



Economic Commission for Africa

Population Environment Development Agriculture Model

User's Manual

**Addis Ababa, Ethiopia
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I. Installation Instructions

The Population, Environment, Development, Agriculture (PEDA) software has been developed by the United Nations Economic Commission for Africa (ECA) in collaboration with the International Institute for Applied Systems Analysis (IIASA). The model is now in a shell containing nine countries, namely, Botswana (July 2000), Burkina Faso (June 1999), Cameroon (December 1999), Ethiopia (July 2000), Madagascar (June 1999), Mali (December 1999), Nigeria (July 2000), Uganda (December 1999), and Zambia (August 1999). In future, more countries will be added to the database in the shell¹.

PEDA runs under MS-Windows 95/98/NT with MS-Office97 (preferably Office 97 Service Release 2) installed. Office 97 Service Release 2 (SR-2) is a free update to Office 97. It contains a series of fixes for each program in Office 97. Details on update can be found at the following address: <http://officeupdate.microsoft.com/downloadDetails/sr2off97detail.htm>

Users may fail to run PEDA under higher versions of Windows and Office. In this case, they may need to install MS-Visual Studio in their computers.

As the model is still undergoing sensitivity analysis, the software may still contain bugs and minor inconsistencies. **PRESENTLY, THE SOFTWARE DOES NOT FUNCTION PROPERLY WITH FRENCH VERSIONS OF OFFICE.**

The speed of the application will depend on the speed of the computer.

To install the software, follow the steps below:

1. Make sure the PEDA CD-ROM is in the drive.
2. Open the folder referring to the PEDA Shell.
3. Double-click on the 'setup.exe' icon. During the set-up, some system files are updated and you may need to restart your computer and restart the set-up procedure before completing the installation.
4. In the set-up screen, change the default directory to 'c:\Program files\PEDA Shell '.

PEDA is under licence to the United Nations Economic Commission for Africa (ECA). The model may be used for demonstrations but not copied or redistributed without the consent of ECA.

¹ For more technical details on the model, refer to 'Population-Environment-Development-Agriculture Model: Technical Manual' 2002, (ECA, Addis Ababa, Ethiopia).

Any inquiries about the model or its implementation, and comments about the software, can be communicated to the Sustainable Development Division (SDD) of ECA:

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The PEDDA software and all accompanying documents can be downloaded from <http://www.uneca.org/popia/>.

2. Input and Output Variables

PEDA is an interactive computer simulation model (developed for MS-Windows), demonstrating the medium-to long-term impact of alternative national policies on the food security status of a population. Through the manipulation of scenario variables, the model enables the user to project the proportion of the population that will be food secure and food insecure for a chosen point in time. As food security is a factor of changes in the field of population, agriculture, the environment and socio-economic development, the model demonstrates the relationships between these fields as well. It also includes the results of the first experiments to introduce an HIV/AIDS component and to illustrate its impact on the other variables in the model. As such, the PEDA model is able to give answers to a wide range of policy questions regarding the nexus interactions.

This section briefly presents the input and output variables of the model in tabular form.

2.1. Input Variables

Input variables, generally referred to as scenario variables, are the variables that can be changed by the user during simulation exercises. For the starting year of the projection, expressed as 'initial year' in the model, they require empirical data (or estimated figures). However, the user can freely decide on the levels of assumption to be attributed to each input variable for its future patterns of evolution.

For ease of manipulation, input variables are located in the model in two categories – *i.e.*, 'general settings and population parameters' and 'dynamic parameter settings'.

A. General settings and population parameters

The general settings parameters (or variables) are summarized in table 2.1.

Table 2-1: Parameter and variable definitions of the general model settings

Initial year	The starting year of the projections. This is the year to which the baseline data apply. Although this value could be changed, it is better not to do so as it corresponds to the initial data.
End of projection period	The end of the projection period. All simulations will be run in single-year steps up to the year specified here and all results will be stored up to the end of the specified period. Although there is no direct limit set to the value of this parameter, projection periods of longer than 50 years will slow down calculations and are subject to increasing uncertainty.
Net food production in the initial year (in daily per capita Kcal)	Refers to the net daily per capita amount of food produced in the starting year. Food production in PEDDA is expressed in terms of its energy equivalent or calories. Note that one has to specify this 'net' food production, that is the total production after deduction of post-harvest losses and a fraction of the production reserved to be used as seeds in the next cropping season. From this information and the level of post-harvest losses in the initial year, PEDDA automatically estimates the gross food production. Once the gross production is determined for the initial year, PEDDA projects it into subsequent years of the projection period in single-year steps using the agricultural production function.
Net food imports in the initial year (in daily per capita Kcal)	Refers to the net daily per capita Kcal imports in the starting year. Combined with the net food production, it results in the net food available for consumption. Fluctuations in net food imports during the projection period can be accounted for by manipulating the scenario variable 'food imports and exports'.
Assumed minimum consumption in Kcal per capita to be food secure	In the PEDDA model, calorie (energy) requirements are used as a proxy for food requirements. "The minimum energy requirement is the amount of energy that is required on average in a population to satisfy the basic physiological needs and the needs for light activities of adults and the normal energy needs of children and adolescents (including the extra needs for growth). Two main factors determine estimation of the energy requirement of a population, namely, the distribution by age and sex and the body weight."* The value of this variable, therefore, varies under different national conditions, or the user can set the value to define different thresholds in order to evaluate its effect on the model interactions.
Land degradation impact factor	This variable reflects the assumed negative impact of population growth on the natural resource stock.
Proportion of cohort (group of people born in the same year) moving to cities	This variable enables the user to set net rural-urban migration rates. A value of 0.2 means that of every cohort born in rural areas, 20% will move permanently to urban areas over their lifetime. These movements are distributed over the different ages according to standard age-specific migration schedules.

* This definition is taken from the African Nutrition Database Initiative (ANDI) website, at <http://www.africannutrition.net/>

In addition, the model uses a number of population variables including total fertility rate (TFR), life expectancy at birth, education (literacy rates). Unlike general setting parameters that are considered constant over the projection period, the population variables are treated dynamically.

B. Dynamic parameter settings

Other input variables can be set in 'dynamic parameter settings'. They include variables of the agricultural production function, variables influencing food availability at country level and HIV/AIDS (see table 2.2).

Table 2-2: Input variables in 'dynamic parameter settings'

Fertilizer	The amount and productivity of fertilizer used in agriculture. The user needs to set a value that expresses a relative improvement/worsening with respect to the conditions in the starting year.
Machinery	The amount and productivity of machinery used in agriculture. The user needs to set a value that expresses a relative improvement/worsening with respect to the conditions in the starting year.
Technical education	In addition to literacy, the user can specify the technical capacity of the rural labour force for agricultural purposes. As with fertilizer and machinery use, one needs to give a value that expresses a relative improvement/ worsening of the conditions in a particular year as compared to the starting year.
Water	This covers the change in weather/climate conditions. Its initial value depends on the climate conditions of the country at the time of initialization. The range of acceptable values for the water scenario variable depends very much on the definition of the water saturation curve. In the current version of PEDa, values for the water scenario variable can range from 0 to 1.5, with 1 describing a situation of optimal rainfall conditions for agriculture. Values higher than 1 indicate a surplus of water and have a negative impact on agricultural outputs.
Irrigation	This covers the efforts made in irrigation, including pipelines, pumps, energy etc. The value of this scenario variable expresses a relative improvement/worsening of the conditions in a particular year as compared to the conditions in the year of initialization.
Size of the rural labour force	Endogenously determined variable.
Literacy of the labour force	Endogenously determined variable.
Land	Endogenously determined variable.
Loss in transport and storage	Individuals will not consume all the food that is produced. Some of the food will be lost during harvest, transport, storage or processing, and some of it will be used as seeds for the next cropping season. For the initial year, one has to specify the proportion of gross production that is not available for consumption for one of the reasons specified above. For the subsequent years in the projection, the user can assume changes in post-harvest losses by manipulating this variable. The range of possible values for this scenario variable runs between 0 to 1, with 0 describing a situation where there are no post-harvest losses and 1 a situation where none of the locally produced food is available for consumption. Although one has to specify the net production in the initial year as part of the initialization process, PEDa automatically recalculates the gross production. The latter is the basis for estimation of food production in the following years of the projection period and from which the post-harvest losses are deducted. Note that post-harvest losses are only applied to locally produced food and not to net imports.

Urban bias factor	This variable enables the user to allocate food disproportionately between urban and rural areas. A value of 1.0 means that the food is distributed proportionally to the size of the population living in urban and rural areas respectively (a state of 'no bias'). A value of 1.1 means that urban areas receive 10% more food than would be allocated under conditions of equal access. The remaining share of the food is then attributed to rural areas. By giving a value lower than 1, the user can assume a 'rural bias' in access to food.
Food imports and exports (net trade)	This variable allows the user to take changes in food imports and exports into account. During the initialization process, one has to specify an absolute value for net food imports. The dynamic scenario variable food imports/exports has a default value of 1 reflecting the conditions in the initial year. By manipulating the value of this scenario variable, the user can make different assumptions regarding net imports/exports. A value of 2, for example, means that the amount of food imported has doubled compared to the initial year.
HIV/AIDS morbidity rates	In the HIV/AIDS scenario variable, the user is expected to set an HIV/AIDS related morbidity pattern over time that is defined in terms of proportions of the young adult population, aged 15-49. A value of 0.02 for this variable means that 2 per cent of the young adult population is assumed to be sick due to an AIDS-related complaint. In any population, this proportion tends to be lower than the HIV prevalence rate because the period of morbidity tends to be shorter than the incubation period.

2.2. Output Variables

Output variables include the standard ones shown in table 2.3.

Table 2-3: Standard output variables in PEDa

Variable	Variable description
Available food	This is the sum of the total amount of food produced in the country in a particular year minus the post-harvest losses, +/- food imports and exports. It stands for the net available food to the population for each year in the projection period and it is expressed in terms of calories. This indicator is only available for the country as a whole.
Births	Total number of births
Current land	The combination of the quantity and quality of land for each year of the projection period. Index value summarizing the effects of land degradation and regeneration. This indicator is only available for the country as a whole.
Deaths	Total number of deaths
Life expectancy (e0)	When requested for each of the eight subgroups separately and sex specific, this is the graduated value of the assumptions of the user. At the country level, however, it is also influenced by changes in the relative weights of the subgroups in the population (provided that different life expectancies have been set for the different subgroups).
Literate Life Expectancy (LLE)	Number of years a person is expected to live in a literate status from the age of 15 onwards.

Fertilizer	Is an input variable.
Food import/exports	Is an input variable.
Food production	This is the gross production for each year of the projection period, and it is expressed in terms of calories. This indicator is similar to food availability, but it does not account for post-harvest losses and imports/exports. This indicator is only available for the country as a whole.
HIV/AIDS morbidity rates	Is an input variable.
Irrigation	Is an input variable.
Loss in transport/storage	Is an input variable.
Machinery	Is an input variable.
Proportion food insecure	In addition to the population size that can be generated by urban/rural place of residence, literacy status and food-security status; the model has an extra output variable that portrays the proportion of food insecure in the country for any year of the projection period. This indicator is only available for the country as a whole.
Total population	Population size. It can be generated for each of the eight sub-populations separately and for both sexes separately. There is also a possibility to extract age-specific information directly from the databases.
Technical education	Is an input variable.
TFR	When requested for each of the eight subgroups separately, this is the graduated value of the assumptions of the user. At the country level, however, it is also influenced by changes in the relative weights of the subgroups in the population (provided that different fertility rates have been set for the different subgroups)
Urban bias factor	Is an input variable.
Water	Is an input variable.

3. How to Use the PEDDA Software

3.1. General Instructions

The PEDDA software runs under **Windows**, is based on **Excel** spreadsheets and uses the **Access** database. PEDDA will run on any machine with Windows, but the power of the machine will influence the speed of calculation. When you start the PEDDA application, you will see the following welcome screen.

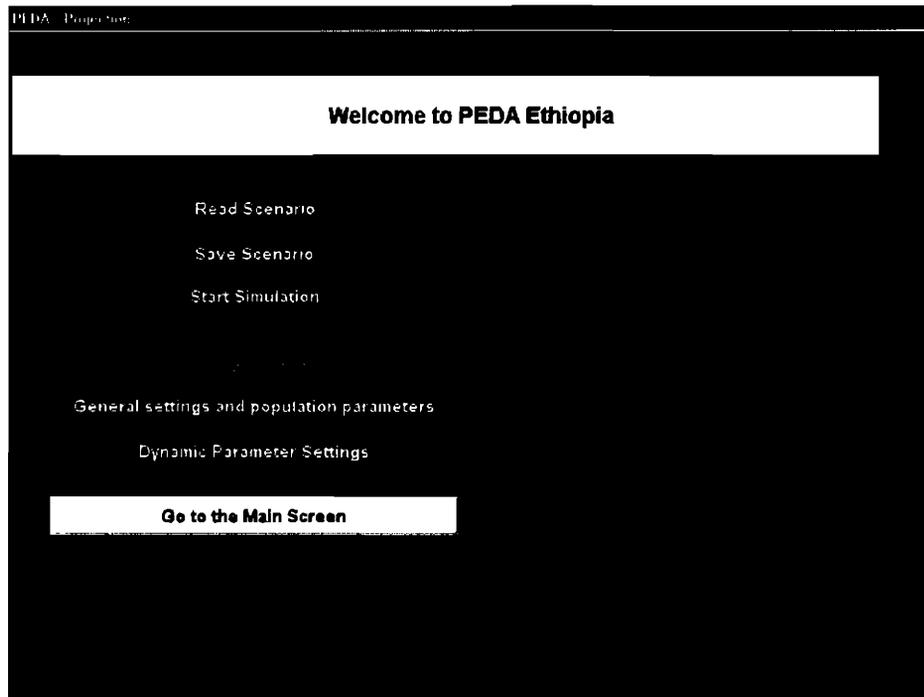


On this screen you can choose among four options:

- “Learn about the model” will give you more information about the structure of PEDDA. The most complete description is given in the Technical Manual (chapter 2).
- “Simulation” will first ask you to choose from the drop-down list one of the countries that has been initialized for PEDDA and will then bring you to the country-specific simulation screen.
- “Presentation of results” will directly bring you to the results of previously calculated and stored scenarios for the countries indicated.
- “Exit” will end the application.

3.2. Using Scenario Settings and Simulations

If you click on Simulation, e.g. for Ethiopia, you will see the country-specific screen, *Welcome to PEDA Ethiopia*, that is shown below. PEDA can only be run for countries that have been initialized. This means that data on the starting conditions and on certain country-specific settings have already been entered. Initializing the model for a new country is not a trivial task and requires substantive analysis and knowledge about the country as well as sufficient knowledge of Excel. More information about the initialization process is given in the Technical Manual (chapter 5). Here we only discuss the scenario variables and parameters that can be set on this user surface.



The button on the top "Read Scenario" allows you to load an already predefined scenario. This is a useful option if you already have a certain baseline scenario for a chosen country that can serve as a starting point to create another scenario by changing only a few variables. Other buttons let you save the current scenario settings under a user-defined name and start the simulation (once you are satisfied with all parameter settings for one specific scenario).

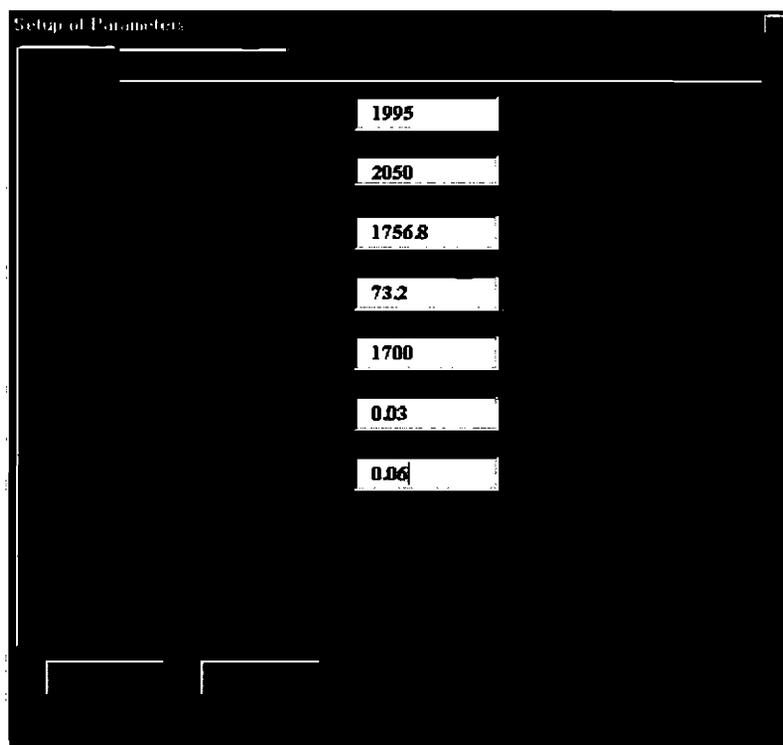
The next two buttons, i.e. "General settings and population parameters" and "Dynamic Parameter Settings" enable you to define new scenario variables and parameters by changing the current scenario settings. The setting of scenarios can be done in two different modes. The "General settings and population parameters" button allows you to change parameters that are kept constant over the projection period or can be set to change in a piecewise linear fashion over time (such as fertility and mortality). For other variables under the

“Dynamic Parameter Settings” button, you can freely define any time path over the simulation period. In order to set those parameters or see what the predefined values of the parameters are, click the appropriate box.

The last “Go to the Main Screen” button lets you go back to the main screen.

3.2.1. General model settings and population parameters

If you click on the “General settings and population parameters” button you get the following screen:



The screenshot shows a window titled "Setup of Parameters" with a dark background. It contains several input fields, each with a white border and a black background, containing the following values from top to bottom: 1995, 2050, 17568, 73.2, 1700, 0.03, and 0.06. There are also some faint lines and shapes at the bottom of the window, possibly representing buttons or a scroll bar.

If you choose the folder “General” tab, you will be able to set some of the basic model specifications that cannot be changed over time or across sub-populations.

Among these general parameters you can first specify the initial year of your calculations. This is typically the year for which the specific-country application has been initialized, i.e. in most cases, the last year for which empirical information is available (but you can also choose other dates if you have specific reasons to do so, such as simulating “alternative histories”). Next, you can determine the end of the projection period. All simulations will be run in single-year steps up to that year and all results will be stored up to the end of the specified period. PEDTA will run scenarios for end points up to the year 2050.

On this general parameter screen, you can also enter the net amount of food produced and imported expressed in terms of kilocalorie available per capita per day in the initial year. You can also enter the assumed minimum energy (in Kcal) required for each individual of the country in order to be considered food secure. This minimum requirement can be chosen according to the definition of malnutrition and food security that you prefer. It will enter the calculations for determining the proportion of the population that will be considered food insecure. This specification will have significant impact on the results. If the minimum requirement is specified rather high, this will result in a greater proportion of the population considered food insecure and vice versa.

On this screen, you can also set the “Land degradation impact factor” which lets you define the assumed impact of an increase in the food-insecure, rural, illiterate population on the land variable. This factor will enter a non-linear land degradation function (see Technical Manual), which also considers population density and the state of the land resource. The state of current land (which combines quantity and quality aspects) will then enter the food production function. This assumed effect of an increase in the food-insecure rural illiterate population is one of the two feedback loops in the model that go from the population to food production. The other one operates through the size and skill level of the population.

Since this model distinguishes between urban and rural areas, migration between the two areas also needs to be considered. This is done by making assumptions on the net movements from rural to urban areas, which is specified here in terms of the proportion of a cohort moving to cities. A value of 0.2 means that of every cohort (that is, group of people born in the same year) 20% will move permanently to urban areas over their lifetime. In the actual calculations these movements are distributed over the different ages according to standard age-specific migration schedules.

If you go to the tab “Sub-populations” you can set parameters separately for each of the eight sub-populations listed. By cross-classifying food-security status, literacy status and rural/urban place of residence eight states are being defined and PEDA performs population projections by age (single year) and sex for each of the groups, also considering movements between the groups in every year. By simply clicking on the field with the name of the sub-population, e.g. the rural/ illiterate/food secure as seen on the screen below, you get a form for defining trends in fertility and mortality of that specific sub-population and educational transition rates for women and men.

For setting future trends fertility, as described by the Total Fertility Rate (TFR), i.e. the mean number of children per woman, and mortality, as described by life expectancy at birth follow a similar scheme. The user has to first enter the values for the starting year of the simulation

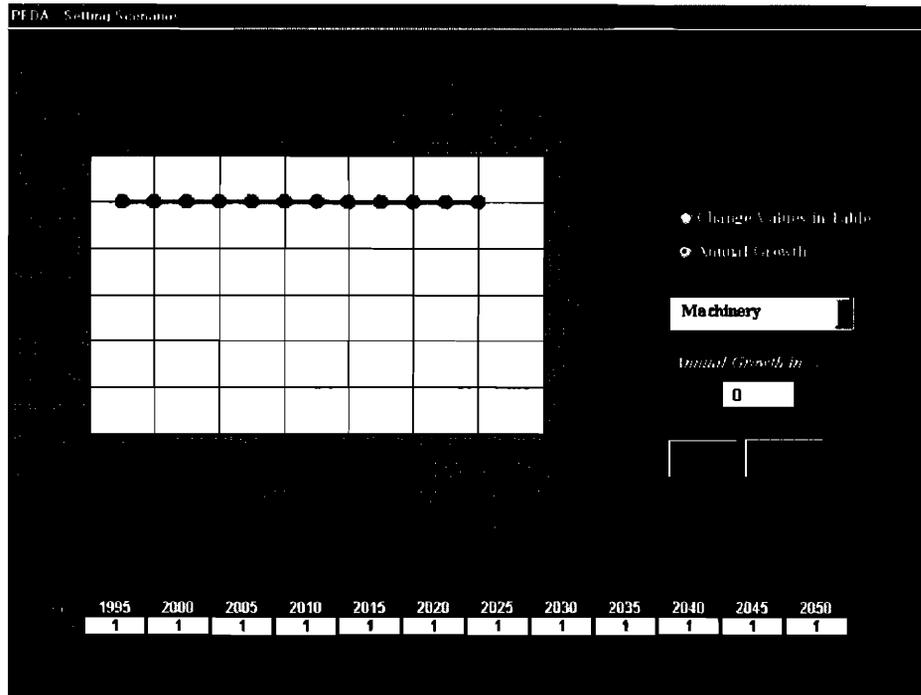


3.2.2. Dynamic parameter settings

If on the country-specific screen (“Welcome to PEDDA Ethiopia”) you choose the button with “Dynamic parameters setting” you will see the following screen. You can choose from the right hand list (which you get by clicking on the little arrow next to the currently listed variable) which scenario variable you want to set. The exact interpretation of these variables and the functional form in which they enter the model are given in the Technical Manual (chapter 3). Fertilizer, machinery and technical education will directly enter the food production function with certain elasticities. “Food import/export” and the “Urban bias factor” relate to the distribution of food to the population. Water is essentially a climate variable referring to rainfall and soil moisture. The initial value of water is set during initialization to correspond with the country’s climate conditions. The impact of water on food production is modeled in a highly non-linear way, with additional water having a strong effect under dry conditions, then coming to saturation where more water brings little change in output and finally moving to flood conditions where more water is destructive. Decreasing or strongly increasing the water variable in certain periods can simulate droughts or floods. The irrigation variable measures the efforts in irrigation but its effect will also depend on the availability of water.

“AIDS morbidity” gives an estimate of the proportion of the young adult population that is already symptomatic with AIDS. This specified level will influence the shape of the age-specific mortality curves applied. Its setting should be consistent with the time paths assumed for life expectancy. The Technical Manual gives information on how to do this (chapter 5).

Except for AIDS morbidity and water, these variables are all treated in index form, which means that their level in the starting year is set to be 1.0 and their levels in all the subsequent years are seen as relative to this starting year. This setting allows you to use the model even if you do not have empirical information about the exact quantitative level of each factor since you only have to specify the relative change as compared to the starting year.



You can change the factors over time either by setting the values numerically in the table below the chart (click on “Change values in table” in upper-right corner) or by applying a constant rate of annual growth (click on “Annual growth”).

For practical reasons, the options for setting values numerically are limited here to every fifth year with intermediate years being interpolated for the simulations.

It is also possible to combine the automatic application of a growth rate with specific numerically entered deviations from the exponential path in certain periods. For this you must first apply a constant growth rate (do not forget to apply it by clicking the OK button), then switch to the manual setting option and change the values in the table as desired. The graph will always give you a representation of all annual values resulting from that procedure.

3.2.3. Simulation

After you have set all the scenario parameters, you click the “Return” button and go back to the country-specific welcome page. There you save the new scenario that you have just defined by clicking the “Save scenario” button. Saving the new scenario assumptions under a new scenario name is the pre-requisite for simulation. When saving, you may specify in the “Short description” box more detailed information about what you have assumed in the scenario, for future reference. After saving has been done, you need to read the same scenario by clicking the “Read scenario” button and selecting the scenario you have created. This action

allows you to upload all scenario assumptions into the place where simulation will be undertaken. Then you can click the “Start simulation” button. This will bring you to the following screen:

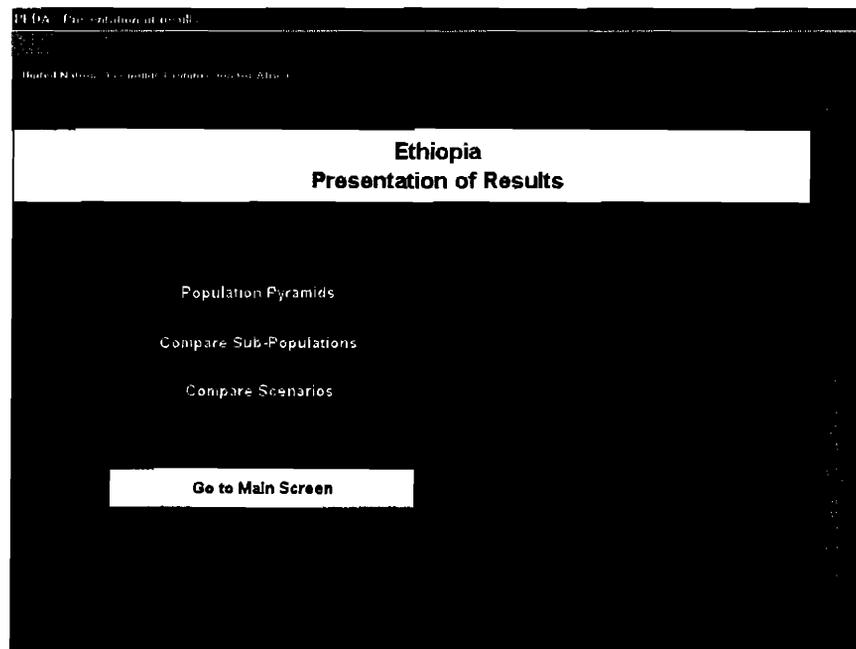


While undertaking simulation, your computer makes projections in a single-year step from the initial year up to the last year of the projection period for all output variables. The time required to carry out simulation depends on the performance of your computer.

3.3. Presentation of Results

For the graphical presentation of results you can choose among three different kinds of graphs:

- (a) Simple or animated Population Pyramids (by age and sex);
- (b) Compare sub-populations for any given scenario;
- (c) Compare scenarios for any given sub-population or the whole country.

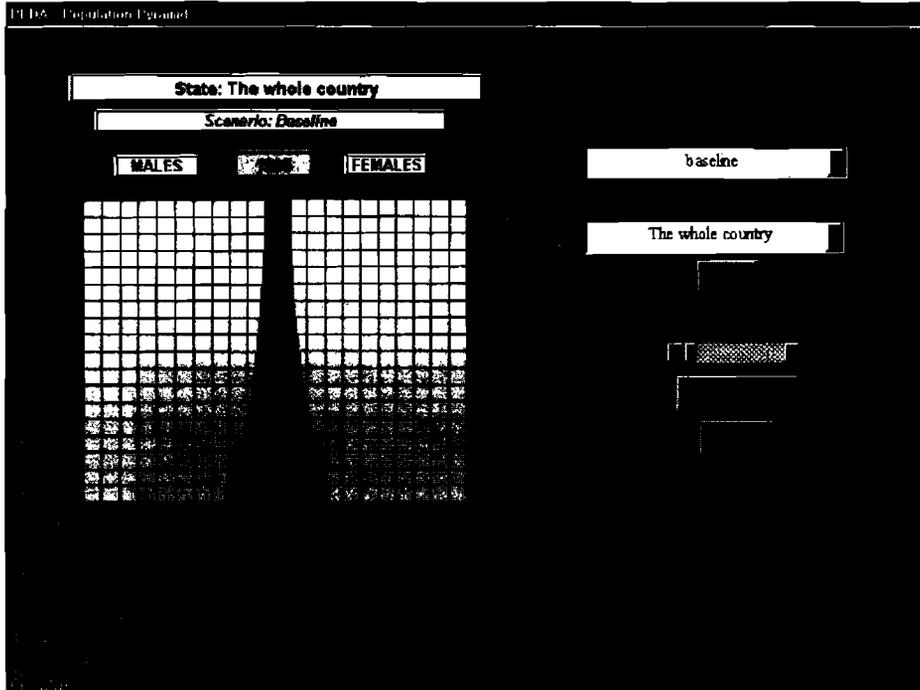


On the graphs, the numerical values corresponding to any point of the line charts will be displayed by moving the mouse to that point.

Since all the results are stored in a database, any table with an appropriate selection of numerical data can be printed on paper or put in a file for further processing.

3.3.1. Population pyramids

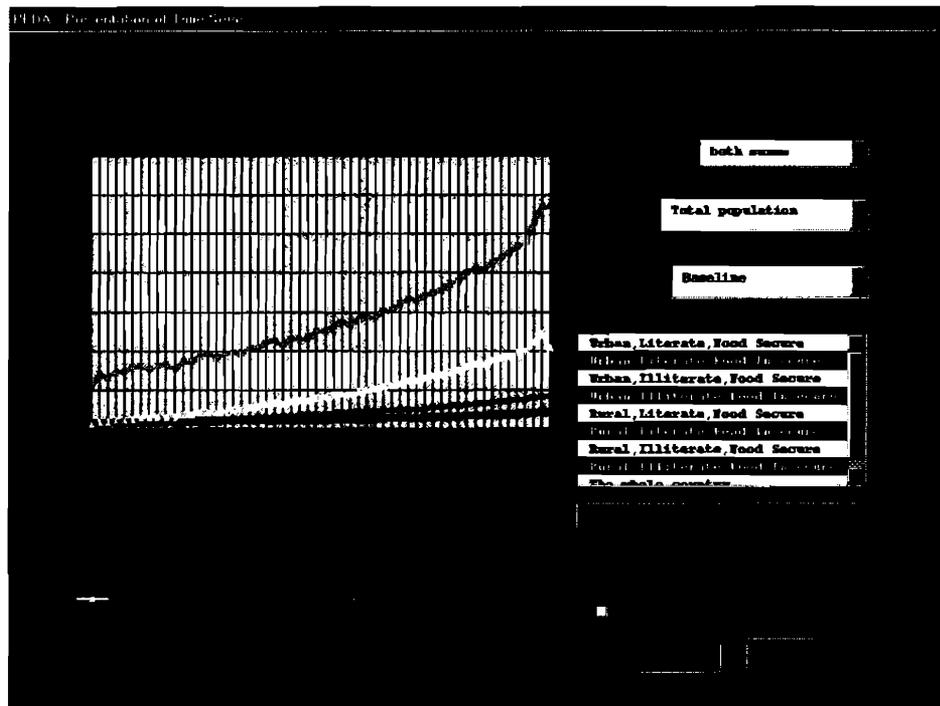
If you click on the "Population Pyramids" button, you will see the following screen:



For any scenario or sub-population (here called state due to multi-state population terminology) that you choose, you see the usual age pyramid with men on the left and women on the right, sorted by age. For the purpose of display, the single-year age groups of the model have been aggregated into 5-year age groups. By moving the time bar (click on the centre piece and move left or right while holding it), you can choose an age pyramid for any simulation year (in a single step or 5-year steps). Alternatively, you can choose an animation, which will show the gradual evolution of the age structure over time if you click on "Animate". These animations can give you a better feeling of the dynamics of the system than only looking at static information. The year stated on top of the pyramid always tells you at what year you are looking. Similarly, the names of the scenario and of the sub-population under consideration are indicated.

3.3.2. Compare sub-populations

If you click on the “Compare sub-populations” button on the “Presentation of Results” screen, you get the following picture, which compares trends over time for different sub-populations under one given scenario.



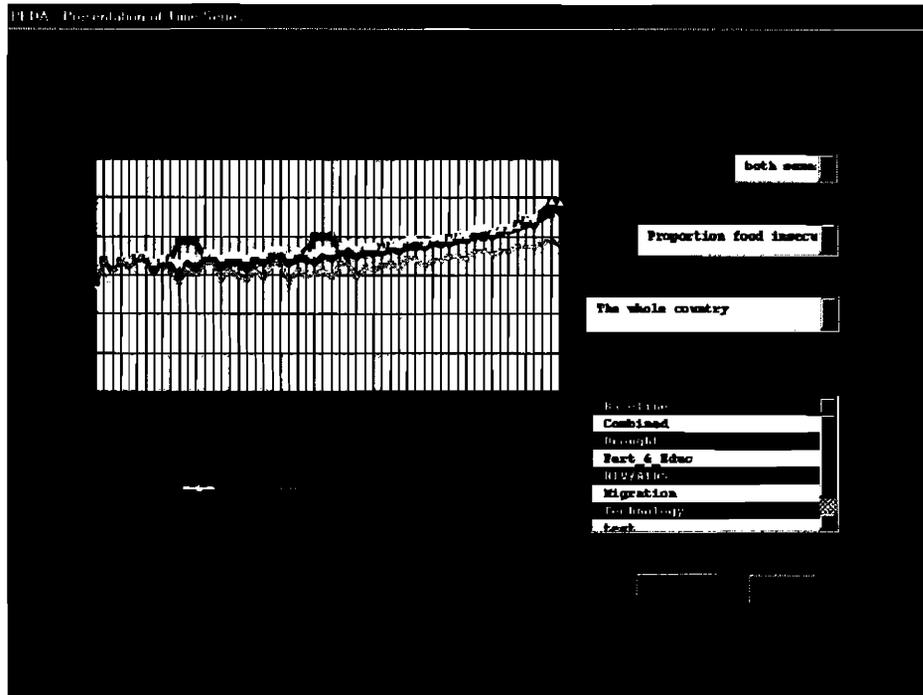
On the right hand side of this presentation screen, you have different options. First, you can choose to plot men or women or both sexes and, secondly, you can choose the demographic indicator to be plotted, which is total population in our example. Next, you must select the scenario for which you want to compare the sub-populations.

In the box below, you can click on any of eight sub-populations (called state here) shown in the graph. You can also choose any number and any combination of sub-populations. Moreover, by clicking on the button “Aggregate” below you can calculate the sum of the chosen sub-populations to be also presented on the graph. To confirm your choice you must hit the “Click to Confirm Selection” button.

As indicated before, you can read the exact numerical value of each point of the graph by moving there with the mouse.

3.3.3. Compare scenarios

If you click the third presentation option “Compare Scenarios”, you will see a similar screen, which compares different scenarios for any selected output indicator and any specific sub-population or the whole country. To do this again, you can choose the sex, the indicator to be plotted and the state (i.e. the sub-population) to be studied. You will then see line charts over time for all the scenarios that you have defined.

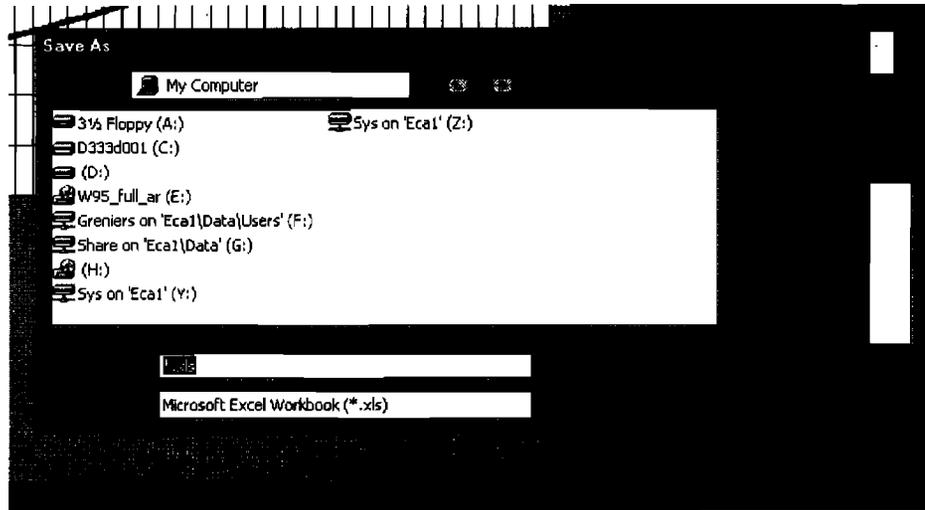


3.4. Additional Useful Features

One very useful option is that under the selection of indicators you can also view some of the most important scenario assumptions that underlie the different scenarios that you examine. Hence, if you do not remember what you assumed in terms of the machinery production factor, for example, in the different scenarios, you can select this indicator on the list and then the graph will display the assumed trends of this parameter for all scenarios. After this, you again select the resulting population size and can compare the assumptions to the results.

On the top line of each of these screens, you find additional options. You can zoom in, i.e. enlarge the graph, or zoom out, i.e. reduce the graph by clicking on the corresponding boxes on the menu bar.

An important option is the “ Save table” button. If you click it, you will get an insert as shown on the following screen print:



On this insert, you can specify the file name under which the table should be stored. These tables can then be formatted and transformed in any way that Excel allows.

Finally, if you want a printout, you can click on the “Print” options and can specify the printer where the graph will be printed.