food Production and Distribution Submodel
YNAPC : Non-agricultural product per capita
CAPH : Capital per hectare
PTFC : Productivity coefficient from CAPH
PMCI : Productivity coefficient from YNAPC
FA : Grain production saturation level
ZPHG : Per hectare use of fertilizer etc.
GRPH : Grain production per hectare
FC : Slope of grain production function at minimum level
FD : Intercept of linear equation relating GRGP to NGGP
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE</td>
<td>Slope of linear equation relating GRGP to NGGP</td>
</tr>
<tr>
<td>GRGP</td>
<td>Gross production of grain crops</td>
</tr>
<tr>
<td>NGGP</td>
<td>Gross production of non-grain crops</td>
</tr>
<tr>
<td>SLVMA</td>
<td>Maximum possible livestock due to carrying capacity</td>
</tr>
<tr>
<td>SLVA</td>
<td>Total livestock in animal units</td>
</tr>
<tr>
<td>SLVAR</td>
<td>Animal use ratio</td>
</tr>
<tr>
<td>XLVPLM</td>
<td>Livestock price-land multiplier</td>
</tr>
<tr>
<td>PXLVP(I), I = 1,...,9</td>
<td>Base price of livestock, by category</td>
</tr>
<tr>
<td>LVPL(I), I = 1,...,9</td>
<td>Development capital cost per livestock unit, by category</td>
</tr>
<tr>
<td>SLV(I), I = 1,...,9</td>
<td>Livestock numbers, by category</td>
</tr>
<tr>
<td>SLVK(I), I = 1,...,9</td>
<td>Livestock adjustment coefficient, by category</td>
</tr>
<tr>
<td>ALVI(I), I = 1,...,9</td>
<td>Annual livestock development, by category</td>
</tr>
<tr>
<td>UALV(I), I = 1,...,9</td>
<td>Investment in livestock development, by category</td>
</tr>
<tr>
<td>SLVMK(I), I = 1,...,12</td>
<td>Meat from livestock coefficient, by category</td>
</tr>
<tr>
<td>FGP(I), I = 1,...,26</td>
<td>Gross regional food production, by category</td>
</tr>
<tr>
<td>SLVV</td>
<td>Gross regional meat production</td>
</tr>
<tr>
<td>AWFM</td>
<td>Additional marine fish production</td>
</tr>
<tr>
<td>FWCM</td>
<td>Catch of marine fish</td>
</tr>
<tr>
<td>FWMM</td>
<td>Maximum catch of marine fish</td>
</tr>
<tr>
<td>FWPM</td>
<td>Maximum land under pond culture</td>
</tr>
<tr>
<td>AWFMK</td>
<td>Growth rate of marine fish production</td>
</tr>
<tr>
<td>AUFWP</td>
<td>Additional land under pond culture</td>
</tr>
<tr>
<td>UFWP</td>
<td>Land under pond culture</td>
</tr>
<tr>
<td>UFWPK</td>
<td>Factor relating pond fish to land under pond fish culture</td>
</tr>
<tr>
<td>WB</td>
<td>Fish pond growth rate</td>
</tr>
</tbody>
</table>
FWCP : Pond fish production
FWCT : Gross fish production
FWCNTK : Meat from fish, coefficient
FWT : Total meat from fish
NGGPK(I),
     I = 1, ..., 8 : Disaggregation coefficients of non-grain crops
GRGPK(I),
     I = 1, ..., 5 : Disaggregation coefficients of grain crops
SPFTK(I),
     I = 1, ..., 26 : Withdrawal for seed, by category, coefficient
SFT(I),
     I = 1, ..., 26 : Total seed, by category
FTS(I),
     I = 1, ..., 26 : Gross food supply, by type
LSFTK(I),
     I = 1, ..., 26 : Coefficients for livestock food withdrawal, by type
LSFT(I),
     I = 1, ..., 26 : Livestock food, by type
FFTK(I),
     I = 1, ..., 26 : Food supply coefficients, by type
FTG(I),
     I = 1, ..., 26 : Gross human food supply, by type
FTN(I),
     I = 1, ..., 26 : Net human food supply, by type
XHMLF(I)
     I = 1, ..., 26 : Coefficients of food losses, by type
FSRPC(I),
     I = 1, ..., 26 : Regionally produced food per capita, by type
CLK(I),
     I = 1, ..., 26 : Calorie content coefficients, by type
PTK(I),
     I = 1, ..., 26 : Protein content coefficients, by type
VCLPCR(I),
     I = 1, ..., 26 : Calories per capita, by type
VPTPCR(I),
     I = 1, ..., 26 : Protein per capita, by type
CLPCR : Total calories per capita produced regionally
PTPCR : Total protein per captia produced regionally
PTAPCR : Animal protein per capita produced regionally
PTAR : Total regional animal protein
PTR : Total regional protein
YPC : Gross regional product per capita
PTNM : Protein needs multiplier
PTPCN : Protein per capita consumption need
PTPCB : Protein per capita consumption, base value
SPTPC : Surplus protein per capita
DPTPC : Protein deficit per capita
PTPCSN : Ratio of protein supply to needs
PTN : Regional protein needs
DPT : Regional protein deficit
SPT : Regional protein surplus
PTPCDR : Regional daily per capita protein supply

5. Pricing Mechanism

TPF : Total fertilizer and related productive factors
PXPF : Price of fertilizer
PXK : Price coefficient
PXLVK : Meat price coefficient
PXLV : Base price of meat
PXLVP : Adjusted meat price
PXGR : Grain price
PXNG : Price of non-grain crops
PXFS : Price of fish
GRV : Dollar value of grain production
NGV : Dollar value of non-grain production
LVV : Dollar value of livestock production
FSV : Dollar value of fish production
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YAPC</td>
<td>Gross agricultural product per capita</td>
</tr>
<tr>
<td>CCLDH</td>
<td>Per hectare capital cost of land development</td>
</tr>
<tr>
<td>PXPTM</td>
<td>Price of protein imports</td>
</tr>
<tr>
<td>FDMV</td>
<td>Dollar value of food imports</td>
</tr>
<tr>
<td>FDMAR</td>
<td>Ratio of food imports to agricultural product</td>
</tr>
<tr>
<td>FDMYR</td>
<td>Ratio of food imports to gross regional product</td>
</tr>
<tr>
<td>FDMMR</td>
<td>Ratio of food imports to total imports</td>
</tr>
<tr>
<td>FDXV</td>
<td>Dollar value of food exports</td>
</tr>
<tr>
<td>FDXAR</td>
<td>Ratio of food exports to gross regional agricultural product</td>
</tr>
<tr>
<td>FDXVR</td>
<td>Ratio of food exports to gross regional product</td>
</tr>
<tr>
<td>FDX9YR</td>
<td>Ratio of FDXV9 to gross regional product</td>
</tr>
<tr>
<td>FDX9AR</td>
<td>Ratio of FDXV9 to gross regional agricultural product</td>
</tr>
<tr>
<td>FDXV9</td>
<td>Value of food exported from region 1 to region 9</td>
</tr>
<tr>
<td>PTX9</td>
<td>Protein exported from region 1 to region 9</td>
</tr>
<tr>
<td>PTX9RR</td>
<td>Ratio of PTX9 to total regional protein</td>
</tr>
<tr>
<td>PTX9SR</td>
<td>Ratio of PTX9 to regional protein surplus</td>
</tr>
<tr>
<td>ENZ</td>
<td>Energy required for plant food production</td>
</tr>
<tr>
<td>ENZPLK</td>
<td>Energy requirements coefficient</td>
</tr>
<tr>
<td>ENZFR</td>
<td>Ratio of energy production to energy requirements in plant food production</td>
</tr>
<tr>
<td>RPXPF</td>
<td>Growth rate of fertilizer price</td>
</tr>
<tr>
<td>RPXPK</td>
<td>Growth rate of price coefficient PXK</td>
</tr>
<tr>
<td>RPXPTM</td>
<td>Growth rate of protein price</td>
</tr>
</tbody>
</table>
B. Model Equations

1. Population Model

\[
\text{POP}_t = \sum_{I=1}^{86} \text{AP}_t(I)
\]

\[
\text{FERT}_t = \begin{cases} 
\text{FERT}_0 & \text{if } t < \text{KONTR} \\
\text{FERT}_{t-1} - (\text{FERT}_0 - \text{FERTE}) \cdot \text{FK}_t, \text{KONTR} \leq t \leq \text{KONTR} + \text{INT} \\
\text{FERTE} & \text{if } t > \text{KONTR} + \text{INT}
\end{cases}
\]

\[
\text{FK}_t = \begin{cases} 
0.7/\text{INT}, \text{KONTR} \leq t < \text{KONTR} + 2 \cdot \text{INT}/7 \\
1.4/\text{INT}, \text{KONTR} + 2 \cdot \text{INT}/7 \leq t < \text{KONTR} + 5 \cdot \text{INT}/7 \\
0.7/\text{INT}, \text{KONTR} + 5 \cdot \text{INT}/7 \leq t \leq \text{KONTR} + \text{INT}
\end{cases}
\]

\[
\text{PPCSAV}_t(I) = \text{PPCSAV}_{t-1}(I + 1), \ I = 1, \ldots, 14
\]

\[
\text{PPCSAV}_t(\text{TL}) = \text{PTPCR}_t \cdot \text{PRODST} \cdot \frac{1000}{365}
\]

\[
\text{PROPCT}_t = \text{PPCSAV}_t(1)
\]

\[
\text{PROFAC}_t = \frac{\text{PRONOR} - \text{XO}}{(\text{PROPCT}_t - \text{XO})} - 1.0
\]

\[
\text{AMPFO}_t = \text{PROFAC}_t \cdot \text{EO} + 1.0
\]

\[
\text{AMPF}_t(I) = \text{PROFAC}_t \cdot [(\text{EO} - \text{EU}) \cdot \exp(-I/\text{EA}) + \text{EU}] + 1.0
\]

\[
\text{AMPF}_t(86) = \text{PROFAC}_t \cdot \text{EU} + 1.0
\]

\[
\text{BAB}_t = \sum_{I=1}^{86} \text{AP}_t(I) \cdot \text{AF}(I) \cdot \text{FERT}_t
\]
\[
T_{t} = 0.5 \cdot B_{t} \cdot A_{t} \cdot A_{t} \cdot A_{t} + \sum_{i=1}^{86} A_{t}(i) \\
\cdot A_{t}(i) \cdot A_{t} \cdot A_{t}(i)
\]

\[
T_{15t} = 0.5 \cdot B_{t} \cdot A_{t} \cdot A_{t} \cdot A_{t} + \sum_{i=1}^{15} A_{t}(i) \\
\cdot A_{t}(i) \cdot A_{t} \cdot A_{t}(i)
\]

\[
C_{t} = B_{t} / P_{t}
\]

\[
C_{t} = T_{t} / P_{t}
\]

\[
C_{t} = C_{t-1} - C_{t-1}
\]

\[
A_{t+1}(1) = B_{t} \cdot (1.0 - 0.5 \cdot A_{t} \cdot A_{t})
\]

\[
A_{t+1}(i) = A_{t}(i-1) \cdot (1 - A_{t} \cdot A_{t+1}(i-1)), i = 2, \ldots, 85
\]

\[
A_{t+1}(86) = A_{t}(86) \cdot (1 - A_{t} \cdot A_{t}) + A_{t}(85) \cdot (1 - A_{t} \cdot A_{t})
\]

2. Economic Model

\[
C_{N} = C_{N-1} \cdot (1 - DNA) + I_{N}
\]

\[
C_{A} = C_{A-1} \cdot (1 - DA) + I_{A}
\]

\[
C_{DA} = C_{A} \cdot DA
\]
CDNA_t = CNA_t \cdot DNA

YNA_t = CNA_t/QNA

YAX_t = CA_t/QA

Y_t = YNA_t + YA_t

Z_t(I) = AINV(I,1) \cdot YA_t + AINV(I,2) \cdot YNA_t , I = 1,2

U_t(I) = A(I,1) \cdot Z_t(1) + A(I,2) \cdot Z_t(2) , I = 1,2

UA_t = A(2,1) \cdot Z_t(2)

UAF_t = UA_t \cdot UAFK

I_{t+1} = GI \cdot YNA_t \cdot SYSYNA_t

SYSYNA_{t+1} = Y_t / YNA_t

IAS_t = (IAKS_t - IAK) \cdot I_t \geq 0.0

IAKS_t = \text{from time-series}

IA_t = IAK \cdot I_t + K1 \cdot IAS_t

SUAF_t = UAF_t + (1 - K1) \cdot IAS_t

INA_t = I_t - IA_t - (1 - K1) \cdot IAS_t
\[ IR_t = I_t \cdot IRK \]
\[ IMN_t = I_t - IR_t \]
\[ IAP_t = IAPK \cdot IA_t \]
\[ IALV_t = IALVK \cdot IA_t \]
\[ IALD_t = IA_t - IAP_t - IALV_t \]
\[ C_t = GC \cdot Y_t \]
\[ G_t = GG \cdot Y_t \]
\[ M_t = GM \cdot Y_t \]
\[ MA_t = MAK \cdot M_t \]
\[ MI_t = \max(M_t - MA_t, IMN_t) \]
\[ MC_t = M_t - MA_t - MI_t \geq 0.0 \]

3. **Land Use Model**

\[ CLGR_{t+1} = CLGR_t + CLDGR_t - CLWGR_t \geq CLGR_t \]
\[ TLWR_t = \frac{TLW_t}{TLM} \]
\[ TLWM_t = f(TLWR_t) \]
\[ TLAW_t = CGR_t \cdot POP_t \cdot TLWM_t \cdot TLWPCB \]
CLAW_t = TLAW_t · CLM/TLM

CLW_t = TLW_t · CLM/TLM

GLW_t = TLW_t - CLW_t

GL_t = GLM - GLW_t

TLLS_t = GL_t + CLR_t

TLW_{t+1} = TLW_t + TLAW_t

FCLR_t = CLR_t/(CLM - CLW_t)

CLD_t = IALD_t/CCLDH_t

CLDNG_t = CLD_t · CLNG_t/CL_t

CLDGR_t = CLD_t · CLGR_t/CL_t

CLWGR_t = CLAW_t · CLGR_t/CL_t

CLNG_t = TA + TB · CLGR_t

CL_t = CLGR_t + CLNG_t

CLR_t = CLM - CL_t - CLW_t ≥ 0.0

4. Food Production and Distribution

YNAPC_t = YNA_t/POP_t
\[ \text{CAPH}_t = \frac{\text{CA}_t}{\text{CL}_t} \]
\[ \text{PTFC}_t = f(\text{CAPH}_t) \]
\[ \text{PMCI}_t = f(\text{YNAPC}_t) \]
\[ \text{FA}_t = \text{PTFC}_t + \text{PMCI}_t + 1.5 \]
\[ \text{TPF}_t = \frac{\text{SUAF}_t}{\text{PXPF}_t} \]
\[ \text{ZPHG}_t = \left( \frac{\text{TPF}_t}{\text{GZPHK}/\text{CLGR}_t} \right) \cdot 1000 \]
\[ \text{GRPH}_t = \text{FA}_t - (\text{FA}_t - \text{FB}) \cdot \exp(-\text{FC} \cdot \frac{\text{ZPHG}_t}{(\text{FA}_t - \text{FB})}) \]
\[ \text{GRGP}_t = \text{CLGR}_t \cdot \text{GRPH}_t \]
\[ \text{NGGP}_t = \text{PD} + \text{FE} \cdot \text{GRGP}_t \]
\[ \text{SLVMA}_t = \text{RLLVS} \cdot \text{TLLS}_t \]
\[ \text{SLVA}_t = \sum_{I=2,4,5,9} \text{SLV}_t(I) \cdot \text{SLVK}(I) \]
\[ \text{SLVAR}_t = \frac{\text{SLVA}_t}{\text{SLVMA}_t} \]
\[ \text{XLVPLM}_t = f(\text{SLVAR}_t) \]
\[ \text{LVPL}_t(I) = \text{PXLVP}(I) \cdot \text{XLVPLM}_t, \quad I = 1, \ldots, 9 \]
\[ \text{UALV}_t(I) = \text{IALV}_t \cdot \text{SLV}_t(I) \cdot \text{SLVK}(I)/\text{SLVA}_t, \quad I = 1, \ldots, 9 \]
\[\begin{align*}
ALVI_t(I) &= UALV_t(I)/LVPL_t(I), \quad I = 1, \ldots, 9 \\
SLV_{t+1} &= SLV_t(I) + ALVI_t(I), \quad I = 1, \ldots, 9 \\
FGP_t(I) &= \begin{cases} 
SLV_t(I) \cdot SLVMK(I)/1000.0, & I = 1, \ldots, 8 \\
SLV_t(9) \cdot SLVMW(I)/1000.0, & I = 9, \ldots, 12 
\end{cases} \\
SLVV_t &= \sum_{I=1}^{5} FGP_t(I) \\
AWFM_t &= FWCM_t \cdot AWFMK \\
AUFWP_t &= UFWP_t \cdot WB \\
FWCP_t &= UFWP_t \cdot UFWPK \\
UFWP_{t+1} &= UFWP_t + AUFWP_t \leq FWPM \\
FWCM_{t+1} &= FWCM_t + AWFM_t \leq FWMM \\
FWCT_t &= FWCM_t + FWCP_t \\
FWT_t &= FWCT_t \cdot FWCNTK \\
FGP_t(13) &= FWT_t \\
FGP_t(13 + I) &= NGGP_t \cdot NGGPK(I), \quad I = 1, \ldots, 8 \\
FGP_t(21 + I) &= GRGP_t \cdot GRGPK(I), \quad I = 1, \ldots, 5
\end{align*}\]
SFT_t(I) = FGP_t(I) \cdot SPFTK(I) , \quad I = 1, \ldots, 26

FTS_t(I) = FGP_t(I) \cdot (1 - SPFTK(I)) , \quad I = 1, \ldots, 26

LSFT_t(I) = LSFTK(I) \cdot FTS_t(I) , \quad I = 1, \ldots, 26

FTG_t(I) = FFTK(I) \cdot FTS_t(I) , \quad I = 1, \ldots, 26

FTN_t(I) = FTG_t(I) \cdot (1 - XHMLF(I)) , \quad I = 1, \ldots, 26

FSRPC_t(I) = FTN_t(I) \cdot 1000/POP_t , \quad I = 1, \ldots, 26

VCLPCR_t(I) = FSRPC_t(I) \cdot CLK(I) , \quad I = 1, \ldots, 26

VPTPCR_t(I) = FSRPC_t(I) \cdot PTK(I)/100.0 , \quad I = 1, \ldots, 26

PTAPCR_t = \sum_{I=1}^{13} VPTPCR_t(I)

PTPCR_t = \sum_{I=1}^{26} VPTPCR_t(I)

CLPCR_t = \sum_{I=1}^{26} VCLPCR_t(I)

PTAR_t = PTAPCR_t \cdot POP_t/1000

PTR_t = PTPCR_t \cdot POP_t/1000

YPC_t = Y_t/POP_t
\[ \text{PTNM}_t = f(YPC_t) \]
\[ \text{PTPCN}_t = \text{PTPCB} \cdot \text{PTNM}_t \]
\[ \text{SPTPC}_t = \max(\text{PTPCR}_t - \text{PTPCN}_t, 0.0) \]
\[ \text{DPTPC}_t = \max(\text{PTPCN}_t - \text{PTPCR}_t, 0.0) \]
\[ \text{PTPCSN}_t = \frac{\text{PTPCR}_t}{\text{PTPCN}_t} \]
\[ \text{PTN}_t = \frac{\text{PTPCN}_t \cdot \text{POP}_t}{1000.0} \]
\[ \text{DPT}_t = \frac{\text{DPTPC}_t \cdot \text{POP}_t}{1000.0} \]
\[ \text{SPT}_t = \frac{\text{SPTPC}_t \cdot \text{POP}_t}{1000.0} \]
\[ \text{PTPCDR}_t = \frac{\text{PTPCR}_t}{365} \]

5. **Pricing Mechanism**

\[ \text{PXLVP}_t = \text{PXLV} \cdot \text{PXLVK} \cdot \text{PXK}_t \]
\[ \text{GRV}_t = \text{GRGP}_t \cdot \text{PXGR} \cdot \text{PXK}_t \]
\[ \text{NGV}_t = \text{NGGP}_t \cdot \text{PXNG} \cdot \text{PXK}_t \]
\[ \text{LVV}_t = \text{SLVV}_t \cdot \text{PXLVP}_t \]
\[ \text{FSV}_t = \text{FWT}_t \cdot \text{PXFS}_t \cdot \text{PXK}_t \]
\[ \text{YA}_t = \text{GRV}_t + \text{NGV}_t + \text{LVV}_t + \text{FSV}_t \]
\[ YAPC_t = \frac{YA_t}{POP_t} \]
\[ CCLDH_t = f(FCLR_t) \]
\[ PXPTM_t = PXPTM_{t-1} \cdot (1 + RPXPTM) \]
\[ PXK_t = PXK_{t-1} \cdot (1 + RPXPK) \]
\[ PXPF_t = PXPF_{t-1} \cdot (1 + RPXPF) \]
\[ FDMV_t = DPT_t \cdot PXPTM_t \]
\[ FDMAR_t = FDMV_t / YA_t \]
\[ FDMYR_t = FDMV_t / Y_t \]
\[ FDMMR_t = FDMV_t / M_t \]
\[ FDXV_t = YA_t \cdot SPT_t / PTR_t \]
\[ FDXAR_t = FDXV_t / YA_t \]
\[ FDXYR_t = FDXV_t / Y_t \]
\[ FDX9YR_t = FDX9V_t / Y_t \]
\[ FDX9AR_t = FDX9V_t / YA_t \]
\[ PTX9RR_t = PTX9_t / PTR_t \]
\[ PTX9SR_t = PTX9_t / SPT_t \]
\[ ENZ_t = TPF_t \cdot ENZPLK \]
\[ ENZFR = CLPCR_t \cdot \frac{POP_t / ENZ_t}{1000} \]
II. TERMINAL INPUT AND DATA BASE

A. Requests from the Model

Playing with the model requires the input of some specific parameters from the keyboard. For this purpose the model issues some appropriate statements on the keyboard. Following each request there is an example for the expected input. This example is primarily intended to show the user the format by which the data are to be entered rather than to give a meaningful set of data.

During a session some or all of the following requests may be issued:

"ENTER REGION, E.G. 09"
At this the user of the model should enter the number of the region for which he intends to run the model (see Table 1). (At the moment data are available only for regions 01 and 09, i.e. North America and South East Asia.)

"ENTER SCENARIO NUMBER, E.G. 06"
There are some scenarios that are already implemented, which may be found in Table 2. If you want to run the model for one of these scenarios you have to type in the corresponding number at this request. If you want to specify parameters yourself you must type "99".

"IF YOU WANT TO ENTER SCENARIO WITH THE CARD READER TYPE '1' AND HIT 'CR' OTHERWISE TYPE '0'"
This provides the possibility of entering scenario 99 either from the card reader or from the keyboard.

"SCENARIO NUMBER NON-EXISTENT--TRY AGAIN"
This message will be issued if you have typed in a non-existing scenario number. Subsequently you will be asked again for a scenario number.

"ENTER EQUIL. CONTROL START/SPAN, E.G. 1985/35"
At this you must enter the year in which fertility control should start, and the number of years after which the equilibrium fertility factor will be reached (for more details see [1]). The format to be used is I4,1X,I2.

"ENTER PRONOR,EO,EU,EA,XO,TL,PRODST, E.G. 44./1.0/0.5/10./0.0/0.0/1.0"

These parameters are used to compute the mortality multiplier due to lack of protein (for more details see [1]). If you do not want to consider lack of protein you must use EO = EU = 0.0. The input format is shown in the above request (i.e. 7(F3.0,1X)).

"ENTER UAFK,K1,IAPK,IALVK,IAFK, E.G. .14/0.1/0.5/.05/0.0"

These parameters are used in the economic submodel to compute the distribution of investments in the agricultural sector (for more details see [3]). The input format is again shown in the request (i.e. 7(F3.0,1X)).

"ENTER INVESTMENT SHIFT PARAMETERS, E.G. 0.063/0.145/0.145/0.145/0.063/0.063"

This time-series which gives the factor of additional investment to the agricultural sector in time-steps of ten years is used to investigate different investment policies. The input format as shown is 6(F5.3,1X).

"ENTER LAND WITHDRAWAL PER CAPITA E.G. 0.001"

This factor is used to calculate the withdrawal of land due to population growth.

"ENTER GZPHK, E.G. 0.666"

This factor is used to calculate the fraction of fertilizer and other productive factors devoted to grain production.

"ENTER RPXPF,RPXPTM,RPXPK, E.G. 0.025/0.025/0.025"

These factors are the growth parameters of the pricing mechanism.
"ENTER NDRU(21)"

The values of NDRU(I), I = 1, 21 are used to control the output provided by the model which consist of 11 tables and 10 plots. The array is entered by format (I21).

The terms appearing in the above requests denote the following:

IREG : In the M.P. World Model the world has been regionalized. There are ten regions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>North America</td>
</tr>
<tr>
<td>02</td>
<td>Western Europe</td>
</tr>
<tr>
<td>03</td>
<td>Japan</td>
</tr>
<tr>
<td>04</td>
<td>Rest of Developed Countries (i.e. Israel, South Africa, Australia, New Zealand)</td>
</tr>
<tr>
<td>05</td>
<td>East Europe and USSR</td>
</tr>
<tr>
<td>06</td>
<td>Latin America</td>
</tr>
<tr>
<td>07</td>
<td>Middle East</td>
</tr>
<tr>
<td>08</td>
<td>Main Africa</td>
</tr>
<tr>
<td>09</td>
<td>South East Asia</td>
</tr>
<tr>
<td>10</td>
<td>China</td>
</tr>
</tbody>
</table>

ISCEN : There are some scenarios with special sets of parameters available (Table 2). If you want to specify your own parameters you must enter 99.

KONTR (EQUILIBRIUM CONTROL START) : Start of the equilibrium policy; must be a multiple of 5, e.g. 1975, 1985, 2000, etc. If you do not want any equilibrium policies specify 2100.
INT (EQUILIBRIUM CONTROL SPAN) : Length of transition interval, i.e. number of years from the start of the equilibrium policy until the equilibrium fertility factor is reached; must be a multiple of 7, e.g. 0, 14, 35 etc.

PRONOR : Daily amount of per capita protein intake (in grams) below which starvation occurs.

EO : Sensitivity of babies to protein deficiency.

EU : Sensitivity of older people to protein deficiency.

EA : Time constant that indicates the number of years that pass until $E(a) - EU$ drops to 37% of $EO - EU$, where $E(a)$ is defined as

$$E(a) = (EO - EU) \cdot \exp \left( -\frac{a}{EA} \right) + EU$$

("Age specific sensitivity to protein deficiency")

XO : Minimal per capita protein consumption (in grams) per day below which all people die due to a lack of protein.

TL : Time delay in the effect of protein deficiency (in years).

PRODST : Protein distribution factor $0 \leq PRODST \leq 1$ which takes into account inadequacies, and inequities in the distribution system which can occur in less developed regions.
KL : Fraction of additional investment to agricultural capital stock.
IAFK : Investment in fishery, coefficient
IAPK : Investment in agricultural production, coefficient
IALVK : Investment in livestock, coefficient
TLWPCB : Per capita land withdrawal, base value (in ha).
GZPHK : Fraction of fertilizer and other productive factors devoted to grain production, coefficient. This coefficient is used to allocate fertilizers and other productive factors to grain crops.
RPXPF : Rate of price increase, fertilizers and productive factors.
RPXPTM : Rate of price increase, protein imports.
UAFK : Expenditure on fertilizer and related productive factors, coefficient.
RPXPK : Ratio of base price increase for calculation of the value of agricultural production.
IAKSA(I), I = 1,6 : Coefficient for shift of investment to agricultural sector in time-steps of 10 years, i.e. for 1975, 1985, 1995, 2005, 2015 and 2025. This time-series is the main tool to investigate different investment policies. In order to avoid unreasonable changes in food production IAKSA(1) ought to be set equal to IAK.
NDRU(I), I = 1, 21 : In order to get only a selection of the 21 pages of available output you may specify NDRU(I) = 1 to get the I-th page of printout or NDRU(I) = 0 to suppress it.

B. Data Base

In addition to a file which contains the prepared sets of scenario data, the food model uses three files which provide the basic data for the different submodels. You can find the formats that are used to read in the data, and the location of data within the file in the listing of the FORTRAN--program.

The following notations are used for data read from device number 3.

NAME(J), J = 1, 12 : Region label with up to 24 characters
A : 2 × 2 input-output matrix for two-sector economic model
CA : Capital agricultural sector (for 1975 in 10⁹ US $)
CNA : Capital non-agricultural sector (for 1975 in 10⁹ US $)
DA : Depreciation rate, agricultural sector
DNA : Depreciation rate, non-agricultural sector
Y : Gross regional product (1975 in 10⁹ US $)
QNA : Capital per output ratio, non-agricultural sector
ENZPLK : Energy requirements, coefficient
IAK : Investment in agricultural sector, coefficient
IRK : Investment regional, coefficient
GI : Total investment, coefficient
GC : Consumption, coefficient
GG : Governmental expenditures, coefficient
GM : Imports, coefficient
MAK : Agricultural imports, coefficient
TLM : Maximum total land (in $10^6$ ha)
TLW : Total land withdrawn for urbanization and economic development (1975 in $10^6$ ha)
CLM : Maximum cultivable land (1975 in $10^6$ ha)
CLGR : Cultivated grain land (1975 in $10^6$ ha)
TA : Subscript of linear equation relating non-grain land to grain land
      \( CLNG = TB \cdot CLGR + TA \)
TB : Slope of linear equation relating grain land to non-grain land
CCLDH : Capital cost for land development per hectare ($10^3$ US $$/ha)$
         Initial value for 1975
PXLV : Base price of meat ($10^3$ US $$/ton)$
PXLVK : Meat price coefficient
PXK : Price coefficient
PXGR : Price of grain ($10^3$ US $$/ton)$
PXNG : Price of non-grain ($10^3$ US $$/ton)$
PXFS : Price of fish ($10^3$ US $$/ton)$
PXPF : Price of fertilizer and other related productive factors (10^3 US $/ton)

PXPTM : Price of protein imports (10^3 US $/ton)

The following data are read from device number 1:

AP(J), J = 1,86 : Population numbers by one year age groups, initial values for 1975 (in millions of people)

AM(J), J = 1,86 : Age-specific mortality distribution by one year age groups.

AF(J), J = 1,86 : Age-specific fertility by one year age groups

FERTO : Fertility factor for 1975

FERTE : Fertility factor that leads to population equilibrium

AMORT : Mortality factor for 1975

AMO : Mortality factor for babies (1975)

The following data are read from device number 4:

SLVK(J), J = 1,9 : Coefficients to correct individual categories of livestock for purposes of aggregating to a single base unit, by livestock category

PXLVP(J), J = 1,9 : Livestock price, base value, by category (10^3 US $/individual)

CLK(J), J = 1,26 : Calorie content, coefficient by category (cal/gm)

PTK(J), J = 1,26 : Protein content, coefficient, by category (percentage)
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>Minimum level for grain productivity per ha (metric tons)</td>
</tr>
<tr>
<td>FC</td>
<td>Slope of grain productivity curve at minimum level</td>
</tr>
<tr>
<td>FD</td>
<td>Intercept of linear equation relating non-grain yield to grain yield</td>
</tr>
<tr>
<td>FE</td>
<td>Slope of linear equation relating non-grain yield to grain yield</td>
</tr>
<tr>
<td>RLLVS</td>
<td>Land livestock support rate</td>
</tr>
<tr>
<td>AWFMK</td>
<td>Growth rate of marine fish production</td>
</tr>
<tr>
<td>WB</td>
<td>Fish pond growth rate</td>
</tr>
<tr>
<td>UFWP</td>
<td>Relationship between land use and pond fish, factor</td>
</tr>
<tr>
<td>FWCM</td>
<td>Catch of marine fish (initial value for 1975 in $10^6$ tons)</td>
</tr>
<tr>
<td>FWCNTK</td>
<td>Meat from fish, coefficient</td>
</tr>
<tr>
<td>UFWP</td>
<td>Land in pond culture (1975 - value in $10^6$ ha)</td>
</tr>
<tr>
<td>FWPM</td>
<td>Maximum fish production in fish ponds ($10^6$ tons)</td>
</tr>
<tr>
<td>FWMM</td>
<td>Maximum catch of marine fish ($10^6$ tons)</td>
</tr>
<tr>
<td>NGGPK</td>
<td>Coefficients which disaggregate non-grain crop production into 8 categories</td>
</tr>
<tr>
<td>GRGPK</td>
<td>Coefficients which disaggregate grain crop production into 5 categories</td>
</tr>
<tr>
<td>SLV(J), J = 1,9</td>
<td>Total livestock by type</td>
</tr>
</tbody>
</table>
SLVMK(J), J = 1,12 : Meat from livestock coefficient, by type (the types of animal food considered are: beef and veal, lamb and mutton, horse meat, other meat, honey, eggs, poultry, edible offal products, milk, cheese and butter)

SPFTK(J), J = 1,26 : Withdrawal for seed, by category, coefficient

LSFTK(J), J = 1,26 : Withdrawal for livestock food, by category, coefficient

FFTK(J), J = 1,26 : Total human food supply, by type, coefficient

XHMLF(J), J = 1,26 : Household and market losses, by type, coefficient

III. OUTPUT

The M.P. Food Model provides quite a voluminous output. The first page shows the region label and the scenario number as well as a reproduction of the input scenario. The variables listed have the following meaning:

PARAMETER: POUL. SECTOR: see section II

PARAMETER: ECON. SECTOR

QNA : Capital per output ratio, non-agricultural sector

IAK : Investment in agricultural sector, coefficient

MAK : Agricultural imports, coefficient

IRK : Investment, regional, coefficient
 GI : Total investment, coefficient
GC : Consumption, coefficient
GG : Governmental expenditures, coefficient
GM : Imports, coefficient

PARAMETER: LAND SECTOR
TLM : Maximum total land (in $10^6$ ha)
TLW : Total land withdrawn for urbanization and economic development (initial value for 1975, in $10^6$ ha)
CLM : Maximum cultivable land (in $10^6$ ha)
TA : Subscript of linear equation relating grain land to non-grain land
TB : Slope of linear equation relating grain land to non-grain land
CLGR : Cultivated grain land (initial value for 1975, in $10^6$ ha)

PARAMETER: FOOD SECTOR
FB : Minimum level for grain productivity per ha (treated constant for each region)
FC : Slope of grain productivity curve at minimum level
FD : Intercept of linear equation in which production of non-grain crops per ha is calculated as a function of the production of grain crops
FE : Slope of linear equation in which non-grain production is calculated as a function of the grain crops production
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLLVS</td>
<td>Land livestock support rate</td>
</tr>
<tr>
<td>AWFMK</td>
<td>Growth rate of marine fish production</td>
</tr>
<tr>
<td>WB</td>
<td>Fish pond growth rate</td>
</tr>
<tr>
<td>UFWPK</td>
<td>Relationship between land use and pond fish</td>
</tr>
<tr>
<td>FWCM</td>
<td>Catch of marine fish (in 10^6 tons)</td>
</tr>
<tr>
<td>FWCNTK</td>
<td>Meat from fish, coefficient</td>
</tr>
<tr>
<td>UFWP</td>
<td>Land in pond culture (in 10^6 ha)</td>
</tr>
<tr>
<td>SLV</td>
<td>Total livestock, by type; the types of livestock considered are cattle, pigs, sheep and goats, horses, other large animals (mules, asses, buffaloes and camels), bees, chickens, all poultry and dairy animals. Livestock numbers are in million of individuals (only for bees there is the honey production in thousands of metric tons). For more details see [2].</td>
</tr>
<tr>
<td>SLVK</td>
<td>Coefficient to correct individual categories of livestock for purposes of aggregating to a single base unit, by livestock category.</td>
</tr>
<tr>
<td>PARAMETER: PRICE SECTOR</td>
<td></td>
</tr>
<tr>
<td>PXLV</td>
<td>Base price of meat (10^3 US $)</td>
</tr>
<tr>
<td>PXLVK</td>
<td>Meat price coefficient</td>
</tr>
<tr>
<td>PXK</td>
<td>Price coefficient (initial value for 1975)</td>
</tr>
<tr>
<td>PXGR</td>
<td>Price of grain crops (10^3 US $)</td>
</tr>
<tr>
<td>PXNG</td>
<td>Price of non-grain crops (10^3 US $)</td>
</tr>
<tr>
<td>PXFS</td>
<td>Price of fish (10^3 US $)</td>
</tr>
</tbody>
</table>
PXPF : Price for fertilizer and other related productive factors (initial value for 1975), \(10^3\) US $/ton

After that you can produce an output of up to 21 pages consisting of 11 tables and 10 plots, which will be described subsequently. The output is controlled by the array NDRU(I), \(I = 1,21\) which you have to enter from the keyboard at the corresponding request from the program (see section II). As described before you have to set NDRU(I) equal to 1 if you want to get the I-th page and equal to 0 if you want to suppress it.

Page 1: Population Indicators

This page contains 9 time-series for the years 1975-2025 concerning the population sector. The different columns are entitled as follows:

- POP : Total population number (in millions)
- BAB : Number of babies (in millions)
- TOT : Number of deaths (in millions)
- FERT : Fertility factor (not to be mixed up with crude birth rate)
- MORT : Mortality factor (not to be mixed up with crude death rate)
- CBR : Crude birth rate
- CDR : Crude death rate
- CGR : Population growth rate
- TOT15 : Number of dead children (i.e. accumulated number of dead children up to an age of 15 years)
Page 2: Capital

This page provides time-series of some relevant economic indicators. Units are \(10^9\) US $:

- **CA**: Capital stock, agricultural sector
- **CNA**: Capital stock, non-agricultural sector
- **Y**: Gross regional product
- **YA**: Gross regional product, agricultural sector, computed within the pricing mechanism using the output of the food-production submodel
- **YAX**: Gross regional product, agricultural sector, computed within the economic submodel. The values of YAX have been retained so that they can be compared with YA, but they do not have any effect on the computations of the model
- **YNA**: Gross regional product, non-agricultural sector
- **YPC**: Regional product, per capita (10³ US $/ha)

Page 3: Investment

In order to investigate different investment policies several investment indicators are shown on this page. Again units are billions of US $:

- **I**: Total investment
- **IA**: Investment, agricultural sector
- **INA**: Investment, non-agricultural sector
- **IR**: Regional investment
- **IMN**: Imports of investment capital needed
IAP : Investment in non-land agricultural capital stock
IALV : Investment in livestock development
IALD : Investment in land development.

Page 4: Land Indicators

This page presents the output from the land-use submodel. Units are millions of hectares:

CLGR : Cultivated grain land
CLNG : Land cultivated with non-grain crops
CL : Cultivated land ( = grain land + non-grain land)
CLD : Cultivated land developed annually
CLW : Total cultivable land withdrawn
CLR : Cultivable land remaining
TLLS : Total land for livestock support
FCLR : Fraction of cultivable land remaining to total cultivable land
CCLDH : Capital cost for land development per ha (10^3 US $/ha)

Page 5: Agricultural Production

SUAF : Total expenditures on fertilizer and related productive factors (units are billions of US $)
PXPF : Price of productive factors (10^3 US $/ton)
ZPHG : Use of fertilizer and related productive factors (kg/ha)
GRPH : Grain production per ha (ton/ha)
GRGP : Gross production, grain crops (10^6 tons)
NGGP : Gross production, non-grain crops (10^6 tons)
ENZ : Energy required for plant food production (10^{12} cal)
ENZFR : Ratio of energy in produced food to that required for plant food production.

Page 6: **Yield**

In order to investigate the effects of increased fertilizer usage this page provides some details on yield indicators:

YNAPC : Regional product, non-agricultural, per capita (10^3 $/cap.)
PMCI : Productivity coefficient from infrastructure
CAPH : Agricultural capital per ha (10^3 US $/ha)
PTFC : Productivity coefficient from capital investment
FA : Saturation level for grain production (ton/ha)
ZPHG, GRGP : see description of page 5

Page 7: **Livestock and Fish**

This page shows some figures on livestock and fish production:

FWT : Meat from fish (10^6 tons)
SLVA : Total livestock number (corrected to a single base unit) in million of individuals
SLVMA : Total livestock supportable on available grazing land in million of individuals

SLVAR : Ratio of total livestock to maximum livestock supportable

LVPLM : Livestock, price-land multiplier, which is a function of SLVAR

IALV : Investment in livestock development ($10^9$ US $)

Page 8: **Protein Indicators**

In order to analyze the regional food situation some protein indicators have been defined:

- **PTR** : Regional protein production ($10^6$ tons)
- **PTPCR** : Annual protein per capita produced regionally (kg/cap.)
- **DPT** : Regional protein deficit ($10^6$ tons)
- **DPTPC** : Per capita protein deficit (kg/cap.)
- **PTN** : Regional protein needs ($10^6$ tons)
- **PTAR** : Animal protein produced regionally ($10^6$ tons)
- **PTAPCR** : Animal protein per capita, regional (kg/cap.)
- **PTPCSN** : Ratio of protein per capita supply to needs
- **PTPCDR** : Regional daily protein per capita (kg/day)
- **SPT** : Regional protein surplus ($10^6$ tons)
Page 9: **Pricing**

This page shows the dollar values of food production:

- **PXLVP**: Adjusted price of meat ($10^3$ US $/ton)
- **GRV**: Dollar value, grain production ($10^9$ US $)
- **NGV**: Dollar value, non-grain production ($10^9$ US $)
- **SLVV**: Total meat production from livestock ($10^6$ tons)
- **LVV**: Dollar value, livestock production ($10^9$ US $)
- **FSV**: Dollar value, fish production ($10^9$ US $)

Page 10: **Imports**

- **FDMV**: Dollar value of food imports ($10^9$ US $)
- **FDMAR**: Ratio of food imports to agricultural production
- **FDMYR**: Ratio of food imports to total GRP
- **FDMMR**: Ratio of food imports to total imports
- **M**: Total imports ($10^9$ US $)
- **PXPTM**: Price of protein imports ($10^3$ US $/ton$)

Page 11: **Exports**

- **FDXV**: Dollar value of exports ($10^9$ US $)
- **FDXAR**: Ratio of food exports to agricultural production
- **FDXYR**: Ratio of food exports to total GRP
- **FDX9AR**: Ratio of food exported from region 1 to region 9 to agricultural production (not implemented)
FDX9YR : Ratio of food exported from region 1 to region 9 to total GRP (not implemented)

PTX9RR : Ratio of protein exported from region 1 to region 9 to total protein produced regionally (not implemented)

PTX9SR : Ratio of protein exported from region 1 to region 9 to regional protein surplus (not implemented)

The following ten pages are graphical representations of the above tables. Therefore, they will not be discussed in detail:

Page 12: Plot of population indicators (POP,BAB,TOT,TOT15)
Page 13: Plot of population growth indicators (CBR,CDR,CGR)
Page 14: Plot of economic indicators (Y,YA,YAX,YNA)
Page 15: Plot of investment indicators (I,IA,INA,IR,IMN)
Page 16: Plot of land indicators (CLD,CL,CLGR,CLW,CLR)
Page 17: Plot of food production (FWT,SLVA,GRGP,NGGP)
Plot 18: Plot of protein indicators (PTN,PTR,DPT,SPT)
Page 19: Plot of protein per capita (PTPCR,PTA,PTR,DPTPC,PTPCN)
Page 20: Plot of imports (FDMAR,FDMYR,FDMMR)
Page 21: Plot of exports (FDXAR,FDXYR)

IV. BATCH VERSION OF THE M.P. FOOD MODEL

To use the facilities provided by the TH Vienna a batch version of the M.P. Food Model has been implemented on CYBER 74. In this batch version a few additional features have been incorporated which are described below.

In order to treat the investment shift to the agricultural sector appropriately a mechanism has been built that adjusts the scenario variable IAKS in such a way that no starvation occurs, but also no surplus protein is produced. This mechanism can be especially helpful when investigating the impact of population policies.
Economic aid or a food aid program may be specified exogenously by means of the time-series AIDF and AIDT (11 data points for each time-series).

Last but not least, MAXIYR is not fixed (= 2025) but may be set equal to 2075 for studying the long-term behaviour of the model.

Due to these changes in the program the data base is also slightly different from that already described. The whole data base (together with the scenario data) is read from device number 1. The actual location of the data may be found from the program listing and the examples that are given at the end of this section.

There are two additional parameters NFLAG and NPER which denote the following:

**NFLAG:** Control parameter, IF

NFLAG = 1 : IAKS is determined so that after a period of NPER years no starvation occurs (if possible; IAKSA is subject to IAK ≤ IAKS ≤ 1). A time-series for IAKSA must not be given.

NFLAG = 0 : IAKS is calculated according to the time-series IAKSA. The program assumes that the time increments of IAKSA are 10 years. So the number of data points depends on MAXIYR (e.g. 6 data points for MAXIYR = 2025).

**NPER** : This parameter denotes the length of the period over which IAKS is optimized in the sense that no protein deficit or surplus occurs after that period, provided a value of IAKS can be found that obeys to IAK ≤ IAKS ≤ 1.
Assuming that the computations start at year \( t_0 \) this is done by solving the equation

\[
PTPCN_{t_0+NPER} - PTPCR_{t_0+NPER} = 0
\]

numerically. This yields a value \( IAKS_{t_0+NPER} \). The values \( IAKS_{t_0+I} \) \( I = 1, \ldots, NPER-1 \) are determined by means of linear interpolation between \( IAKS_{t_0} \) and \( IAKS_{t_0+NPER} \).

After that the computations consider the interval \( t_0 + NPER \) to \( t_0 + 2 \cdot NPER \) etc.

The values for AIDT and AIDF are read by format (11F6.2). They correspond to 5 year or 10 year increments for MAXIYR = 2025 or MAXIYR = 2075 respectively.

The output of the model provides now an additional page that will be printed if NDRU(12) = 1. The actual printing of the provided plots can be controlled by means of NDRU(I), \( I = 13, \ldots, 22 \) (see Chapter III).
## EXAMPLE 1. Sample set of data for the batch version of the Food Model (without optimizing IAKS)

<table>
<thead>
<tr>
<th>LAND</th>
<th>509.0</th>
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| AP    | 15.77 | 16.18 | 17.12 | 15.75 | 15.49 | 13.75 | 12.92
| AP    | 12.91 | 11.2 | 11.64 | 11.31 | 10.95 | 10.56 | 9.23 | 9.96

### SOUTH EAST ASIA

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| ECO  | 0.144970 | 0.18 | 0.128593 | 0.154979 | 0.299985 | 0.124960 | 0.173960 |

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| FFLVP | 0.12499 | 0.04299 | 0.01499 | 9.09999 | 0.00000 | 0.00500 | 0.00000 | 0.00000 |
| PFLVP | 0.00500 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| CLK  | 2.30 | 4.38 | 2.88 | 0.94 | 1.64 | 2.90 | 1.38 |
| CLK  | 1.63 | 1.43 | 4.65 | 3.00 | 7.16 | 1.32 | 3.50 |
| CLK  | 3.80 | 3.48 | 3.60 | 3.49 | 3.87 | 0.92 | 0.22 |
| CLK  | 3.45 | 2.59 | 2.75 | 2.00 | 0.00 | 20.00 |
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<td>0.1</td>
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<tr>
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<tr>
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<tr>
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</tr>
<tr>
<td>XHLF</td>
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</tr>
<tr>
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<tr>
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<td>1995</td>
<td>35.44</td>
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<td>0.25</td>
</tr>
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<td>0.5</td>
<td>0.05</td>
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<td></td>
</tr>
</tbody>
</table>

TECHN.AI
FOOD AID

111111111111
### EXAMPLE 3. Set of prepared scenarios to be used under DOS

| 09 | 1 2100 00 | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 02 | 2100 00  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 03 | 1995 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 04 | 1975 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 05 | 1975 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 06 | 1995 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 07 | 1985 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 08 | 1985 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
| 09 | 1985 35  | 44.0 | 1.0 | 0.25 | 10.0 | 25.0 | 0.0 | 0.7 | SEA |
|    | 0.500    | 0.0  | 0.5 | 0.05 | 0.022| 0.667| 0.025| 0.025| SEA |
|    | 0.144997 | 0.0  |     |      |      |      |      |      |      |
LISTING 1. Batch version of the Food Model used at TH Vienna

```fortran
PROGRAM MPFOOD(INPUT, OUTPUT, TAPE1=INPUT, TAPE9=OUTPUT)
C
REAL IALV, IALD, NGGP, M, IAFK, IAFV, IAUKA, INA, MA
REAL IAK80, IAK8U, INV, IAS, IAP, IMN, IR, IAKSN
REAL IAKS, KI, IAPK, IALV, MAK, MC, IAK, IRO, IAK, LSFTK, NGGP
DIMENSION A(2,2), NAME(12), AP(6), AF(6), AM(86), SLV(9), PXLVP(9),
1 CLK(26), PTK(26), SPFTK(26), LSFTK(26), FFTK(26), NGGP(8), GRGP(5),
2 SLV(9), SLVMK(12), XHMLF(26), PPCSAV(15)
C
DIMENSION IAKSKA(12)
DIMENSION DRUPDP(9,101), DRUFO1(11,101), DRUF2(6,101), DRUFP3(7,101),
2 DRUFP4(6,101), DRUFR1(6,101), DRUFR2(6,101), DRUFR3(7,101),
DIMENSION OLD(155), AIDT(11), AIDF(11)
COMMON /DRUCK/ DRUPDP, DRUFO1, DRUF2, DRUFR1, DRUFR2, DRUFR3, NAME
COMMON /AIV/ ISTAT, IYR, IREC, ISEN
COMMON /AH/ PTPCR, TLPCR, TLPCF, PDP, CGR, IALD, CCLDH, Y, YA, YNA, C
1 A, CL, CLGR, TLS, FCL, IALV, TPF, SUAF, XPXPF, GRGP, NGGP, SLV, SLVMK, XHMLF
2, F, PTK, SPFTK, LSFTK, FFTK, NGGP, GRGP, SLV, SLVMK, XHMLF
COMMON /POPI/ KONTR, INT
COMMON /POPR/ PROR, EO, EU, EA, K0, TL, CBR, CDR, FERT, AMORT, TOT, TOT15,
1 PRDST, FERTE, FERHT, AM0, AP, AF, AM
COMMON /ECO/ MA, IAFK, IAKS, KI, IAPK, IALV, MAK, YAX, MC, A, DA, DNA, QNA,
1 IAK, IRK, GI, GG, GI, GM, IA, INA, INV, IAS, IAP, IMN, IR, TAOKR, AID
COMMON /LAND1/ TLWPCR, TLW, CLM, TA, TB
COMMON /LAND2/ CLNG, CLD, CLW
COMMON /FD1/ GZPHK, FB, FD, FE, FC, RLLVS, AWFMK, WB, UFWPK, UFWP, FCN, FWCN
1 TK, SLV, PXLVP, CLK, TPT, SPFTK, LSFTK, FFTK, NGGP, GRGP, SLV, SLVMK, XHMLF
2, F, PTK, SPFTK, LSFTK, FFTK, NGGP, GRGP, SLV, SLVMK, XHMLF
COMMON /FOO/ DPT, PTV
COMMON /PRI/ RPXPF, RPXPTM, PXLV, PXLVK, PXK, PXGR, PXNG, PXFS, RPXPF, PXPT
1M
COMMON /PRO/ FDMV, FDMAR, FDMYR, FDMMR, FDXV, FDXAR, FDYR, FDX9YR, FDX9AR
1, PTX99R, PTK9SR
COMMON /OPTIM/ PPCSAV, CAX, SYNSYA, CLR, NFLAG
COMMON /ULD/ OLD
COMMON /AID/ AIDF, AIDT, MAXIYR
C
C
ISTAT = 1975
READ(1, 6000) MAXIYR
K = (MAXIYR - ISTAT)/10 + 1
READ(1, 1500) (NAME(J), J=1,12)
READ(1, 1025) A
READ(1, 1025) CA, CNA, DA, DNA, Y, QNA, ENZPLK
READ(1, 1025) IAK, IRK, GI, GG, GM, MAK
READ(1, 1025) TLW, TLW, CLM, CLGR, TA, TB, CCLDH
READ(1, 1025) PXLV, PXLVK, PXK, PXGR, PXNG, PXFS, RPXPF, PXPTM
C
READ(1, 6000) (AP(J), J=1,86)
READ(1, 6000) (AM(J), J=1,86)
READ(1, 6000) (AF(J), J=1,86)
READ(1, 6000) FERTE, FERTE, AMORT, AM0
C
READ(1, 7000) (SLV(J), J=1,9)
READ(1, 7000) (PXLVP(J), J=1,9)
READ(1, 7200) (CLK(J), J=1,26)
```
PROGRAM MPFOOD 74/74 OPT=1

READ(1,7000) (PTK(J),J=1,26)
READ(1,7200) F5,FC,FD,FE,RLLVS,AWFMK,wb,UFMSPK,FWMH,FWCNTK,UFWP,FWP
I,FWHM
READ(1,7000) (NGGPK(J),J=1,8)
READ(1,7000) (GrGPK(J),J=1,5)
READ(1,7000) (SLV(J),J=1,9)
READ(1,7000) (SLVMK(J),J=1,12)
READ(1,7000) (SPFTK(J),J=1,26)
READ(1,7000) (LSFTK(J),J=1,26)
READ(1,7000) (FFTK(J),J=1,26)
READ(1,7000) (XHMLF(J),J=1,26)

C
1 READ(1,1250) ISCEQ,NFLAG,NPER
READ(1,1250) IREG
READ(1,1290) NSC,KONTR,INT,PRONOR,EO,EU,EA,XO,TL,PRODST
READ(1,1190) K1,IAFK,IAPK,IALVK,TLWPCTB,GPAMK,RPXM,RPXPTM
READ(1,1190) UFK,RPXM
IF (NFLAG.EQ.1) GO TO 92
READ(1,1190) (IAKSA(JJ),JJ=1,K)
92 READ(1,1330) (ADT(JJ),JJ=1,11)
READ(1,1330) (AIDF(JJ),JJ=1,11)
PTPCB = PRONOR*365*0/(1020.0*PRODST)
IAKS = IAK
IY = 0
CALL ECO
CALL LAND
CALL PRICE
WRITE(9,5010) (NAME(J),J=1,12), ISCEQ
WRITE(9,2000)
WRITE(9,2100)
WRITE(9,2200)
WRITE(9,2300) KONTR,INT,PRONOR,EO,EU,EA,XO,TL,PRODST
WRITE(9,2100)
WRITE(9,2210) QNA,IAK,MAK,IRK,GJ,GC,GG,GM,IAPK
WRITE(9,2120)
WRITE(9,2210) UFK, K1,IALVK
IF (NFLAG.EQ.1) GO TO 93
WRITE(9,2110)
WRITE(9,2210) (IAKSA(JJ),JJ=1,K)
93 DO 95 I=1,2
 WRITE(9,2210) (A(I,J),J=1,2)
95 CONTINUE
WRITE(9,2030)
WRITE(9,2170)
WRITE(9,2210) TLH,TLW,CLM,TA,TG,CLGR,TLWPCTB
WRITE(9,2300)
WRITE(9,2130)
WRITE(9,2210) FB,FC,FD,FE,RLLVS,AWFMK,wb,UFMSPK
WRITE(9,2140)
WRITE(9,2120) FWMH,FWCNTK,UFWP,GZPHK
WRITE(9,2150)
WRITE(9,2130)
WRITE(9,2140)
WRITE(9,2130) (SLV(J),J=1,9)
WRITE(9,2130)
WRITE(9,2130)
WRITE(9,2210) (SLVK(J),J=1,9)
IF(NFLAG .EQ. 1) GO TO 8040
JMAX = MAXIYR - ISTAT + 1
KK = JMAX/10
DO 100 K = 1, KK
DIFF = IAKSA(K+1) - IAKSA(K)
DO 101 J = 1, 10
IYR = ISTAT -1 + J*(K-1)*10
IAKS = IAKSA(K) + DIFF*(J-1)/10.0
CALL POPUL
CALL LAND
TPF = SUAF/PXPF
CALL FOOD
CALL PRICE
CALL ECO
100 CONTINUE
IAKS = IAKSA(6)
GO TO 9800
8040 IYR = ISTAT
8050 IF(IYR .GT. MAXIYR) GO TO 120
IAKSO = IAKS +0.05*NPER
IAKSO = AMIN1(IAKSO,1.0)
IAKSO = IAKS - 0.05*NPER
IAKSN = AMAX1(IAKSO,IAK)
NFLAG = 0
CALL SET
9009 IAKSN = (IAKSO + IAKSU)/2.0
DIF = IAKSO - IAKSU
IF(DIF .GT. 1.0E-6) GO TO 9050
NFLAG = 1
9050 IEND = IYR + NPER +1
IEND = MIN0(IEND,MAXIYR)
I1 = IYR
DIF1 = (IAKSN-IAKS)/NPER
XIAK5 = IAKS
DO 9100 J = I1, IEND
IAKS = XIAKS + DIF1*(IYR-I1+1)
CALL POPUL
CALL LAND
TPF = SUAF/PXPF
CALL FOOD
CALL PRICE
CALL ECO
IYR = IYR + 1
9100 CONTINUE
IF(NFLAG .EQ. 1) GO TO 9700
IF (OPTPC .GT. 0.0) GO TO 9500
IAKSO = IAKSN
GO TO 9600
9500 IAKSU = IAKSN
9600 CALL RESLT
GO TO 9722
9720 GO TO 8052
9800 CONTINUE
   IYN = MAXIYR
   CALL POPUL
   CALL LAND
   TPF = SUAF/PXPF
   CALL FOOD
   CALL PRICE
   CALL ECO
120 CONTINUE
   CALL DRUCK(MAXIYR)

C
C
1025 FORMAT(6X,7F10.7,F4.2)
1030 FORMAT(11F6.2)
1050 FORMAT(3I2)
1090 FORMAT(1X,12,2X,14,2X,12,7(3X,F6.3))
1100 FORMAT(7X,7(F9.3),F6.3,3X)
1270 FORMAT(1H,20X,3F12.6)
1500 FORMAT(1PA2)
2000 FORMAT(1H0, " PARAMETER : POPUL. SECTOR ")
2010 FORMAT(1H0, " PARAMETER : ECND. SECTOR ")
2020 FORMAT(1H0, " PARAMETER : FOOD SECTOR ")
2030 FORMAT(1H0, " PARAMETER : LAND SECTOR ")
2040 FORMAT(1H0, " PARAMETER : PRICE SECTOR ")
2100 FORMAT(1H0, " KONTR INT PRONO ")
1H EO
2 PNOO ST " 
2110 FORMAT(1H0, " QNA IAK MAK ")
1 IRK GI GC GG GM
2 IAPK " 
2111 FORMAT(1H0, 29X,4X,"IAKS (1)",4X,"IAKS (2)",4X,"IAKS (3)",4X,"IAKS (4)",4X,"IAKS (5)",4X,"IAKS (6)"")
2115 FORMAT(1H0, " INPUT-OUTPUT MATRIX " )
2120 FORMAT(1H0, " UAFK KI IALV ")
1K " 
2130 FORMAT(1H0, " WLLVS AFWMK FB FC UFWPK " )
1 FE " 
2135 FORMAT(1H0, 29X," CATTLE PIGS SHPGTS HORESES " )
1 MABC HONEY POULTR MPOUL CBSG " 
2136 FORMAT(1H0, 29X," SLVK SLV SLVK SLV SLV " )
1 SLVK SLV " 
2137 FORMAT(1H0, 29X," SLVK SLV SLVK SLVK SLV " )
1 SLVK SLV " 
2140 FORMAT(1H0, " FWCM FWCTK UFW " )
1 P GZPHK " 
2145 FORMAT(1H0, " PXGR PXGL PXFS RPXPF RPXPF RPXPF " )
1 PXK " 
2160 FORMAT(1H0, " TLM TLWPTL TLWPCB " )
1 TA TB CLGR " 
2200 FORMAT(1H0, 29X,4X,14,9X,12,5X,7F12.6)
2210 FORMAT(1H0, 29X,9F12.6)
5001 FORMAT(1H1,12A2,37X,13HSCENARIO RUN ,12)
6000 FORMAT(8X,8F9.5)
PROGRAM MPFOOD    74/74    OPT=1

7003 FORMAT(1X,7F10.5)
6002 FORMAT(1H1)
8003 FORMAT(14)

C
STOP
END
SUBROUTINE RESET
REAL IALV, IALD, NGGP, MA, IAFK, IAFV, INA, M
REAL IAKS, 1, IPK, IALV, MK, MC, IAK, IRC, IAS, LSFTK, NGGP
COMMON /AL/ ISTAT, IY, IEP, IGEV
COMMON /AP/ PTCP, CLPC, PTPC, PTAP, PAP, CGR, IALU, CLDH, Y, YA, YNA, C
1A, CL, CLGR, TLLS, FCLR, IALV, TPF, SAF, PXPF, GGRP, NGGP, SLVV, FWT, M, SPT, PT
2H, ENZPLK, ENZFR, ENZ, SAVV, IAFK, IAFV, YPC, DPTCP
COMMON /CPPR/ PRONOM, EQ, EU, EA, X2, TL, CBR, CDR, FERT, AMORT, TOT, TOT15,
1PRNOM, FERT, AMM, AP, AF, AM
COMMON /ECON/ MA, UAFK, IA, IAKS, K1, IAPK, IALVC, MAK, YAX, MC, A, DA, DNA, QNA,
1IAK, IIR, GI, GC, GG, GM, IA, CNA, INA, IVA, IAS, IA, IMN, IR, TAIOR, AID
COMMON /LANDI/ TLWPC, TLH, TLW, CLM, TA, TB
COMMON /LANDO/ CLNG, CLD, CLM
COMMON /FDII/ GZP, FB, FD, FE, FC, RLLVS, AWFMK, WB, UFWP, UFWP, FCM, FCMN
1TK, SLV, PXLV, CLK, PTK, SPFTK, LSFTK, FTFK, NGGP, GRGPK, SLV, SLVMK, XHMLF
2, FPM, FMM
COMMON /PR/ RPXPF, RPXPTM, PXLV, PXLV, PXK, PXGR, PXNG, PXFS, RPXPF, PXPT
1M
COMMON /OPTM/ PPCSAV, CAX, SYSYN, CLR, NFLAG
COMMON /OLO/ OLO
DIMENSION A(2,2), AP(86), AF(86), AM(86), SLV(9), PXLV(9),
1CLK(26), PTK(26), SPFTK(26), LSFTK(26), FTFK(26), NGGP(8), GRGPK(5),
2SLV(9), SLVMK(12), XHMLF(2), PPCSAV(15)
DIMENSION OLO(155)
IYR = OLO(1)
FERT = OLO(2)
DO 10 I = 1, 86
10 AP(I) = OLO(I)
DO 20 I = 1, 15
20 PPCSAV(I) = OLO(I)
YA = OLO(104)
YNA = OLO(105)
IA = OLO(106)
INA = OLO(107)
CNA = OLO(109)
SYSYN = OLO(110)
TLK = OLO(111)
CLH = OLO(112)
CLDH = OLO(113)
CL = OLO(114)
CLNG = OLO(115)
CLGR = OLO(116)
DO 30 I = 1, 9
30 SLY(I) = OLO(I)
FWCM = OLO(126)
UFWP = OLO(127)
PTPC = OLO(128)
PXX = OLO(129)
PXXTM = OLO(130)
PXXPF = OLO(131)
INV = OLO(132)
IR = OLO(133)
IMN = OLD(134)
IAP = OLD(135)
IALV = OLD(136)
IALU = OLD(137)
IAS = OLD(138)
CLU = OLD(139)
FCLR = OLD(140)
TLLS = OLD(141)
CLW = OLD(142)
Y = OLD(143)
YAX = OLD(144)
AIO = OLD(145)
TAION = OLD(146)
ENZ = OLD(147)
ENZFR = OLD(148)
IAMS = OLD(149)
SUAF = OLD(150)
CA=OLD(151)
RETURN
END
SUBROUTINE SET
REAL  ILAV, ICLP, NCP, *MK, IFLL, IA, YA
REAL  IA, IAS, IAP, IMA, IP
REAL  IAKS, R, IAPK, ILAVK, MAK, MC, IAK, IRK, IA, LSFTK, NGGPK
COMMON /AI/  ISTAT, IYR, IREG, ISEC
COMMON /AM/  PTPCR, CLPCR, PTPCR, PTAPCR, POP, CGR, IALD, CCLDH, Y, YA, YNA, C
IA, CL, CLGR, TLLS, FCLR, ILAV, TPC, SL&F, PXPF, GHGP, NGGP, SLVV, FWT, M, SPT, PT
2R, ENZPLK, ENZFR, ENZ, SAVV, IAFK, IAFV, YPC, DPTPC
COMMON /POP/  PRONOR, EC, EUC, EA, XL, CB, EL, FT, FER, AMORT, TOT, TOT15,
1PRDST, FERTE, FERTO, AM3, AP, AF, AM
COMMON /ECON/  MA, UAFK, IAKS, R, IAPK, IALVK, MAK, YAX, MC, A, DA, DNA, QNA,
1IAK, IRK, GI, CC, GG, GM, IA, CNA, INA, INV, IAS, IAP, IMN, IR, TAIDR, AID
COMMON /LANDI/  TLWPCCB, TLM, TLA, CLM, TA, TB
COMMON /LANDO/  CLNG, CLD, CLW
COMMON /FDI/  ZPSHK, FB, FD, FE, FC, RLLVS, AWFMK, WB, UFZPK, UFZP, FWCN, FWCN
1TK, SLVK, PXLVP, CLK, PTK, SPFTK, LSFTK, FFTK, NGGPK, GRRGP, SLV, SLVMK, XHMLF
2, FWPM, FWMM
COMMON /PRI/  RPXPF, RPXPTM, PXLV, PXLVK, PXK, PXGR, PXNG, PXFS, RPXPK, RPT
1M
COMMON /OPTIM/  PPCSAY, CAX, SYSYNA, CLR, NFLAG
COMMON /OLD/  OLD
DIMENSION  A(2,2), AP(R6), AF(R6), AM(R6), SLVK(22), PXLVP(9),
1CLK(26), PTK(26), SPFTK(26), LSFTK(26), FFTK(26), NGGPK(8), GRRGP(5),
2SLV(9), SLVMK(22), XHMLF(26), PPCSAY(15)
DIMENSION  OLD(155)
OLD(1) = IYR
OLD(2) = FERT
DO 10 I=1, 86
11 = I+2
10  OLD(I) = AP(I)
DO 20 I=1, 15
11 = I+88
20  OLD(I) = PPCSAY(I)
OLD(104) = YA
OLD(105) = YNA
OLD(106) = IA
OLD(107) = INA
OLD(108) = CAX
OLD(109) = CNA
OLD(110) = SYSYNA
OLD(111) = TLW
OLD(112) = CLR
OLD(113) = CCLDH
OLD(114) = CL
OLD(115) = CLNG
OLD(116) = CLGR
DO 30 I=1, 9
11 = I + 116
30  OLD(I) = SLV(I)
OLD(126) = FWCM
OLD(127) = UFZPK
OLD(128) = PTPCR
OLD(129) = PXK
OLD(130) = PXPTM
OLD(131) = PXPF
OLD(132) = INV
OLD(133) = IR
OLD(134) = IMN
OLD(135) = IAP
OLD(136) = IALV
OLD(137) = IALD
OLD(138) = IAS
OLD(139) = CLO
OLD(140) = FCLR
OLD(141) = TLLS
OLD(142) = CLW
OLD(143) = Y
OLD(144) = YAX
OLD(145) = AID
OLD(146) = TAIDR
OLD(147) = ENZ
OLD(148) = ENZFR
OLD(149) = IAKS
OLD(150) = SUAF
OLD(151) = CA
RETURN
END
SUBROUTINE POPUL
REAL IALV,IALU,ALGF,IALF,IALSA
DIMENSION DRCPR(9,101),DRCMC(11,121),DRCSC(8,101),DRLAN(9,101)

COMMON /DRUCPR/,DRCMC,DRCSC,DRLAN,DRUFO1,DRUFO2,DRUFO3,DRCMC
COMMON /POPR/,PROMC,EC,EA,E2,TL,CBR,CDT,FERT,AMRT,TOT,TOT15,
COMMON /AI/,ISTAT,1YF,1EG,ISCEN
COMMON /AP/,PTPCN,CLPCN,PTPC,PTPCM,PTAPCM,POP,CGR,IALD,COLDH,Y,YA,YNA,C
COMMON /ACL,CLG,TLA,FCLR,IALV,TPF,SWAF,PXPF,GRGP,NGGP,SLVV,FWT,M,SPT,PT
COMMON /OPTM/,PPCSAV,CAV,SYSTYPE,CLR,NFLAG

C
C INITIALISATION
C
POP = 0.0
DO 35 J = 1,84
POP = POP + AP(J)
35 CONTINUE
C
C START
C
IF (IYR .EQ. ISTAT) FERT = FERT0
IF (IYR .EQ. KONT) 102,40,42
40 IF (INT) 60,80,45
45 FK = 0.7/INT
IF (IYR .EQ. KONT .EQ. INT) 50,80,80
50 IF (IYR .EQ. KONT) 5*INT/7.0,75.15
60 IF (IYR .EQ. KONT .EQ. 2*INT/7.0.7,75.75
70 FK = 2.0
75 FERT = FERT .EQ. (FERT0 .EQ. FERT) * FK
GO TO 100
80 FERT = FERT
100 CONTINUE
C
C MORTALITY MULTIPLIER
C
IF (EQ .EQ. TL .EQ. 0) GO TO 160
IF (IYR .EQ. ISTAT) GO TO 130
DO 129 I = 1,15
PPCSAV(I) = PRONOR
129 CONTINUE
GO TO 160
130 PPCPR = PTPCR*PROST*1000.0/365.0
PPCPCN = PPCSAV(1)
IMAX = TL+2.5
IF (IMAX .LE. 0 ) IMAX = 1
IF (IMAX = 1) 142,142,135
135 DO 140 I = 2,IMAX
J = I-1
PPCSAV(J) = PPCSAV(I)
140 CONTINUE
142 PPCSAV(IMAX) = PPCPR

C
C
IF (PHONOK .LE. PROFCN) GO TO 160
IF (PROPCN .LE. 0.5) GO TO 143
PROFAC = (PHONOK/PHONOK) / (PROPCN / PROPCN) = 1.0
GO TO 144
143 PROFAC = 40.0
144 AMPF0 = PROFAC*EO + 1.0
AMPF(86) = PROFAC*EU + 1.0
DO 150 I = 1, 85
E = EU
IF (EO + EO, EU, OR, EA, EQ, 0) GO TO 145
E = (EO = EU) * EXP(-1/EA) + EU
145 AMPF(I) = PROFAC*E + 1.0
150 CONTINUE
GO TO 180
160 DO 170 I = 1, 86
AMPF(I) = 1.0
170 CONTINUE
AMPF0 = 1.0
180 CONTINUE
BAb = 0.0
DO 190 I = 1, 86
BAb = BAb + AP(I) * AF(I) * FERT
190 CONTINUE
TOT = 0.5*BAb*AMOf * AMORT*AMPF0
DO 200 I = 1, 15
TOT = TOT + AP(I) * AM(I) * AMORT * AMPF(I)
200 CONTINUE
TOT15 = TOT
DO 205 I = 1, 86
TOT = TOT + AP(I) * AM(I) * AMORT * AMPF(I)
205 CONTINUE
AMPF(86) = AMPF(85) * (1.0 - AMORT*AM(85)*AMPF(85)) + AMPF(86) * (1.0 - AMORT*AM(85)*AMPF(85))
DO 210 I = 1, 84
J = 84 - I
J1 = J + 1
AP(J) = AP(J1) * (1.0 - AMORT*AM(J1) * AMPF(J1))
210 CONTINUE
AP(1) = BAb * (1.0 + 0.5 * AMPF0 * AMORT)
CBF = BAb / POP
CDK = TOT / POP
CGR = CBF = CDR
II = IYR - ISTAT + 1
DRUP0P(1, II) = POP
DRUP0P(2, II) = BAb
DRUP0P(3, II) = TOT
DRUP0P(4, II) = FERT
DRUP0P(5, II) = AMORT
DRUP0P(6, II) = CBF
DRUP0P(7, II) = CDR
DRUP0P(8, II) = CGR
DRUP0P(9, II) = TOT15
POP = 0.0
DO 220 J = 1, 86
P0G = POP + AP(J)
220 CONTINUE
RETURN
SUBROUTINE POPUL  74/74  OPT=1

END

FTN 4,4+R401
SUBROUTINE ECO

DIMENSION A(2,2), AINV(2,2), Z(2), U(2), PPCSAV(15)

DIMENSION DRUC1(11,101), DRUC2(8,101), DRUFO(9,101)

COMMON /DRUCK/ DRUC1, DRUC2, DRUFO

COMMON /IYR/ PPCSAV, CAX, SYSYNA, CLR, NFLAG

COMMON /ISTAT, IYR, ISTAT, ISCEN

COMMON /IYR/ PPCSAV, CAX, SYSYNA, CLR, NFLAG

INITIALISATION

IF (IYR = ISTAT) 10, 40, 40

10 DET = (1, 0 - A(1, 1)) * (1, 0 - A(2, 2)) - A(1, 2) * A(2, 1)

AINV(1,1) = (1, 0 - A(1, 1)) / DET

AINV(2,2) = (1, 0 - A(2, 2)) / DET

AINV(1,2) = A(1, 2) / DET

AINV(2,1) = A(2, 1) / DET

YNA = CNA / QNA

CAX = CA

YA = Y = YNA

YAX = YA

GA = CA / YA

SYSYNA = Y / YNA

Z(1) = AINV(1,1) * YA + AINV(1,2) * YNA

Z(2) = AINV(2,1) * YA + AINV(2,2) * YNA

U(1) = A(1,1) * Z(1) + A(1,2) * Z(2)

U(2) = A(2,1) * Z(1) + A(2,2) * Z(2)

UA = A(2,1) * Z(2)

SUAF = UA * SUAF

TAID = TAID(ISTAT)

TAIDM = TAID / SUAF

I = GI * Y

IA = IAK * I

INA = I - IA

IR = IRA * I

IMN = I - IR

IAP = IAPK * IA

IALV = IALVK * IA

IAFV = IAFK * IA

IALD = IA - IAP - IALV - IAFV

M = GM * Y

GO TO 500

CONTINUE

START

II = IYR - ISTAT + 1

DRUEC1(1,II) = CA

DRUEC1(2,II) = CNA
SUBROUTINE EOC 74/74 OPT=1 FTN 4.4*R40

DRUOC1(3, II) = Y
DRUOC1(4, II) = YA
DRUOC1(5, II) = YAX
DRUOC1(6, II) = YNA
DRUOC1(7, II) = YPC
DRUOC1(8, II) = IAS
DRUOC1(9, II) = I < S
DRUOC1(10, II) = AIO
DRUOC1(11, II) = TAIDR
DRUOC2(1, II) = I
DRUOFP(P, II) = IA
DRUOC2(3, II) = INA
DRUOC2(4, II) = IP
DRUOC2(5, II) = IHN
DRUOC2(6, II) = IAP
DRUOC2(7, II) = IALV
DRUOC2(8, II) = IALD
CAX = CAX*(1.0-DA) + IA
CA = CAX
CNA = CNA*(1.0-DNA) + INA
CDA = CAX*DA
CDNA = CNA*DNA
YAX = CAX/TA
YNA = CNA/GNA
Y = YNA + YA

GROSS OUTPUT, INTERMEDIATE DEMAND

Z(1) = AINV(1, 1)*YA + AINV(1, 2)*YNA
Z(2) = AINV(2, 1)*YA + AINV(2, 2)*YNA
U(1) = A(1, 1)*Z(1) + A(1, 2)*Z(2)
U(2) = A(2, 1)*Z(1) + A(2, 2)*Z(2)
UA = A(2, 1)*Z(2)
UAF = UA*UAFK

INVESTMENT

I = G1*YNA*SYSYN
SYSYN = Y/YNA
IAS = (IAXS - IAK)*I
IAS = AMAX(IAS, 0.0)
IA = IAK*I + K1*IAS
SUAF = UAF + (1.0 - K1)*IAS
AID = TAID(IYR)
TAIDR = AID/SUAF
SUAF = SUAF + AID
INA = I + K1*IAS - IA - IAS
IR = I*IRK
IMN = I - IR
IAP = IAPK*IA
IALV = IALVK*IA
IAFV = IAPF*IA
IALD = IA - IAP - IALV - IAFV

CONSUMPTION, GOVERNMENTAL EXPENDITURES, IMPORTS

C = G*C*Y
SUBROUTINE ECO

G = GG*Y
M = GM*Y
MA = MAX(M, M)

IF (INN - M + MA) > 0
    MI = M - MA
    GO TO 90

80 MI = IMN

90 MC = M - MA - MI
    MC = AMAX1(MC, 0.0)

500 CONTINUE
    RETURN

END
SUBROUTINE LANL
REAL IALV,IALD,NGGP,M,IAFK,IAFV
DIMENSION DRUPOP(4,10),DRUEC1(11,10),DRUEC2(8,10),DRULAN(9,10)
1,DRUP01(17,10),DRUPO2(7,10),DRUPO3(6,10),DRUPO4(10,10),
2,DRUPT(6,10),DRUP2(6,10),DRUP3(7,10),NAME(12)
DIMENSION HFLSAV(15)
COMMON /DRUCK/DRUPOP,DRUEC1,DRUEC2,DRULAN,DRUPO1,
1DRUPO2,DRUPO3,DRUPO4,DRUPR1,DRUPR2,DRUPR3,NAME
COMMON /LANDI/TLWPC,TLW,CLM,TA,TB
COMMON /LANDO/CLNG,CLD,CLW
COMMON /AI/ISTAT,IYR,IREG,ISCEN
COMMON /AR/PTPCR,CLPCR,PTPCH,PTAPCR,POP,CRG,IALD,CCLDH,Y,YA,YNAC,
1A,CL,CLGR,CNL,CLPR,IAVF,IAFV,TPF,SUAF,PXPF,GRGP,NGGP,SLVV,FWT,M,SPT,PT
2K,ENZP,FK,ENZ,SAYV,IAFK,IAFV,YPC,OPTPC
COMMON /OPTIM/PPCSAV,CAX,SYSYNA,CLR,NFLAG

C
C
C
IF(IYR-ISTAT)10,40,40
10 CLNG=TA+TB*CLGR
CLGR=CLM/TLW
CL=CLGR+CLNG
CLW=TLW*CLWR
GLM=TLW-CLM
CLW=CLM-CL=CLW
GO TO 100
40 TLWR=TLW/TLW
II = IYR - ISTAT + 1
DRULAN(1,II) = CLGR
DRULAN(2,II) = CLNG
DRULAN(3,II) = CL
DRULAN(4,II) = CLD
DRULAN(5,II) = CLFR
DRULAN(6,II) = TLLS
DRULAN(7,II) = CLFR
DRULAN(8,II) = FCLR
DRULAN(9,II) = CCLDH
TLW=TLW/FCLR
TLW=CLG*POP*TLW*TLWCB
CLAW=TLAW*CLWR
CLW=TLW*CLWR
GLW=TLW-CLW
GL=GLM-GLW
TLLS=GL+CLR
TLW=TLW+TLAW
FCLR=CLR/(CLM-CLW)
CLD=IALD/CCLDH
CLNG=CLD*CLNG/CL
CLGR=CLD*CLGR/CL
CLFR=CLD*CLGR/CL
CLG=CLGR+CLDF=CLWFR
CLNG=TA+TB*CLGR
CL=CLGR+CLNG
CLR=CLM-CL=CLW
IF(CLR,GT,0)Go TO 100
CLR=0,0
CLD=0,0
SUBROUTINE LAND

CLGR = CLGR + CLGCR + CLNGR
CLNG = TA + TB*CLGR
CL = CLGR + CLNG

END
REAL FUNCTION TLWF(TLWR, IREG)

10 IF (0.2 - TLWR) GT 10.10
   TLWF = -6.1 * TLWR + 1.0
   GO TO 200

200 IF (0.3 - TLWR) GT 30.30
   TLWF = 1.1 - 0.6 * TLWR
   GO TO 200

30 IF (0.4 - TLWR) GT 40.50, 50
   TLWF = 1.28 - 1.2 * TLWR
   GO TO 200

40 IF (0.5 - TLWR) GT 50.60, 70, 70
   TLWF = 1.6 - 2.0 * TLWR
   GO TO 200

50 IF (0.6 - TLWR) GT 60.90, 90
   TLWF = 2.1 - 3.0 * TLWR
   GO TO 200

60 IF (0.65 - TLWR) GT 100, 110, 110
   TLWF = 3.9 - 6.0 * TLWR
   GO TO 200

70 CONTINUE

RETURN
END
SUBROUTINE FOOD
REAL IALV, IALN, NGGP, M, IAFK, IAFV
REAL LSFTK, NGGPK, LVLP, LSFT
DIMENSION PPCSAV(15)
DIMENSION ALVI(9), CLK(26), FFTK(26), FGP(26), FTN(26), FTS(26),
1 FSPLL(26), FGP(26), NGGP(26), PTK(26), PXLVP(9)
2 SFT(26), SLV(4), SLV(4), SLV(4), SPFTK(26), UALV(9), VCLPCR(26),
3 VPTPCK(26), XHMLF(26), FTG(26), LSFT(26)
DIMENSION DRUPPOP(9, 101), DRIECD(11, 101), DRIECD(8, 101), DRUAN(9, 101)
1, DRUF01(10, 101), DRUF02(7, 101), DRUF03(6, 101), DRUF04(10, 101),
2 DRUP1(6, 101), DRUP2(6, 101), DRUP3(7, 101), NAME(12)
COMMON /DRUCK/, DRUPPOP, DRIECD1, DRIECD2, DRUAN, DRUF01,
1 DRUF02, DRUF03, DRUF04, DRUP1, DRUP2, DRUP3, NAME
COMMON /FN1/, GPZPK, F1, FD, FE, FC, RLLVS, AWFHK, WH, UFPWP, UFPF, FWCM, FWCN
1 TK, SLVK, PXLVP, CLK, PTK, SPFTK, LSFTK, FFTK, NGGPK, GRGPK, SLV, SLVK, XHMLF
2, FWPM, FWM
COMMON /FIN/, OPT, PTN
COMMON /I0/, ISTAT, IYR, IREG, ISCEN
COMMON /AR/, PTPCR, CLPCR, PTPCB, PTPCR, POP, CGR, IALO, CCLDM, Y, YA, YNA, C
1A, CL, CLGR, TLLS, FCLR, IALV, TPF, SUA, XPFP, GGAP, NGGP, SLVV, FWT, M, SPT, PT
2R, ENZPLK, ENZFR, ENZ, SAVV, IAFK, IAFV, YPC, DTPC
COMMON /OPTIM/, PPCSAV, CAX, SYNSA, CLR, NFLAG

INITIALISATION

CROP PRODUCTION

YNAPC = YNA/POP
CAPH = CA/CL
PTFC = PTFCF(CAPH, IREG)
PMCI = PMCIF(YNAPC, IREG)
FA = PMCI + PTFC + 1.5
ZPHG = TPF * GPZPK / CLGR * 1000, 0
TEMP = FA - FA
GPHG = FA - TEMP * EXP(= FC/TEMP * ZPHG)
GRGP = CLGR * GPHG
NGGP = FD * FE * GRGP

LIVESTOCK PRODUCTION

SLVMA = RLLVS * TLLS
SLVA = SLV(2) * SLV(2) * SLV(4) * SLV(5) * SLV(9)
SLVAR = SLVA / SLVMA
XLVPLM = XLVPLF (SLVAR, IREG)
DN = 40 J = 1, 9
LVPL(J) = PXLVP(J) * XLVPLM
UALV(J) = IALV * SLV(J) * SLV(K) / SLVA
ALV(J) = UALV(J) / LVPL(J)
SLV(J) = SLV(J) + ALV(J)
40 CONTINUE
60 50 J = 1, 8
FGP(J) = SLV(J) * SLVMK(J) / 1000, 0
50 CONTINUE
80 62 J = 9, 12
FGP(J) = SLV(9) * SLVMK(J) / 1000, 0
62 CONTINUE
SUBROUTINE FOOD 74/74 OPT=1

SLVV = 0.0
GO TO 70 J=1,5
SLVV = SLVV + FGP(J)
70 CONTINUE
SAVV = FGP(7) + FGP(8) + FGP(9)

FISH PRODUCTION

IF(IYR.EQ. ISTAT) GO TO 88
AWFM = FWCH*AWFMK
AUFWP = UFWP*WBP
88 FWCP = UFWP*UFWPK
UFWP=A MIN1(UFWP+AUFWP,FKPM)
FWCM = A MIN1(FWCM*AWFM,FWMM)
FWCT = FWCM + FWCP
FWI = FWCT*FWNTK
FGP(13) = FWT

FOOD PRODUCTION

DO 88 J=14,21
I=J-13
FGP(J)= NGGP*NGGPK(I)
88 CONTINUE
DO 90 J=22,26
I=J-21
FGP(J)= GRGP*GRGPK(I)
90 CONTINUE
CLPCR = 0.0
PTPCR = 0.0
DO 120 J=1,26
SFT(J) = FGP(J)*SPFTK(J)
FTS(J) = FGP(J)
LSFT(J) = LSFTK(J)*FTS(J)
FTG(J) = FFTK(J)*FTS(J)
FTN(J) = FTG(J)*FTL(J)
FSHPC(J) = FTN(J)*1000.0/PDP
VCLPCR(J) = FSHPC(J)*CLK(J)
VPTRCR(J) = FSHPC(J)*PTK(J)/100.0
CLPCR = CLPCR + VCLPCR(J)
PTPCR = PTPCR + VPTPCR(J)
120 CONTINUE
PTAPCR = 0.0
DO 110 J=1,13
PTAPCH = PTAPCR + VPTPCR(J)
110 CONTINUE
PTAR = PTAPCR*POP/1000.0

NEEDS

PTH = PTAPCR*POP/1000.0
AID = FAID(IYR)
PTCPH = (PTR + AID)*1000.0/PDP
FAIDR = 4ID/PTR
YP = Y/PDP
PTNM = PTNMF(YPC,IERG)
PTPCN = PTPCN*PTNM
SUPOUTINE F00D  74/74  OPT=1  FTN 4.4+R4

SPTPC  =  AMAX1(PTPCR - PTPCN, 0.0)
OPTPC  =  AMAX1(PTPCN - PTPCR, 0.0)
PTPCSN =  PTPCR/PTPCN
PTN  =  PTPCN*POP/1000,0
OPT =  OPTPC*POP/1000,0
SPT =  SPTPC*POP/1000,0
PTPCVR =  PTPC4/365,0
II  =  IYR  -  ISTAT  +  1
DRUF01(1, II) =  SUAF
DRUF01(2, II) =  PXPF
DRUF01(3, II) =  ZPHG
DRUF01(4, II) =  GRPM
DRUF01(5, II) =  GRGP
DRUF01(6, II) =  NGGP
DRUF01(7, II) =  ENZ
DRUF01(8, II) =  ENZFR
DRUF01(9, II) =  AIO
DRUF01(10, II) =  FAIDR
DRUF02(1, II) =  YNAPC
DRUF02(2, II) =  PMCI
DRUF02(3, II) =  CAPM
DRUF02(4, II) =  PTFC
DRUF02(5, II) =  FA
DRUF02(6, II) =  ZPHG
DRUF02(7, II) =  GRPM
DRUF03(1, II) =  FWT
DRUF03(2, II) =  SLVA
DRUF03(3, II) =  SLVMA
DRUF03(4, II) =  SLVAR
DRUF03(5, II) =  XLVPLM
DRUF03(6, II) =  IALV
DRUF04(1, II) =  PTR
DRUF04(2, II) =  PTPCR
DRUF04(3, II) =  DPT
DRUF04(4, II) =  DPTPC
DRUF04(5, II) =  PTN
DRUF04(6, II) =  PTAR
DRUF04(7, II) =  PTAPCR
DRUF04(8, II) =  PTPCSN
DRUF04(9, II) =  PTPCDR
DRUF04(10, II) =  SPT

500  CONTINUE
RETURN
END
REAL FUNCTION PTFCF(CAPM, IREG)
PTF CF = 0.2171468 * ALOG(CAPM) + 1.0
RETURN
END
REAL FUNCTION PMCIF(YNAPC,IREG)

PMCIF = 0.1737361*ALOG(YNAPC) + 1.4

END
FUNCTION XLVPLF

C

REAL FUNCTION XLVPLF(SLVAR,IREG)
IF(SLVAR = 1.0) 10, 10, 20
10 XLVPLF = SLVAR/1.0 + 0.9
GO TO 30
20 XLVPLF = EXP(ALOG(2.0)*(2.0*SLVAR - 1.0)) = 1.0
30 CONTINUE
RETURN
END
C

REAL FUNCTION PTNMF(YPC,IREG)
IF (IREG .NE. 9) GO TO 35
IF (YPC .LT. 0.13) 15,16,15
10 PTNMF = 1.0
   GO TO 40
15 XHELP = 1.0 - 3.58/(YPC+0.13006)
   IF (XHELP) 20,20,30
20 PTNMF = 1.0 + (80.0*EXP(XHELP))/44.0
   GO TO 40
30 PTNMF = 1.0 + 80.0/44.0
   GO TO 40
35 PTNMF = 1.0
40 CONTINUE
   RETURN
END

SUBROUTINE PRICE

REAL ILVL, ILEN, NGRP, Y, IAFL, JAFV
DIMENSION PCSAV(15)
DIMENSION DRUFC1(11,11), DRUFC2(6,101), DRULAN(9,101)
1, DRUFC1(11,11), DRUFC2(6,101), DRULAN(9,101),
2, DRUPR1(6,11), DRUPR2(6,101), DRUHP3(7,101), NAME(12)
COMMON /DRUFC1/, /DRUFC2/, /DRULAN/, /DRUFO1/,
L, DRUFO2, DRUFO3, DRUFO4, DRUPR1, DRUPR2, DRUHP3, NAME
COMMON /IAI/, /ISTAT/, /IYR/, /IREG/, /ISCEN/
COMMON /PCSCAV/, /LCLCR/, /PTPC1/, /PTPC2/, /PTAFCR/, /PCFG/, /ICR/, /IALD/, /CCLD/, /V, /Y, /A, /C /
1, /CL/, /CLG/, /TLLS/, /
2, /FCL/, /IALV/, /TFP/, /SUAF/, /PXPF/, /GRSP/, /NGGP/, /SLV/, /FMT/, /M/, /SPT/, /PT /
3, /E7FLK/, /E7ZV/, /E7FV/, /SADV/, /IAFL/, /IAFV/, /YP/, /PCPTC /
COMMON /PR1/, /PXPF/, /PXPTM/, /PXLV/, /PXLVK/, /PXLR/, /PXNG/, /PXFS/, /PXPK/, /PXPR/
1, /PXQR/, /PXSR/
COMMON /PFO/, /FOMAR/, /FDMMR/, /FDXV/, /FDXR/, /FDX9R/, /FDX9AR /
1, /PTXQR/, /PTXSR/
COMMON /FUV/, /DPT/, /PTN/
COMMON /OPTIM/, /PPCSAV/, /CA/, /SYSCN/, /CLR/, /NFLAG /
REAL NGV, LVV

INITIALISATION

IF(IYR-ISTAT) 10, 30, 30
10 TPF = SUAF/PXPF
GO TO 100
30 PXLVP = PXLV*PXLV*PXK
GRV = GRGP*PXGR*PXK
NGV = NGGP*PXNG*PXK
LVV = SLV*PXLVP
FSV = FMT*PXFS*PXK
YA = GRV+NGV+LVV+FSV
YAPC=YA/POP
IF (FCLR=1, &PE=10) 40, 40, 35
35 CCLDH = Y*CCLD(FCLR, IREG)
GO TO 50
40 CCLDH = 1.0E+10
50 CONTINUE

IMPORTS

FDMV = DPT*PXPTM
FDMAR = FDMV/YA
FDXVY = FDMV/Y
FDX9R = FDMV/Y
FDX9AR = FDMV/YA
PTX9AR = PTX9/PTR
PTX9SR = 0.0
IF (SPT .GE. 1.0E-5) PTX9SR = PTX9/SPT
C ENERGY

ENZ = TPF*ENZPLK
ENZFR = CLFCR*PDP/ENZ/100000
II = IYR - ISTAT + 1
DRUP1(1,II) = PXLVP
DRUP1(2,II) = GNV
DRUP1(3,II) = NGV
DRUP1(4,II) = SLVV
DRUP1(5,II) = LVV
DRUP1(6,II) = FSV
DRUP2(1,II) = FDMV
DRUP2(2,II) = FDMAR
DRUP2(3,II) = FDMVR
DRUP2(4,II) = FDMMR
DRUP2(5,II) = M
DRUP3(6,II) = PXPTM
DRUP3(1,II) = FDXV
DRUP3(2,II) = FDXAR
DRUP3(3,II) = FDXMR
DRUP3(4,II) = FDX9YV
DRUP3(5,II) = FDX9AR
DRUP3(6,II) = PTX9RR
DRUP3(7,II) = PTX9SR
PXPTM = PXPTM*(1.0+RPXPTM)
PXK = PXK*(1.0+RPXPK)
PXPF = PXPF*(1.0+RPXPF)

100 CONTINUE
RETURN
END
REAL FUNCTION XKCLDH(FCLR,IREG)
GO TO (120,200,210,220,230,240,250,260,270,280,900,990)IREG
120 IF (.45-FCLR) 120,140,140
120 XKCLDH = 2.1
GO TO 2000
140 IF (.1-FCLR) 140,160,170
160 XKCLDH = -(2.2*FCLR)/0.55 + 2.3 + 0.22/0.55
GO TO 2000
180 XKCLDH = (2.3+(.1-FCLR)*16.0)
GO TO 2000
200 XKCLDH = 1.2 +.8*EXP(-16.87*FCLR)
GO TO 2000
900 IF (.1-FCLR) 910,910,920
910 XKCLDH = -.35*FCLR + .155
GO TO 220
920 IF (.05-FCLR) 930,930,940
930 XKCLDH = -.6*FCLR + .68
GO TO 220
940 IF (.03-FCLR) 950,950,960
950 XKCLDH = -.25*FCLR + 1.65
GO TO 220
960 IF (.01-FCLR) 970,970,980
970 XKCLDH = -.105*FCLR + 4.05
GO TO 220
980 XKCLDH = -9700.0*FCLR + 100.0
2000 CONTINUE
RETURN
END
SUBROUTINE DRUCK(MAXIYR)
DRUCK PROGRAMM FUR FOO D ANALYSIS PACKAGE
DIMENSION DRUPD(9,11), DRUEC1(11,101), DRUEC2(8,101), DRULAN(9,101)
1, DRUF01(7,1,101), DRUF02(7,1,101), DRUF03(4,101), DRUF04(10,101),
2, DRUPR1(6,1,11), DRUPR2(6,1,11), DRUPR3(7,1,11), NAME(12), FLD(9,51)
DIMENSION NDRU(22)
COMMON/DRUCK/ DRUPD, DRUEC1, DRUEC2, DRULAN, DRUF01,
1, DRUF02, DRUF03, DRUF04, DRUPP1, DRUPR2, DRUPR3, NAME

READ(1,BM06) (NDRU(I),I=1,22)
JJ=MAXIYR-1974
DO 235 J=1,22
IF (NDRU(1).NE.1) GO TO 235
DO TO(1,2,3,4,5,6,7,8,9,11,12,10,13,14,15,16,17,18,19,21,22,23),1
1 WRITE(9,1320) (NAME(J),J=1,12)
WRITE(9,1320)
DO 20 J=1,JJ
IYR = 1974 + J
WRITE(9,1310) IYR, (DRUPD(P,L,J),L=1,9)
20 CONTINUE
GO TO 235
2 WRITE(9,1520) (NAME(J),J=1,12)
WRITE(9,1330)
DO 30 J=1,JJ
IYR = 1974 + J
WRITE(9,1340) IYR, (DRUEC1(L,J),L=1,7)
30 CONTINUE
GO TO 235
3 WRITE(9,1510) (NAME(J),J=1,12)
WRITE(9,1350)
DO 40 J=1,JJ
IYR = 1974 + J
WRITE(9,1360) IYR, (DRUEC2(L,J),L=1,8)
40 CONTINUE
GO TO 235
4 WRITE(9,1520) (NAME(J),J=1,12)
WRITE(9,1370)
DO 50 J=1,JJ
IYR = 1974 + J
WRITE(9,1380) IYR, (DRULAN(L,J),L=1,9)
50 CONTINUE
GO TO 235
5 WRITE(9,1530) (NAME(J),J=1,12)
WRITE(9,1390)
DO 60 J=1,JJ
IYR = 1974 + J
WRITE(9,1400) IYR, (DRUF01(L,J),L=1,8)
60 CONTINUE
GO TO 235
6 WRITE(9,1540) (NAME(J),J=1,12)
WRITE(9,1410)
DO 70 J=1,JJ
IYR = 1974 + J
WRITE(9,1340) IYR, (DRUF02(L,J),L=1,7)
70 CONTINUE
GO TO 235
SUBROUTINE DRUCK  74/74  OPT=1  FTN 4.4+R401

1  WRITE(9,1550)  (NAME(J),J=1,12)
WRITE(9,1430)  
DO 99 J=1,11
  IYK = 1974+J
  WRITE(9,1440)  IYK,(DRUFO3(L,J),L=1,6)
99 CONTINUE
  GO TO 235

8  WRITE(9,1560)  (NAME(J),J=1,12)
WRITE(9,1440)  
DO 90 J=1,11
  IYK = 1974+J
  WRITE(9,1385)  IYR,(DRUFO4(L,J),L=1,10)
90 CONTINUE
  GO TO 235

9  WRITE(9,1570)  (NAME(J),J=1,12)
WRITE(9,1450)  
DO 100 J=1,11
  IYR = 1974+J
  WRITE(9,1400)  IYR,(DRUPR1(L,J),L=1,6)
100 CONTINUE
  GO TO 235

10 WRITE(9,1580)  (NAME(J),J=1,12)
WRITE(9,1460)  
DO 110 J=1,11
  IYR = 1974+J
  WRITE(9,1400)  IYR,(DRUPR2(L,J),L=1,6)
110 CONTINUE
  GO TO 235

11 WRITE(9,1590)  (NAME(J),J=1,12)
WRITE(9,1470)  
DO 120 J=1,11
  IYR = 1974+J
  WRITE(9,1340)  IYR,(DRUPR3(L,J),L=1,7)
120 CONTINUE
  GO TO 235

12 WRITE(9,1600)  (NAME(J),J=1,12)
WRITE(9,1480)  
DO 130 J=1,11
  IYR = 1974+J
  WRITE(9,1402)  IYR,(DRUEC1(L,J),L=8,11),(DRUF01(L,J),L=9,10)
130 CONTINUE
  GO TO 235

13 WRITE(9,3020)  (NAME(J),J=1,12)
WRITE(9,3010)  
DO 139 J=1,51
  FELD(1,J) = DRUPOP(1,J)/20.0
  FELD(2,J) = DRUPOP(2,J)
  FELD(3,J) = DRUPOP(3,J)
  FELD(4,J) = DRUPOP(9,J)
  FELD(5,J) = 0.0
130 CONTINUE
  CALL BILD(FELD,4)
  GO TO 235

14 WRITE(9,3020)  (NAME(J),J=1,12)
WRITE(9,3010)  
DO 149 J=1,51
  FELD(1,J) = DRUPOP(6,J)
FPOP(1,J) = DRUPOP(7,J)
FPOP(2,J) = DRUPOP(8,J)
FPOP(3,J) = 0.0
FPOP(4,J) = 0.0
140 CONTINUE
CALL BILD(FIELD,3)
GO TO 235
15 WRITE(9,3050) (NAME(J),J=1,12)
WRITE(9,3050)
DO 150 J=1,51
FPOP(1,J) = DRUEC1(3,J)
FPOP(2,J) = DRUEC1(4,J)
FPOP(3,J) = DRUEC1(5,J)
FPOP(4,J) = DRUEC1(6,J)
FPOP(5,J) = 0.0
150 CONTINUE
CALL BILD(FIELD,4)
GO TO 235
16 WRITE(9,3060) (NAME(J),J=1,12)
WRITE(9,3070)
DO 160 J=1,51
FPOP(1,J) = DRUEC2(1,J)
FPOP(2,J) = DRUEC2(2,J)
FPOP(3,J) = DRUEC2(3,J)
FPOP(4,J) = DRUEC2(4,J)
FPOP(5,J) = DRUEC2(5,J)
160 CONTINUE
CALL BILD(FIELD,5)
GO TO 235
17 WRITE(9,3080) (NAME(J),J=1,12)
WRITE(9,3090)
DO 170 J=1,51
FPOP(1,J) = DRUPLAN(4,J)
FPOP(2,J) = DRUPLAN(3,J)
FPOP(3,J) = DRUPLAN(1,J)
FPOP(4,J) = DRUPLAN(5,J)
FPOP(5,J) = DRUPLAN(6,J)
170 CONTINUE
CALL BILD(FIELD,5)
GO TO 235
18 WRITE(9,3100) (NAME(J),J=1,12)
WRITE(9,3110)
DO 180 J=1,51
FPOP(1,J) = DRUFD3(1,J)
FPOP(2,J) = DRUFD3(2,J)
FPOP(3,J) = DRUFD4(5,J)
FPOP(4,J) = DRUFD4(6,J)
FPOP(5,J) = 0.0
180 CONTINUE
CALL BILD(FIELD,4)
GO TO 235
19 WRITE(9,3120) (NAME(J),J=1,12)
WRITE(9,3130)
DO 190 J=1,51
FPOP(1,J) = DRUFD4(5,J)
FPOP(2,J) = DRUFD4(1,J)
FPOP(3,J) = DRUFD4(3,J)
FELD(4,J) = DRUFO4(10,J)
FELD(5,J) = 0.0
190 CONTINUE
CALL BILD(FELD,4)
GO TO 235
21 WRITE(9,3140) (NAME(J),J=1,12)
WRITE(9,3150)
DO 210 J=1,51
FELD(1,J) = DRUFO4(2,J)
FELD(2,J) = DRUFO4(7,J)
FELD(3,J) = DRUFO4(4,J)
SPTPC = DRUFO4(12,J)*1000.0/DRUP0P(1,J)
IF (SPTPC .GT. 0) FELD(3,J) = SPTPC
FELD(4,J) = 25.0
FELD(5,J) = 0.0
200 CONTINUE
CALL BILD(FELD,4)
GO TO 235
22 WRITE(9,3160) (NAME(J),J=1,12)
WRITE(9,3170)
DO 220 J=1,51
FELD(1,J) = DRUPR2(2,J)
FELD(2,J) = DRUPR2(3,J)
FELD(3,J) = DRUPR2(4,J)
FELD(4,J) = 0.0
FELD(5,J) = 0.0
210 CONTINUE
CALL BILD(FELD,3)
GO TO 235
23 WRITE(9,3165) (NAME(J),J=1,12)
WRITE(9,3175)
DO 230 J=1,51
FELD(1,J) = DRUPR3(2,J)
FELD(2,J) = DRUPR3(3,J)
FELD(3,J) = 0.0
FELD(4,J) = 0.0
FELD(5,J) = 0.0
220 CONTINUE
CALL BILD(FELD,3)
235 CONTINUE
1300 FORMAT(1H1,12A2,3X,"POPULATION INDICATORS")
1310 FORMAT(1H1,14A8,9F12.6)
1320 FORMAT(1H0,12X," POP B A B B T O T F E R T")
1330 FORMAT(1H0,24X," C A C N A Y Y A")
1340 FORMAT(1H0,10X,14A8,7F12.6)
1350 FORMAT(1H0,10X,14A8,7F12.4)
1360 FORMAT(1H0,10X,14A8,7F12.5)
1370 FORMAT(1H0,12X," I I A N A I R")
1380 FORMAT(1H0,12X," I A N A I R")
1390 FORMAT(1H0,24X," S U A F P X P F Z P M G G R P H")
1 GRGP NGGP ENZ ENZFR "")
1402 FORMAT(1H,16X,14,8X,5F12.4,3F12.6)  
1401 FORMAT(1H,12X,14,8X,F12.5,F12.6,F12.3,F12.6,3F12.4,F12.6)  
1400 FORMAT(1H,16X,14,8X,3(F12.4,F12.6))  
1417 FORMAT(1H0,24X,"YNAPE" PMLI CAPIH 
1 PTNC  
1 FA "ZPHM GRPH ",/  
1 LVPD "IALV 
1440 FORMAT(1H0,8X,"PTR PCPPC PTCPSN PTPCWR SPT 
1  "/  
1450 FORMAT(1H0,30X,"PXLPV GRV NVG SLVV 
1460 FORMAT(1H0,30X,"FDNX FDMMR FDMR 
1 M "/  
1470 FORMAT(1H0,24X,"FDYV FDYAR FDXYR FDX9YR 
1 FDY9AR PT9AR PTTAPCR PTPCSCD SPT 
2 "/  
1480 FORMAT(1H0,35X,"IAS",7X,"IAMS",7X,"TECHN.AID",2X,"T.AID/SUAF",4X, 
1 "FOOD AID",3X,"F.AID/PTC")  
1505 FORMAT(1H1,12A2,30X,"CAPITAL ")  
1510 FORMAT(1H1,12A2,30X,"INVESTMENT ")  
1520 FORMAT(1H1,12A2,30X,"LAND INDICATORS")  
1530 FORMAT(1H1,12A2,30X,"AGRICULTURAL PRODUCTION")  
1540 FORMAT(1H1,12A2,30X,"YIELD")  
1550 FORMAT(1H1,12A2,30X,"LIVESTOCK AND FISH ")  
1560 FORMAT(1H1,12A2,30X,"PROTEIN INDICATORS")  
1570 FORMAT(1H1,12A2,30X,"PRICE ")  
1580 FORMAT(1H1,12A2,30X,"IMPORTS ")  
1590 FORMAT(1H1,12A2,30X,"EXPORTS ")  
1600 FORMAT(1H1,12A2,30X,"SHIFT AND AID")  
1610 FORMAT(1H1,12A2,40X,"POPUL. INDICATORS")  
1620 FORMAT(1H1,12A2,40X,"POPUL. GROWTH INDICATORS")  
1630 FORMAT(1H1,12A2,40X,"ECON. INDICATORS")  
1640 FORMAT(1H1,12A2,40X,"INVESTMENT")  
1650 FORMAT(1H1,12A2,40X,"LAND INDICATORS")  
1660 FORMAT(1H1,12A2,40X,"FOOD PRODUCTION")  
1670 FORMAT(1H1,12A2,40X,"PROTEIN INDICATORS")  
1680 FORMAT(1H1,12A2,40X,"PROTEIN PER CAPUT")  
1690 FORMAT(1H1,12A2,40X,"IMPORTS")  
1700 FORMAT(1H1,12A2,40X,"EXPORTS")  
3010 FORMAT(1H0,"POP = 1 (SCAL.FACT. = 20.0), BAB = 2, TOT = 3, TOT1 
15 = 4 ")  
3030 FORMAT(1H0,"CBR = 1, COD = 2, CGR = 3")  
3050 FORMAT(1H0,"Y = 1, YA = 2, YAX = 3, YNA = 4")  
3070 FORMAT(1H0,"I = 1, IA = 2, INA = 3, IR = 4, IMN = 5")  
3090 FORMAT(1H0,"CLD = 1, CL = 2, CLGR = 3, CLW = 4, CLR = 5")  
3110 FORMAT(1H0,"FWT = 1, SLVA = 2, GRGP = 3, NGGP = 4")  
3130 FORMAT(1H0,"PTN = 1, PTR = 2, DPT = 3, SPT = 4")  
3150 FORMAT(1H0,"PTPCR = 1, PTAPCR = 2, DPTPC(SPTPC) = 3, PTPC(PB) 
15 VALUE = 4")  
3170 FORMAT(1H0,"FDMMR = 1, FDMR = 2")  
3175 FORMAT(1H0,"FDY9AR = 1, FDYAR = 2")  
8005 FORMAT(1H1)  
8006 FORMAT(2311)  
STOP  
END
SUBROUTINE BILD(EING, NR)
DIMENSION FELD(102), EING(5, 51), Z(51), CL(5)
DATA CL /"1", "2", "3", "4", "5"/
DATA STR /"=" , "BL", "/, SPA /" I"/
X: MAX = EING(1, 1)
X: MIN = X: MAX
DO 10 J = 1, 51
DO 10 i = 1, 5
X = X: MAX - EING(I, J)
IF(X .LT. 0) X: MAX = EING(I, J)
X = X: MIN - EING(I, J)
IF(X .GT. 0) X: MIN = EING(I, J)
10 CONTINUE
IF(X: MAX .NE. X: MIN) GO TO 15
IF(X: MAX .EQ. 0, 0) X: MAX = 1.0
X: MAX = X: MIN + 0.5*ABS(X: MAX)
X: MIN = X: MIN - 0.5*ABS(X: MAX)
15 DIFF = X: MAX - X: MIN
SPR = DIFF/50.0
Z(I) = X: MAX
DO 20 K = 2, 51
Z(K) = Z(K-1) - SPR
20 CONTINUE
Y = SPR/2.0
NZ = 50
DO 30 K = 1, 51
NZ = NZ + 1
IF(NZ .EQ. 51) GO TO 50
DO 40 I = 1, 102
40 FELD(I) = BL
DO 45 I = 2, 102, 10
45 FELD(I) = SPA
GO TO 60
50 DO 55 I = 1, 102
55 FELD(I) = STR
NZ = 1
60 CONTINUE
FELD(I) = Z(K)
DO 70 I = 1, NR
M = 0
DO 65 J = 1, 50
M = M + 2
XHELP = ( EING(I, J+1) + EING(I, J)) / 2.0
A = EING(I, J) - Z(K)
IF(A .LT. -Y) GO TO 63
IF(A .GT. Y) GO TO 63
FELD(M) = CL(I)
63 A = XHELP - Z(K)
IF(A .LT. -Y) GO TO 65
IF(A .GT. Y) GO TO 65
FELD(M+1) = CL(I)
65 CONTINUE
A = EING(I, 51) - Z(K)
IF(A .LT. -Y) GO TO 70
IF(A .GT. Y) GO TO 70
FELD(102) = CL(I)
70 CONTINUE
SUBROUTINE BILD

80 WRITE(9,1060) (FELD(J), J=1,102)
WRITE(9,1010)

C
C
100 FORMAT(1X,11,1,2X,1X,141)
101 FORMAT(1X,1975,7X,8C,6X,85)
1 05 10 15 20 25 90 95 2000
RETURN
END
REAL FUNCTION FAID(IYR)
DIMENSION AIOT(IYR),AIDF(IYR)
COMMON /AIOT/AIDF,AIOT,MAXIYR
X = ((IYR-1975)*10.0)/(MAXIYR-1975)
IU = INT(X) + 1
IU = IU + 1
FAID = AIDF(IU)*(IU - X) + AIDF(IU)*(X + 1 - IU)
RETURN
END
REAL FUNCTION TAILD(IYR)
DIMENSION AIDT(11), AIDF(11)
COMMON /AIDP, AIDF, AINT, MAXYR

x = ((IYR - 1975) * 10.0) / (MAXYR - 1975)
IU = INT(x) + 1
I0 = IU + 1
TAILD = AIDT(IU) * (IU - x) + AIDT(I0) * (x + 1 - IU)
RETURN
END
References


