RURAL WOMEN IN DEVELOPMENT MODEL

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UNITED NATIONS

Department for Economic and Social
Information and Policy Analysis
DESIPA

International Research and Training
Institute for the Advancement of Women
INSTRAW

This manual is based on its shorter version originally formulated by Professor Scott Moreland of the Center for Development Policy of the Research Triangle Institute, Research Triangle Park, North Carolina

FOREWORD

One of the main features of the last three United Nations Development Decades has been the central role of women in all aspects of development. As United Nations agencies have sought to assist governments in development planning, UN technical advisers have been learning increasingly that socio-economic planning that does not account for the contribution of women to development through their reproductive and productive roles cannot lead to sustainable development. Unless women become equal partners with men --both as contributors and beneficiaries-- development programmes cannot yield the desired results. Gender is a crucial variable in the development formula.

Since 1975, when the first women's decade was inaugurated, the entire UN system has tirelessly supported the efforts of member countries in making women active participants in the development process. The number of conventions, strategic plans and actions implemented since then are a testimony to the unwavering support the United Nations has lent to women's advancement.

The technical cooperation programme of the United Nations has a substantial and far-reaching mandate to promote women in development (WID) issues. The United nations Department for Economic and Social Information and Policy Analysis (DESIPA), and its predecessor organizations, have always assigned the highest priority to women's roles and issues connected to women in development. Promotion of WID has been sustained, despite limited resources and in the face of a dramatically increasing demand for technical cooperation.

One operational area which is of the highest priority to the United Nations --human resource development through training-- has always claimed priority in technical cooperation despite scarcity of means. DESIPA's specific measures to promote women in development have entailed efforts to design training tools and raise awareness on issues of concern.

Women have always contributed to survival, sustenance and development. However, the scope and measured value of that contribution has remained modest, and women have been viewed as passive contributors --unseen, unacknowledged and invisible. In effect, women's potential for genuine economic contribution has remained untapped, and women often have been deprived of the benefits of change and progress.

Like many other international, governmental and non-governmental agencies, DESIPA is keenly aware of the urgent need to raise awareness of women's role in development. The Task Force on Women in Development which was established under the chairmanship of Ms. Dunja Pastizzi-Ferencic, Former Director of the United Nations International Research and Training Institute for the Advancement of Women (INSTRAW), has adopted an approach to raise the awareness of women's issues in development, as well as to ensure that WID issues and concepts are translated into action and incorporated into concrete programmes. With regard to these models, one strategy is to establish analytical training tools that provide a framework for logical and consistent thinking about WID issues. The second is to raise awareness among planners, policy makers, politicians, administrators and government decision-makers about such issues by

demonstrating, with the aid of statistics, how policies designed to support women in fulfilling their intrinsic socio-economic development potential, can achieve an equitable, balanced and sustainable development process. Through quantitative inputs and analyses in these statistically based frameworks emerge qualitatively significant and policy-relevant models.

Currently these models are teaching tools and conceptual frameworks to serve as a basis for recognizing the multisectoral dimensions in the planning process must employ to ensure equitable participation of men and women in development. These models cannot, as yet, be used for decision at the national level. However, if the required data at the national level can be collected, the validity of the models can be fully established. The models could then serve as the basis for development policy, investment planning and programmatic interventions --essential building blocks of socio-economic development.

Two members of the Task Force on Women in Development, Ms. Krishna Roy of the Population Division, DESIPA and Ms. Jeanne-Marie Col of the Public Administration and Development Management Division, DDSMS, prepared these models in collaboration with other colleagues. The models have been demonstrated international seminars, workshops and other training activities for middle and senior level government officials. Considerable interest and enthusiasm have been generated among audiences, resulting in a great demand for additional copies and more opportunities to use them. The models have now been amended and improved, and should be extensively disseminated. The United Nations International Research and Training Institute for the Advancement of Women has generously contributed to their publication.

It gives me great pleasure to present these models to interested development practitioners in the hope the models will be of help in enhancing women's contribution to sustainable development.

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May 1994

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I. INTRODUCTION

Issues related to "women in development" (WID), or more specifically, the contribution of women to national socio-economic development in the Third World, have received increasing attention in the last two decades. This is especially true since the 1975 International Women's Conference in Mexico. Many studies have attempted to document the quantitative contribution of women. Many writers have attempted to provide a theoretical rationale as well as empirical evidence for the proposition that improving the role of women in various ways can be beneficial or even necessary for development to take place. The arguments are many, and it is not the purpose of this study to summarize the findings to date. Interested readers, however, may find a sample of these studies in the bibliographic references in Appendix 4 of this report.

In the developing countries, where action is taking place, hundreds of well-intentioned women-oriented development projects are now being financed by donor agencies in an effort to capitalize on the potential contribution of women. In general, development planning is paying more attention to the role of women. It can be expected that, as more studies are undertaken to analyze the role of women in development, increasing emphasis will be put on re-assessing development projects to fully involve women in the process.

In spite of all this interest in WID, there still is no clearly defined analytical model which permits a systematic assessment of women's contribution to social and economic development. The model discussed here is a very modest attempt to capture some of the economic elements of the potential contribution of women to the development of an economy. The model is limited to examining women's role in an agricultural household. Since the vast majority of Third World women live in rural areas and their families subsist on agricultural production, this model will be relevant to a large proportion of the population.

Another reason for such "stereotyping" is that the contribution of rural women has been traditionally left out of formal analysis because their activities are mostly non-market-oriented. As an "awareness raising" model, it is important to highlight the often understated contribution of these women. The model is conceived at the micro level (i.e., the household) and therefore it faces the same problems as any micro model — aggregation of results from the micro to the macro (i.e., regional and national level use), is justified only under certain conditions.

The purpose of the model is to provide an analytical device which can show the affect of various policies in the arena of women in development on social and economic progress. It is a model that demonstrates an analytical framework with which WID issues can be imaginatively and logically discussed. It is, in essence, an example of such analysis. The model is useful for training participants in workshops and

other training activities on WID issues. Its primary objective is to help workshop participants become familiar with a method of analyzing WID-related problems, and to internalize a framework for conceptualizing the issues involved and relationships among them in the context of development planning. Users of this model in its present stage of development can learn from it a method of logical thinking and analysis rather than derive specific, detailed real life solutions. It also may be useful to sensitize policy-makers to WID. Thus, it is an awareness-raising model.

Strictly speaking, the model in its present form is not an empirically-based model of the actual role and contribution of women in a particular country. On the contrary, it is a generalized model based on stylized "facts" relevant to a rural household. While the model is not empirically based, meaning the parameters are not the results of econometric regressions, it can be empirically verified (see Appendix 1 for a simple example for empirically estimating parameters for the basic equations of the model), and most of the relationships built into it are based on actual observations in the field. Moreover, efforts have been made in the actual computer version of the model to specify parameters typical of developing country situations. However, until empirical research is undertaken to verify the model, users are reminded that the model is a teaching tool and its results can only be viewed as tentative.

As a teaching tool, attempts have been made to simplify the model to the point where it is easy to learn and easy to use. This also implies that the model is by no means complete. But an effort has been made to keep its complexity to a minimum and to construct a meaningful model that approximates reality as closely as possible.

The computer version is a quantitative model which yields a numerical solution for the model's endogenous (i.e., dependent) variables. But the main interest in the model's use is in the qualitative information these quantities signify. It is the insight these numbers provide into women's contribution, not the quantification of the indicators themselves, that is most important. For example, the model should not be used to answer questions like "by how much does women's income go up or down when their access to education increases?", but, "does it go up at all and does it go up consistently?" or "does it go up by more than a similar policy oriented toward men?".

The model is very general, highly illustrative and easy to learn. It involves the use of a personal computer. The basic computer operations necessary for running it are introduced in Appendix 2 of this document. Readers who wish to refresh their knowledge of DOS and LOTUS 1-2-3 can use that section as a reference for some common terms and commands. A 5-1/4-inch DOS-formatted disk containing the model is included at the end of Appendix 2. The rest of this document is organized into three chapters. The theoretical model itself is first presented in Chapter II. Chapter III is a test run which includes a description of the simulation model and the results of exercises illustrating implications of policy changes. The manual ends with concluding remarks.

II. THE MODEL

A. Background and main assumptions

As already mentioned, there are a number of elements that one would ideally like to have included in a general WID model. For the purposes of teaching a method with minimal complications, the scope here has been limited to a few key aspects. After all, the function of a model is to simplify reality so that interrelationships among the factors involved become easier to understand. In theory, one can add more elements to a model to more closely approximate real life, but there is always the risk of the model becoming so complicated and intimidating that it could turn out to be a veritable black box. With this "trade-off" in mind, the model constructed is a compromise. More specifically, it is built on a few assumptions, which are stylized facts observed in many developing countries. No claims are made, however, that these assumptions accurately describe the situation of women in any particular country.

To keep the model simple and well-focused on the role of women, assumptions regarding the contribution of men have been simplified, but not denied or overlooked. What is intended in making these assumptions is to highlight the role of women, other conditions being equal. The aim is to prove how government policies aimed at strengthening women's role can improve the welfare of families. From an analytical point of view, the assumption regarding men's contribution is justified because (1) calculations are greatly simplified, and (2) the model's validity is not compromised, since men's contribution in the areas included in this model is not negated or impeded by policies directed at women.

The basic assumptions of this model are discussed below:

Assumption 1: There is a sexual division of labour.

This assumption implies that for a given productive activity (e.g., growing crops), men's and women's tasks vary. For example, men may clear the land and plant the crops, and leave weeding and harvesting to women.

Assumption 2: There is a sexual division of productive activities.

This assumption is based on the observation that men and women are often engaged in different productive activities in agriculture. For example, in West Africa women have their own crops, which they tend (as opposed to predominantly "male" crops). Similarly, women are usually responsible for the care of small animals (chickens and goats) whereas men tend the larger animals (cattle). Women grow crops used for family consumption, such as garden vegetables and other staples. Men's crops are often cash crops that are mainly for the market. Sexual division of labour also applies to the kind of activity in which men and women engage. Women, more than men, engage in handicrafts, which are both used

at home and marketed. Such sexual division of labour applies to market wage-earning jobs as well.

Assumption 3: There is a sexual disparity in terms of access to productive resources.

In addition to differences in productive activities and tasks, there are also disparities regarding access to factors of production other than labour. Such inputs as land, credit, extension services and education are complementary to labour in production, and access to them is not equal for both genders. There is documented evidence which shows that women are at a disadvantage on this count. In many countries women do not have rights to inheritance of land and property. Thus, in many cases they have no collateral to be able to obtain credit. Therefore, women try to substitute their own labour for the other factors of production to which they do not have easy access. It has been found that spouses help out in each other's crops (Assumption 1), and the most usual form this takes is through labour. Research in this area does not establish that spouses share capital to which men have access that women lack.

The obstacles to female access may vary from country to country, even from factor to factor. In some cases, it may be traditional inequalities between the sexes, or cultural stigma that discourages women from having direct contact with non-relative males who provide services. In other cases, women may be able to overcome these social disadvantages, but they still may find themselves tied entirely to child care and other household chores.

Assumption 4: Women and men have unequal economic power, and this inequality can adversely affect productivity.

Economic power has been defined in this study as the ability to retain the returns of one's labour or to have control over the use of such returns. Often, women are powerless to keep the fruits of their labour and are thus exploited. Blumberg's (1988) study makes a strong case for this assumption. In many African countries, men and women of the same household maintain separate purses. This phenomenon can be interpreted as an indication that women try to control their income. Studies have shown that the ability to retain one's income or returns from labour has a significant effect on the productivity of one's labour. These studies conclude that many well-meaning rural development projects could have been more successful in helping women if they had taken account of the relative control women have over their earnings. Where women have more control over their income, their responsiveness to the introduction of new technologies, seeds and production techniques is greater, and can lead to greater increases in productivity.

Assumption 5: Women devote a significant amount of their time to non-income earning activities.

The biological role of women as child-bearers and the societal norms of women's roles in the family result in women having to devote a significant amount of their time to such home-based, non-income

earning activities as child care and housework. Compared to women, men spend considerably less time on such home activities. These non-income earning activities have social value, yet are overlooked in the measurement of gross national product (GNP) or other development indicators that are conventionally used. The actual amount of time a woman spends in such activities is directly influenced by the size of her family. Therefore, family size also affects the amount of time a woman spends in other activities, such as agriculture or market wage-earning employment. The model also takes into account the amount of time men spend on household activities, which is assumed to be a small proportion of the time women spend on these activities.

Assumption 6: Fertility is related to women's education, labour force participation and access to family planning services.

Almost all studies of the determinants of fertility show that female education and labour force participation are important factors in determining fertility. Since family planning services provide knowledge and means for controlling fertility, there is a direct correlation between access to such services and fertility. Family planning practice involves both men and women. However, it is observed that the intensity of practice is higher on the part of women than men. In this model it is assumed that the proportion is 1:5 for men to women.

B. The structure of the model

In this section, the structure of the model is defined and relationships among the variables are explored. Relationships are expressed as mathematical equations. An attempt is made to explain the significance of each parameter and the rationale behind each one of the expressions.

The present model differs from most other computer models which have been developed for analyzing issues in developing countries (such as the United Nations Population and Development Simulation Game) in two important aspects.

First, it is not a macro model with variables defined at the national or regional level. It is a household, or micro level model. Many WID issues, especially in the rural agricultural sector, can be better identified and defined at the micro level, and it is at the grassroots level that policy interventions are urgently needed and are also likely to become more effective. This does not exclude macro analysis, but aggregation from the micro to the macro level entails another step not considered in this model.

Second, the model is a static model — a time dimension is not present in it. This does not imply that comparison over time is not possible. One can compare the final outcome under different policy options and derive conclusions, such as, "if policy A is changed, the resulting effects will be...." But the model does not reveal the amount of time it actually takes to implement policies or for their effects to fully materialize. Nor is the mechanism through which policies are implemented discussed. Put simply, this

model takes the user from one solution to another as policy variables are manipulated. In this sense the model does explain the eventual effect of a policy. This type of "what happens if..." comparison is often referred to as a "comparative static" study, as against a study of the concerned dynamic process itself.

The structure of the model reflects the main elements of women's role in rural, agrarian economies of the Third World, as well as the main assumptions listed in the preceding section. The model consists of four inter-related components:

- Allocation of time among various activities;
- Agricultural production;
- Cash income; and
- Family size.

The overall evaluation is summarized in a synthetic measure denominated "household welfare." A higher value of this welfare index represents a better outcome.

The main exogenous/policy variables in the model are:

- Level of education of women/men (Ef, Em);
- Share of women's/men's total cash income controlled by women/men (gf, gm);
- Access to capital for use by women/men for the purpose of their total production in agriculture (Kf, Km);
- Share of men's total retained income going to the home(s);
- Access to family planning services (FPP);
- Access to agricultural extension services for women/men (Af, Am);
- Rate of market wage for women/men (wf, wm);
- Percentage of agricultural time spent on own crops by women/men (vf, vm);
- Price per unit of agricultural crop of women/men (Pf, Pm);
- Share of agricultural product of women/men marketed for cash (df, dm);
- Amount of land available to women/men for agriculture (Rf, Rm); and
- Total amount of time available (T) (this is the same for both sexes).

It should be noted that percentage/share variables are represented in small letters and others in capital letters. Throughout the model, the subscript "f" refers to female variable and "m" to male variable.

The term "retained income" refers to that part of the income over which the earner has control. (Yf and Ym, which we will define later in this chapter, are retained incomes). For ease of use and understanding, many of the above variables are employed in the model as index variables above or below 1, relative to a reference level. The reference level can be relative to men's standard as in the example, and at the same time it can be for a specific scenario to permit comparison with others. Index numbers represent relative values rather than absolute levels. By indexing these variables, computations are simplified since the numbers become much smaller. This also facilitates comparison of the impact of changes in policies between different scenarios or countries. For example, a situation where "women's education is increased by 50%" is more general than one where "government funding for women's education is increased from $10 million to $15 million." By indexing variables, it is possible to allow for country-specific reference levels to be used without changing the structure of the model. For example, in some countries the reference level of education for women (index value 1) may be two years' primary schooling while in some others it may imply finishing five years of primary school. The model, however, can be used in analyzing the impact of raising female education in either group of countries.

The main endogenous/dependent variables are:

- Total agricultural output produced by women/men (Of/Om);
- Total cash income that women/men earn (Yf, Ym);
- Total time spent on agricultural production by women/men (Lf, Lm);
- Total time spent on market employment by women/men (Mf, Mm);
- Total time spent on home work by women/men, averaged by the size of the household (Hf, Hm);
- Family size (S); and
- Household welfare index (U).

By manipulating the model's exogenous variables, users can explore their impact on the model's main endogenous variables. Many of the exogenous variables are the model's equivalents of policy interventions.

C. Relationships among the "Building Blocks" of the model

The model is based on five major hypotheses regarding interrelationships. These interrelationships are:

1. Use of time

Other things being equal, the amount of time devoted to an activity will determine the output. Hence it would be useful to consider the allocation of a typical man's/woman's time among farming, market wage employment and non-crop home work. First, the model assumes a fixed amount of time (T) as being available to a person. This amount may be biologically determined as the natural time minus the hours needed to rest and to feed in order to sustain one's physical condition. T, therefore, may vary from person to person. However, this variance is not accounted for in this model.

In the following analysis it is assumed that the block of time one allocates to market wage employment is positively related to the market wage rate (w), meaning if the wage rate is higher, people will be induced to devote more time to market employment. In this model the market wage rate is expressed as a percentage of the total market value of time spent producing and marketing agricultural output. For example, assuming a hired agricultural worker produces a certain amount of output during a specific farming season, which can be sold for $100; out of this total market value of the product, if $50 are paid to the worker as wages, the wage rate in this example is 50% (or 0.5). The advantage of measuring wage rate this way is twofold. First, absolute quantity is simplified to a percentage. Second, one does not have to know exactly how many hours a person actually worked to calculate the average hourly wage rate, as illustrated by the above example.

The other fraction of the total value is reserved for repayment of principle and interest on loans the employer used to purchase capital equipment and returns for his labour, entrepreneurial and managerial services. This allowance can be viewed as the deduction made by the employer who provides the equipment, time and talent. The following equation describes the relationship between the share of total time devoted to market wage employment and the wage rate:

$$m = \text{Min}\,[(0.2 + 0.1\,w)\,,\ 0.8],$$ where

m = share of time devoted to market employment, and

w = wage rate.

This formula applies to both men and women, and hence subscripts have not been used. The mathematical function Min [... , ...] compares the values of all its arguments and assigns the smallest value to the variable on the left side. For instance, if the wage rate is equal to 1, then the value of the first argument will be $0.2 + 0.1 \times 1 = 0.3$, which is smaller than 0.8. Applying the formula, we then get $m = 0.3$, meaning the person will devote 30% of his/her total time to market employment.

The first element inside the bracket is a constant term (0.2), which is not related to wage rate. It represents the amount of time one will allocate to market wage employment independent of wage rate because one needs cash income to purchase necessary personal or household items not produced by any member of the family. The term 0.1 w captures the positive relationship between the portion of one's time spent in market employment and wage rate. As a whole the main implication of this equation is that a person devotes 80% of his/her time or a percentage determined by the expression (0.2 + 0.1 w), whichever is smaller, to market wage employment. In other words, a person decides what proportion of his/her time is to be used for market wage employment when a wage rate is given, with the constraint that it will not exceed 80%. This 80% limit is set because in the present model the household is rural and therefore a person has to reserve some time for farming on his/her own piece of land and also for house work. Nonetheless, 80% is an arbitrary limit used to illustrate the point and, therefore, should not be taken as fixed. In reality, this limit is determined by social as well as cultural factors such as the degree of self-sufficiency and cultural stigmas against women working outside the home.

Next, the amount of time spent in home activities is taken as a function of the size of the family. Home activities include child care, food preparation, water and fuel gathering, and can include tending small animals such as chickens and goats. Based on empirical observations of traditions and customs, it is assumed that men spend less time in home activities than women do. Therefore, the expressions used to determine the percentage of time spent in home activities are:

$$hf = 0.1 + 0.05\ S, \text{ and}$$

$$hm = 0.01 + 0.01\ S.$$

In these equations, h is the proportion of one's time spent in non-market, non-crop, home activities, and S is the size of the family. This formulation needs very little explanation.

Finally, the amount of time remaining will be used for agricultural production. Therefore, the expression for calculating this residual is $l = 1 - m - h$, which applies to both sexes.

Now, to summarize the use of time among three different components:

1) Amount of time allocated to market employment

   $M = m.T = \text{Min}\ [(0.2 + 0.1\ w), 0.8].T$

2) Amount of time devoted to household chores

   $Hf = hf.T = (0.1+0.05S)T$

   $Hm = hm.T = (0.01+0.01S)T$

3) Amount of time spent in agricultural production

   $L = l.T = (1 - m - h).T$

It may be remembered that Assumption 2 postulates that men and women raise different crops. To reflect that assumption, it is taken for granted that each sex spends a fraction of his or her agricultural time on his or her "own crops." This fraction is denoted by v. Therefore, women devote vf percent of their agricultural time tending their crops and (1 - vf) helping the males of the household with "male" crops. The same split, though very likely a different fraction, for which vm is used, applies to men as well. The rationale is that certain tasks performed by men, such as clearing the field and planting (as mentioned in Assumption 1), are necessary in women's production.

To summarize, the total amount of time available to a person is divided among different activities. The amount of time one uses for wage employment is directly related to the wage rate, with higher wages inducing more time to be allocated to such employment, up to 80% of one's total time. The amount of time a person devotes to household work is determined by the family size, since larger families require more time to care for. The rest of the time available will be allocated to agricultural production, where both sexes have their own crops and help the opposite sex with some of the tasks of raising their crops.

2. Agricultural production

For simplicity, it is assumed that there is only one agricultural/animal husbandry output per sex (crop or livestock). This means that the model does not allow one to analyze policies that affect production mix, since including more than one output would make the model unduly complicated, given its illustrative purpose.

In the tradition of economics, output is seen as a function of the factors of production — labour, capital and land. In addition, access to agricultural extension services and the share of income one retains from one's production (i.e., economic power or the incentive factor, which we also have referred to as retained income) directly influence productivity. Agricultural extension services enhance the productivity of all production factors. Economic power directly influences the incentive to work. The assumption is that if one is able to control only a small amount of the fruits of one's labour, then the incentive to shirk or seek other options will be high.

As a result, productivity and production will be lower. Therefore, greater economic power will lead to higher productivity via the economic incentive mechanism. Thus, agricultural extension services and the share of one's income under the control of oneself enter the production function in the same way as the other four traditional factors of production. A multiplicative functional form is employed to reflect the economic rationale that, while it is possible to substitute among factors, all are necessary. Following is the equation describing the women's production function in detail.

$Of = [Lf.Ef.vf + Lm.Em.(1-vm)]^{0.4}Kf^{0.3}Af^{0.1}gf^{0.1}Rf^{0.2}$, where

Of = total agricultural output produced by women;

Lf = total time spent on agricultural production by women;

Ef = female education level;

vf = % of female agricultural time spent on own crop;

Lm = total time spent on agricultural production by men;

Em = male education level;

vm = % of male agricultural time spent on own crop;

Kf = as defined in the list of exogenous variables;

Af = access to agricultural extension services for women;

gf = share of women's income controlled by women; and

Rf = amount of land available to women.

It may be noticed that both women's and men's education enter the production function. This is because the level of education acts as a "quality" index and so positively affects production in conjunction with the level (or quantity) of labour. The term (Lf.Ef.vf) gives quality-adjusted labour input contributed by women; vm is the percentage of men's agricultural time devoted to men's own crop. Hence (1-vm) is the percentage of men's agricultural time used to help women in women's crop. For instance, men may spend some time to clear the land and to plant the crop for women, as was assumed earlier. Then the term (Lm.Em.(1-vm)) represents the quality-adjusted labour input, to the production of women's crop, made by men. Thus, the term inside the brackets is the total quality-adjusted labour input, both by women and men, in the production of women's crop.

The other terms in the equation are self-explanatory. Kf is the capital input, Rf is the land input, and Af and gf are the other two non-traditional inputs, namely agricultural extension services and the incentive factor. The small constants represent the productivity, or productive power, of each factor. They appear in the equation as the power parameters in the exponential expressions. In this functional form, an increase or decrease in any particular production factor will have an effect on the total output modified by its power parameter. A greater power parameter means the greater impact a change in input will have on total output. The difference in the magnitude of these constants thus represents the difference in the productivities of different factors, or the contribution of each factor to total output.

By strict analogy, men's production function is expressed as:

$Om = [Lm.Em.vm. + Lf.Ef.(1-vf)]^{0.4}Km^{0.3}Am^{0.1}gm^{0.1}Rm^{0.2}$

3. Income

Net cash income has two main components. The first is income derived from the sale of agricultural production. This is determined by the level of production, the share of the production marketed and the prices.

The second component is the income derived from wage employment. Its size is determined by the wage rate and the amount of time devoted to such employment. As explained earlier, wage rate is expressed in terms of a portion of the market value of one's output because an allowance is made for repayment of loans made to purchase necessary capital equipment.

Consequent to the assumption (Assumption 2) that men and women engage in different productive activities (both agricultural and market wage employment), male and female income is calculated separately. What is meant by male/female income is the amount of income over which men/women have actual control, in the sense men/women spend this income in the way they see fit. In agricultural activities, there is also a division of tasks. Therefore, there may be tasks performed by one sex for the other which may be compensated for. For this reason it is useful to subdivide the first component of cash income, income from the sale of agricultural output, into male and female proportions. In market wage employment, men and women perform different jobs and are paid at different rates. But it is assumed in this model that no help from the other sex is needed to do one's jobs.

Following the reasoning above, women's cash income may be expressed through the following equation:

$$Yf = Of.Pf.df.gf. + Om.Pm.dm(1-gm) + Mf.Of.Pf.wf, \text{ where}$$

Yf = Total cash income that women retain out of the total cash income they earn;

Of = Total agricultural output produced by women;

Om = Total agricultural output produced by men;

gf = share of women's total cash income controlled by women;

gm = share of men's total cash income controlled by men, where the term "cash income" pertains to the total cash income he earns from the agricultural sector alone;

df = share of women's agricultural production that is marketed;

dm = share of men's agricultural production that is marketed;

Pf = price per unit of women's crop;

Pm = price per unit of men's crop;

Mf = Total amount of time allocated to market employment by women; and

wf = wage rate earned by women in market employment in percentage. (See how wage rate is determined in Section C of this chapter, page 8.)

Since most of women's production is consumed by the family, only a portion will be marketed for cash. (Of.Pf.df) gives the total income derived from selling this fraction of women's production in the market. Out of this income women control gf percent. Therefore, the first term in the formula helps calculate the cash income that is derived from selling some of women's production which is actually controlled by women. The rest of the income derived from women's production goes to men's account because women do not have total control over the fruits of their labour. By the same token, some income derived from the sale of men's production may become available to women. This may be compensation for the work women have done to help men with their crop or to market men's production for them. The term (Om.Pm.dm.(1-gm)) in the Yf equation captures this element. It may be noticed that (1-gm) represents the fraction of income from selling men's crop that is actually controlled by women. The presence of this term does not contradict Assumption 4, which states that there is a sexual inequality regarding economic power. This inequality lies in the magnitudes of gf and gm. A small gf (female control) and a large gm (male control) imply inequality.

Since wage rate is defined in terms of a fraction of the market value of one's production, the product (Of.Pf.wf) is the wage level for female market employment. Multiplying the wage level by the amount of time women spend on such employment (Mf) gives the female income derived from wage employment.

To recapitulate, in the female income equation, the first term on the right side is the cash income under women's control — retained income — derived from the sale of the portion of women's output not consumed by the family; the second term represents the income under women's control derived from the sale of the portion of men's crop not consumed by the family. These two terms give the total cash income derived from the sale of agricultural production. The last term captures cash income derived from women's market employment.

The equation for male cash income is an exact duplicate of women's income equation, with subscript "m" "f" interchanged. Therefore, only the equation is given without further detailed term-by-term explanation.

$$Ym = Om.Pm.dm.gm + Of.Pf.df.(1-gf) + Mm.Om.Pm.wm.$$

It is to be noted that Ym is used in the final equation where a part of men's income has been used as contribution to family expenditure.

4. Family size

A major element in the analysis of women's contribution to development concerns fertility. Fertility is important, not only because it is women who bear children, but also because it is typically women who provide most of the care for them and such care is very time-consuming. Thus, factors that influence the number of children will, inter alia, affect other uses of women's time, which in turn determine the economic contribution of women to development. However, it goes without saying that caring for children itself is a significant contribution by women to the society at large.

In this model, fertility behavior is captured through a family size variable, since the model is static. Empirical studies have demonstrated that the size of the family is directly influenced by the level of female education, by access to family planning services and by women's participation in market oriented wage-earning activities, among many cultural and economic factors. More specifically, the present model singles out these three factors. All the three have been observed to work toward reducing the number of children born, which thus determines the family size. To reflect the fact that these factors exert different degrees of negative influence on family size, constants of different magnitudes have been used in the same manner they are used in the production function. One way to rationalize this formulation is to think of these three factors as producing a reduction in family size, with each factor having a different degree of effectiveness or power.

The mathematical presentation of this reasoning is:

$$S = 4.\ Ef^{-0.1} mf^{-0.2} (FPPf + FPPm)^{-0.1}, \text{ where}$$

S = size of family;

Ef = female education level;

mf = share of time devoted to market wage employment by women;

FPPf = family planning services available to women; and

FPPm = family planning services available to men.

The number "4" is a constant parameter, whose meaning in this model is the size of family at a reference point. The main reason for choosing "4" instead of "3" or "5", is to signify size of a nuclear family of parents and two children, implying replacement level fertility. Users can change this constant according to their own preferences or the more representative actual information from their countries.

5. Household welfare

A synthetic index denominated household welfare measures and ranks the impact of policies on the model's main outputs, namely, solutions to the endogenous variables. This index is designed to serve

as a summary of the model's outcome under one set of policy interventions, with a given set of parameters, so that different policy alternatives can be compared. Unlike some micro-level models, the household welfare function here is not an objective function of a welfare-maximizing model. When the present model is solved, it does not automatically search for the highest value of this function subject to the other relationships. If one did not consider the financial and social costs and other constraints involved in each policy option, the index, in principle, could be increased indefinitely.

The welfare index is a function of three main components of household welfare — cash income used for the household, agricultural production retained for household consumption and the amount of time spent in home activities. Although these are not the only factors that affect the well-being of a household, others are not being taken into account for the sake of manageability and because of the illustrative nature of this model. It, nevertheless, captures the essence of household welfare. Income and home consumption summarize the production side of the model, and any policy change that affects women's and men's production will be reflected through these two components. The amount of time spent in home activities which captures the level of physical well-being of the household is a function of family size and is influenced by family planning, women's education and economic participation. The household welfare index is, in fact, the outcome of a utility function (a device economists use to measure the satisfaction derived from consuming goods and services) which has weights attached to each of its components. Users can change these weights to reflect their own priorities. If a component is considered to be unimportant, a zero weight can be assigned to it. Similarly a component with high priority can be given a greater weight. By assigning different weights one can compare the values of the index to see how the ranking of policies will change even if all other factors (policy as well as parameters of the model) are held unchanged.

The household welfare function is expressed as:

$$U=[Yf + s.Ym]^{w1}[Om(1-dm)+ Of.(1-df]^{w2}(Hf+Hm)^{w3}, \text{ where}$$

s = share of men's total retained income going to the home;

Hf = women's total time spent at home, averaged by the size of the household;

Hm = men's total time spent at home, averaged by the size of the household; and

w1, w2, w3 = weights assigned for each component of household welfare (exogenous).

All the remaining variables are as defined earlier.

It is easy to recognize that the first term (Yf + s.Ym) is the income component of the household welfare. It has been repeatedly observed in developing countries that most, if not all, of women's income is spent on the household. Women use their income to cover expenses for nutrition, clothing for the family, etc. Because women traditionally engage in production activities that require a very small investment, they contribute the bulk of their income, whatever its size, for the welfare of the household. This is the

empirical reason for including a major part of women's income in the "income component" of the welfare index. Men on the other hand, it is hypothesized, give a small percentage of their income for family use. This may result from cultural factors or from the fact that men need to invest more of the income in their productive activities. The percentage they do contribute to household welfare in terms of cash income is denoted as "s". So "s.Ym" represents the amount of men's income contribution to the household. This amount may be greater than Yf in some cases. However, the hypothesis for the present model is that women contribute a considerably larger portion of their income to household welfare.

The second term [Om(1-dm) + Of(1-df)] is the home consumption component of the welfare function. Since dm(df) is the share of men's (women's) agricultural production marketed, 1-dm (1-df) is then the portion of the men's (women's) output retained for household consumption. This percentage multiplied by the total output (Om and Of for male and female outputs respectively) gives the amount of output retained for home consumption. As part of the crops produced by both sexes is consumed by the household, there are two parts to this component.

The last term (Hf+Hm) is the home activity component of the household welfare. As assumed in an earlier section, men spend a small proportion of their time caring for children or performing other household chores; women's time spent on such activities is much more substantial. However, both men's and women's time spent on the household enter the household welfare index. The amount of time used here is in per capita terms (time spent by women or men on each member of the household) since it captures the immediate impact of family planning on the welfare of the household. The rationale for this component in the index is quite obvious. Women and men devote their time to care for the children, to feed and clothe the family, etc. These activities do not have a market value (except for the opportunity cost which is not accounted for in this model), but they directly affect the well-being of a household.

In short, this household welfare index is being used to measure the overall impact of a policy on the well-being of the family. In calculating this index, the total cash income spent on household welfare, the amount of agricultural product a family consumes and time allocated to family-oriented activities are included.

D. Data and parameters of the model

The above model is general enough to become applicable to the situation of women across the Third World. Of course, African women differ from Asian and Latin American women, but the differences can be accounted for in the model in terms of parameter values, which define the functional relationships in the model. Hence, the model could eventually be established for three or four regions (North Africa and West Asia, Sub-Saharan Africa, Latin America, and Asia).

Ideally the parameters and functions in such a model should be established at the regional level through

econometric estimation. However, it is doubtful that appropriate data exist. National statistical and demographic yearbooks normally do not provide the kind of micro data required for such estimation. Specially designed household surveys have to be conducted to collect the necessary data. (Please see Appendix 3 for the important variables that should be included in surveys.) Alternatively one may use a combination of individual country studies which can be distilled into "stylized facts" for a set of stereotype countries.

In the present study data from a variety of sources have been used to establish a base solution for the model. While many of the parameters are "reasonable" for many developing countries, there is enough variation across countries and even within countries to suggest that a data bank of parameters needs to be established and a data base of solutions derived from the data bank. It is beyond the scope, however, of the present study to establish a data base for a set of real countries.

As pointed out in the introductory chapter, this model is constructed as a tool for teaching the user a method to conceptualize and possibly analyze issues connected with women in development, rather than provide practical solutions. If one can master the method presented in this model and apply it for solving the problems in his/her own country by modifying or expanding it, the primary objective of this model will have been achieved.

III. THE COMPUTER SIMULATION MODEL AND POLICY EXERCISES

The model described in the previous chapter is relatively simple and does not require very sophisticated software to solve. To simulate the model on a personal computer, the commercial software package, LOTUS 1-2-3, which is widely available, has been used. In this section, an introduction to the LOTUS-based model is given and a few policy exercises are carried out. The computer model is very simple and easy to use.

A. Organization of the worksheet

The United Nations Rural Women in Development Model is distributed as one single diskette. The model itself is contained in a single LOTUS spreadsheet bearing the file name RURWID.wk1. On the same diskette, there is another directory STORYBRD which contains a story board summarizing the purposes, assumptions used, and exogenous as well as endogenous variables of the model. As in the case of any software, a backup copy should be made before using the model. To run the RURWID model, a personal computer with a DOS operating system is required. The machine should be able to support the LOTUS 1-2-3 program. To view the story board a computer with graphics capability is necessary. The minimal requirement is a graphic desplay terminal and a computer with a graphic card installed. Any IBM-XT or above or its "compatibles" will be sufficient. The story board can be brought up on the screen by using DOS commands.

The worksheet is divided into three panels. The diagram on the following page illustrates the range and contents of each panel.

	ROWS	COLUMNS		
		A B C	E F G	H I
Headers	1			
	.			
	.			
	.			
	6			
Endog.	7			
Variables	8			
	:			
	26			
	.			
	.			
	30			
Exog.	31	For the		For the
Variables	:	current		reference
and	:	solution		solution
Parameters	59			

In the first panel (columns A to C), the current solution is presented. A reference (or baseline) solution is saved in columns H and I. The percentage changes between the current and reference solutions are provided in columns E to G.

In the upper left part (rows 7 - 30) of the current solution panel the values of the model's endogenous variables for the current solution are found. In the bottom left panel the values of the model's exogenous variables and its parameter values (rows 31 - 59) are found.

Similarly for the reference solution, the values of the endogenous variables are found in the same rows (7 - 30). As in the current solution panel, the values of the exogenous variables as well as of the parameters, which were used to establish the reference run, are presented in rows (31 - 59). Unlike the cells in the current solution panel which contain the 1-2-3 formulas for calculating endogenous variables, the reference run panel contains only values, because these are the results of the application of the same formulas.

The model contains simultaneous relations between variables. To solve the model, the spreadsheet iterates several times before arriving at a solution. This is done through the "recalculation" command with iterations set, for this model, to 10. Users are advised not to change the status of the recalculation mode.

If users wish to establish a new reference run, the exogenous variables and parameters should be

assigned appropriate values in the current run panel. The model will calculate the solution. After all the desired changes have been made, the current run panel should be copied over to columns H and I, including the values of the new baseline solution, exogenous variables and parameters.

B. Using the spreadsheet model to simulate policy options

Using the RURWID spreadsheet is straightforward. All of the cells where formulas are found are "protected" and cannot be altered unless the user unprotects them. The unprotected cells are those cells which are then under user control. These are the model's exogenous variables and parameters. A change in any of these will result in a new solution. The model is constructed in such a way as to obtain a new solution every time an exogenous variable is changed. Therefore it is very easy to use. To experiment with different options, the user needs only to change the value of the exogenous variable that corresponds to a particular policy, and the solution is automatically calculated. Any new solution can be compared to the reference solution by either comparing the endogenous variable values in the two solutions or by consulting the percentage change columns.

As it is presently set up, the spreadsheet allows for only two solutions at a time. However, more than two solutions can be stored by copying the values (endogenous, exogenous, parameters and percentage changes) of a solution over to empty columns.

It is time to experiment with a few policy options. The users are reminded that, as explained earlier, any lessons learned from these policy exercises should be understood as examples or scenarios. Empirical verification and further refinements are necessary to make these lessons relevant to any particular real life situation.

First, a baseline reference solution has to be established. In this reference run, parameters are given values that approximately correspond to what may be the situation in many developing countries. They are the parameters that have been used in describing the model. As discussed earlier in the Data and Parameters section, while these parameters may approximate reality, they are not statistically obtained. Therefore, the particular parameter values are arbitrary to a certain extent. But the arbitrariness does not interfere with the illustrative power of the model.

In Table 1A on the next page, "Reference" values of the model's exogenous and policy variables are presented. For ease of use and interpretation, many of these values are index numbers without units. For example, the education variable is such an index factor. Here for men the variable has a value of 1, whereas for women the value is set for the reference solution at 0.4. Similar differences can be noticed for other variables.

TABLE 1A

Reference Run
Value of Exogenous Variables

Exogenous Variables	Men	Women
Education (E)	1.0	0.4
Capital (K)	1.0	0.6
Land	1.0	0.5
Extension Services (A)	1.0	0.7
Market Wage as % of Agr. (w)	1.0	0.6
Control of Own Income (g)	1.0	0.7
Prices (P)	1.0	1.0
% Prod. Marketed (d)	0.8	0.2
Family Planning (FPP)	0.2	1.0
% of Men's Income for Home	0.1	

Table 1B on the next page shows the solution to the model for the Reference Run. Different patterns of time use can be noted between men and women. These are within the range of values as reported in Dixon-Mueller (1985). The base solution family size is set at 5.64, representing a relatively high level of fertility, but an (as yet) incomplete family.

TABLE 1B

Reference Solution
Rural Women in Development Time and Production Model

Allocation of Time	Men	Women
Pct.Time Home Activities (h)	6.64%	38.18%
Pct.Time Wage (m)	30.00%	26.00%
Pct. Time Ag. Production (l)	63.36%	35.82%
% Ag.Time Own Crop (v)	90.00%	80.00%
Time Use (Day equivalents)		
Total Available (T)	300.00	300.00
Wage Employment (M)	90.00	78.00
Home Activities (H)	19.91	114.53
Ag. Production (L)	190.09	107.47
Tot. Agric.Production	79.76	34.14
For Market	63.81	6.83
For Home	15.95	27.31
Cash Income	7244.52	1602.56
FAMILY SIZE	5.64	
HOUSEHOLD WELFARE	273.00	

Effects of Increased Education for Women

Table 2 on the next page shows the results of an exercise in which the education coefficient of women (0.4 in the Reference Solution) is raised to the level of men (1.0 in the Reference Solution). Given the initial differences between male and female education levels in the Reference Solution, this represents a significant increase in women's education coefficient amounting to 250%.

TABLE 2

Impact on Household Welfare of Increasing Women's Education to the Same Level as Men

Allocation of Time	Men	Women	% Changes	
Pct.Time Home Activities (h)	6.14%	35.71%	-7.44	-6.46
Pct.Time Wage (m)	0.00%	26.00%	0.00	0.00
Pct. Time Ag. Production (l)	63.86%	38.29%	0.78	6.89
% Ag.Time Own Crop (v)	90.00%	80.00%	0.00	0.00
Time Use (Day equivalents)				
Total Available (T)	00.00	300.00	0.00	0.00
Wage Employment (M)	90.00	78.00	0.00	0.00
Home Activities (H)	18.43	107.13	-7.44	-6.46
Ag. Production (L)	191.57	114.87	0.78	6.89
Tot. Agric.Production	82.48	45.76	3.41	34.03
For Market	65.99	9.15	3.41	34.03
For Home	16.50	36.61	3.41	34.03
Cash Income	7492.13	2147.89	3.42	34.03
FAMILY SIZE	5.14		-8.76	
HOUSEHOLD WELFARE	325.00		19.24	

Columns 1 and 2 of Table 2 above give the values of the solution while columns 3 and 4 give the percentage changes from the Reference Run for each variable. The interpretation of this and the following tables should be focused primarily on the qualitative, rather than the quantitative information they contain. Hence, what is of interest is the changes in their signs and not so much their magnitude. As can be seen, there are significant changes in the solution. Female and male home activities decrease, while time spent in agricultural activities increases. Agricultural output increases because of the increase in time spent in agriculture and in the level of education. It may be noticed that the rate of increase in women's production is higher than that of men. Cash income increases proportionately. Family size decreases as a result of this increase in women's education. The combined effect on household welfare is positive. An interesting result is the effect on men. Because some of women's income is appropriated by men any increase in women's income does have a corresponding impact on

men's income; besides, to the extent that some of women's time in agriculture is spent tending male crops, any increase in female agricultural labour translates into an increase in male crop production. Smaller family also reduces the amount of time men spend on home activities and leaves more time for production. This is another indirect impact on men.

Effects of Wage Equality

In the next exercise, given in Table 3 on the next page, the results of increasing women's wage level relative to that of men are seen.

Here the policy has the effect of changing the allocation of women's time away from home and agricultural activities and toward wage employment. In fact, there is only a minor effect on the amount of home activities of women as in the case of men. Less time available for women to devote to agricultural production means proportionately less time available to help in men's production. And therefore, although men's agricultural time increases, their production declines slightly. More wage employment means more cash income. The higher rate of female participation in formal market employment means that family size will diminish moderately. The welfare index increases as a result of increase in income.

TABLE 3

Impact on Household Welfare of Increasing Women's Wage Level to That of Men

Allocation of Time	Men	Women	% Changes	
Pct.Time Home Activities (h)	6.48%	37.38%	-2.40	-2.08
Pct.Time Wage (m)	30.00%	30.00%	0.00	5.38
Pct. Time Ag. Production (l)	63.52%	32.62%	0.25	-8.95
% Ag.Time Own Crop (v)	90.00%	80.00%	0.00	0.00
Time Use (Day equivalents)				
Total Available (T)	300.00	300.00	0.00	0.00
Wage Employment (M)	90.00	90.00	0.00	15.38
Home Activities (H)	19.43	112.15	-2.40	-2.08
Ag. Production (L)	190.57	97.85	0.25	-8.95
Tot. Agric.Production	79.70	33.35	-0.08	-2.31
For Market	63.76	6.67	-0.08	-2.31
For Home	15.94	26.68	-0.08	-2.31
Cash Income	7238.99	3006.37	-0.08	87.60
FAMILY SIZE	5.48		-2.82	
HOUSEHOLD WELFARE	344.00		26.23	

Effects of Increasing Women's Control of Own Income

In this exercise (summarized in Table 4, below) a woman's control of her earnings is raised to 100%.

TABLE 4

Impact on Household Welfare of Increasing Women's Control of Their Income

Allocation of Time	Men	Women	% Changes	
Pct.Time Home Activities (h)	6.64%	38.18%	0.00	0.00
Pct.Time Wage (m)	30.00%	26.00%	0.00	0.00
Pct. Time Ag. Production (l)	63.36%	35.82%	0.00	0.00
% Ag.Time Own Crop (v)	90.00%	80.00%	0.00	0.00
Time Use (Day equivalents)				
Total Available (T)	300.00	300.00	0.00	0.00
Wage Employment (M)	90.00	78.00	0.00	0.00
Home Activities (H)	19.91	114.53	0.00	0.00
Ag. Production (L)	190.09	107.47	0.00	0.00
Tot. Agric.Production	79.76	35.38	0.00	3.63
For Market	63.81	7.08	0.00	3.63
For Home	15.95	28.30	0.00	3.63
Cash Income	7242.47	1662.87	-0.03	3.76
FAMILY SIZE	5.64		0.00	
HOUSEHOLD WELFARE	278.00		1.97	

The above table shows that this has an immediate productivity impact in agriculture, but in the present model has no effect on the allocation of time. Household welfare increases due to the positive effect of women's income under their own control.

Effects of Increased Family Planning

In this exercise (presented in Table 5 below) family planning access has been increased to simulate the adoption of more effective contraceptive methods. The experiment consists of doubling the family planning index variable. This has the expected effect of decreasing family size and, *inter alia*, decreasing home activities and increasing agricultural time.

TABLE 5

Impact on Household Welfare of Increased Family Planning

Allocation of Time	Men	Women	% Changes	
Pct.Time Home Activities (h)	6.26%	36.29%	-5.69	-4.94
Pct.Time Wage (m)	30.00%	26.00%	0.00	0.00
Pct. Time Ag. Production (l)	63.74%	37.71%	0.60	5.27
% Ag.Time Own Crop (v)	90.00%	80.00%	0.00	0.00
Time Use (Day equivalents)				
Total Available (T)	300.00	300.00	0.00	0.00
Wage Employment (M)	90.00	78.00	0.00	0.00
Home Activities (H)	18.77	108.87	-5.69	-4.94
Ag. Production (L)	191.23	113.13	0.60	5.27
Tot. Agric.Production	80.02	34.63	0.33	1.43
For Market	64.02	6.93	0.33	1.43
For Home	16.00	27.70	0.33	1.43
Cash Income	7268.22	1625.42	0.33	1.43
FAMILY SIZE	5.26		-6.70	
HOUSEHOLD WELFARE	276.00		1.22	

Obviously there are many more policy possibilities. Users are encouraged to run their own policy options. Through these exercises with different policy options, the user can see the impact of these changes on the time use, agricultural production, family size and household welfare index.

IV. CONCLUDING REMARKS

The model described in the previous chapters is a relatively simple yet illustrative one. The primary goal of this model is to introduce a method for conceptualizing WID issues and for analyzing qualitative and to a lesser extent quantitative aspects of women's role in development. It is also intended as an awareness raising model, an illustration, which, it is hoped, will help policy-makers and the public understand the importance of WID issues. In this sense, it is a general model. But the model in its present form is not one which is based on generalized statistical evidences to define its parameters.

As a teaching tool, the model has been constructed to be simple, easy to learn and easy to use. The attempt to make it practically relevant has made the examples, it is hoped, interesting. But a compromise between immediate applicability and structural simplicity had to be struck. Hence, application of the model to any specific country will require extensive empirical verification and modification of the parameter values. Modifications also may be called for in the assumptions with respect to functions and their arguments, to account for cultural and social circumstances in any particular country. It is hoped that this model has demonstrated an analytical method with which one can customize the model to fit one's own needs and priorities.

APPENDIX 1

AN EXAMPLE OF PARAMETER ESTIMATION

Before applying any theoretical model, one needs to estimate all the parameters of the model. This requires the expertise of an econometrician. Various methods have been developed to empirically estimate a model, but only the simplest method will be outlined in this appendix as an illustration of how it can be done. Since teaching statistics and econometrics is not the purpose of this documentation, the technical issues, both in statistical manipulation and econometrics theory, will not be discussed here. Only a simple example using women's production equation will be introduced to show the procedure of parameter estimation.

The theoretical proposition underlying the production equations (women's as a special case at hand) is that a set of factors of production are necessary in producing agricultural output. These factors may be substituted for one another, but all are required. Furthermore, each factor has a productivity, or productive power to contribute to the production of output. In our particular model, five factors are included — labour, capital, agricultural extension services, share of women's income controlled by women and land. Mathematically this relationship can be expressed as:

$$Of = [Lf.Ef.vf + Lm.Em(1-vm)]^{a} Kf^{b} Af^{c} gf^{d} Rf^{e}, \text{ where}$$

lowercase letters a, b, c, d and e are the parameters representing the productivity of respective production factors.

To empirically estimate these parameters, data should be collected on women's total agricultural output, how much time men and women spend in agricultural production, the education levels of men and women, the percentage of men and women's agricultural time used for their own crops, the amount of capital women have, women's access to agricultural extension services, the share of women's income controlled by women and the amount of land women can use. After these data have been collected over a reasonably large sample, one can proceed to the estimation step. Notice that we have a non-linear equation here. To use the simplest and most common regression method, the equation has to be transformed into a linear form. This can be accomplished by taking the natural logarithm:

$$\ln(Of) = a.\ln[Lf.Ef.vf + Lm.Em.(1-vm)] + b.\ln(Kf) + c.\ln(Af) + d.\ln(gf) + e.\ln(Rf).$$

This transformed equation can be estimated by the Ordinary Least Squares (OLS, for short) method. The resulting estimated values of the parameters a, b, c, d and e can then be plugged back into the women's production function, and the equation can be called an empirically based relationship.

All other equations in the UNWID model can be estimated accordingly. To estimate the whole model, however, more sophisticated econometrics methods will yield better results, since the model involves simultaneous equations.

Readers are reminded once more that this model is intended to teach a method of analyzing WID issues, not as a device to generate policies. Therefore, the task of empirically establishing the model has been left out of this documentation. Consequently, only a simple illustration of estimation procedures, instead of a thorough introduction to econometrics, is given in this appendix. Interested readers may consult with econometricians or may read any econometrics textbook to more fully understand the technicalities involved in empirical applications.

APPENDIX 2

BASICS OF OPERATING A PERSONAL COMPUTER (PC)

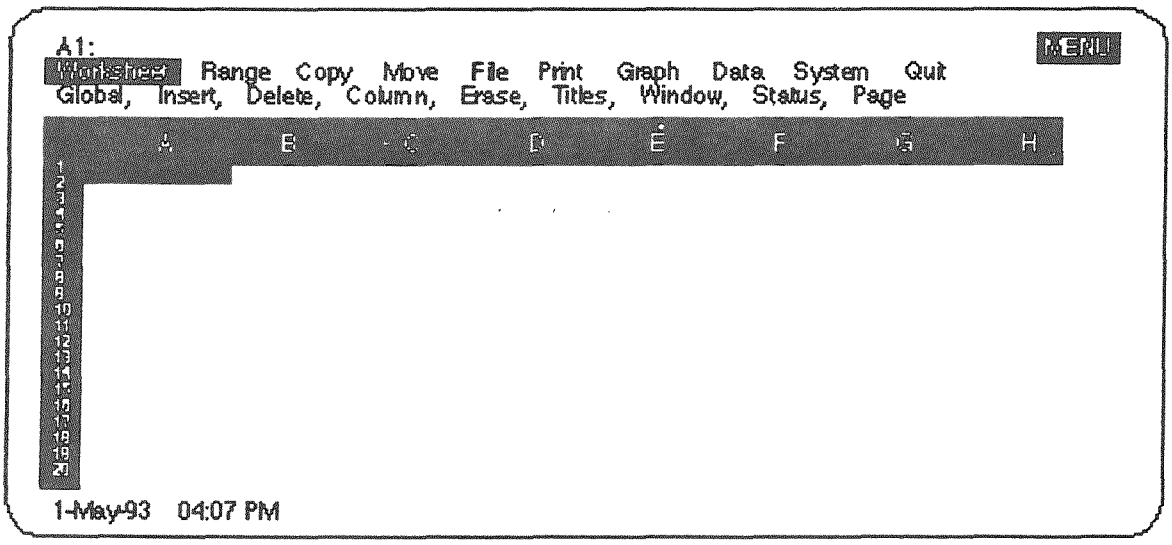
A. Hardware requirements and employment of software

As explained in the text of this document, a personal computer with a DOS operating system is required to run this model. The machine should be able to support the LOTUS 1-2-3 program. The model itself is contained in a single LOTUS spreadsheet bearing the file name RURWID.wk1. To view the story board, a computer with graphics capability is necessary. The minimal requirement is a graphic display terminal and a computer with a graphic card installed. Any IBM-XT or above or its "compatibles" will be sufficient. The story board can be brought up on the screen by using DOS commands.

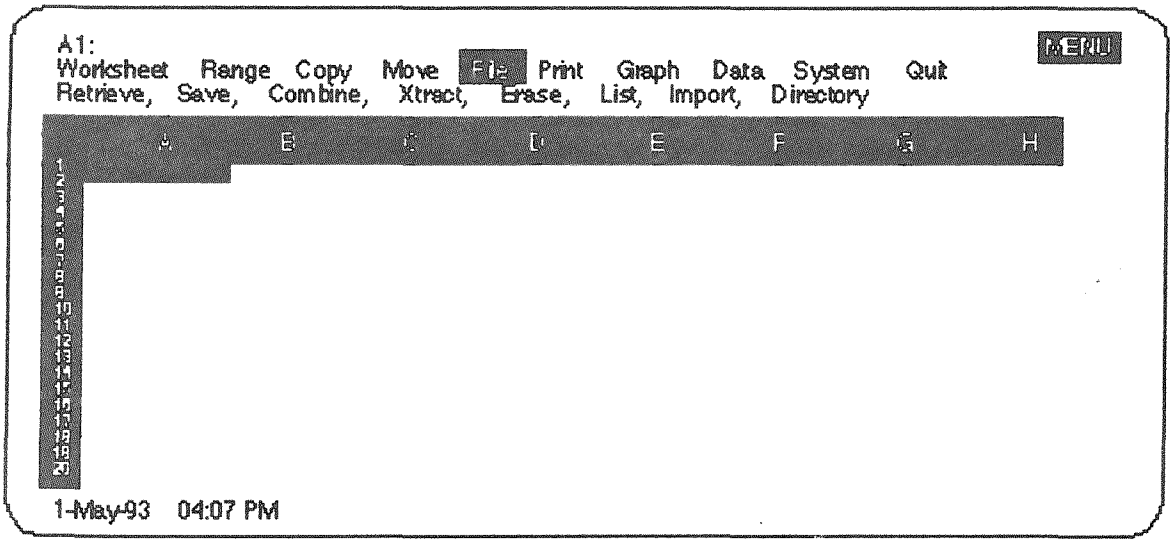
Since the purpose of this document is teaching a method of analyzing WID issues rather than teaching computer techniques, the coverage of this appendix will be limited to materials necessary to use the software including its appropriate use and manipulation. An introduction to the basic concepts and skills needed by this model will also be covered.

To activate the story board, the program disk has to be inserted in drive A or B and the drive door closed. Typing "CD\STORYBD <——/" and "ST UNWID.SH <——/" in the same sequence, brings the story board on the screen. The space bar has to be pressed to view the next screen and subsequent items. To interrupt, the "ESC" key may be pressed followed by "Yes" or "No" when asked, according to whether one wants to continue.

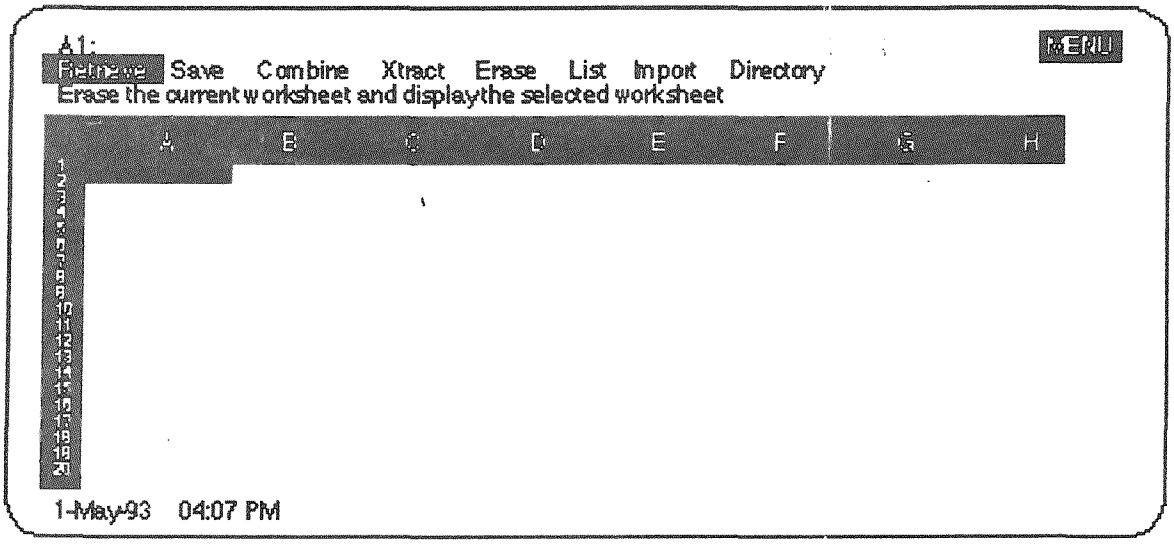
To use the worksheet, in which the model itself is stored, LOTUS 1-2-3 needs to be installed and activated first. After the product logo screen, a worksheet appears on the screen. At this stage, the menu mode has to be entered by pressing "/" at which time the screen should look like this:



The arrow key should be used to select/highlight the item "File" as shown in the following illustration:



Following this selection, the screen should be:



Selecting "Retrieve" and hitting "<------/ " will bring up the directory of files in the current drive. The user is prompted to specify from which drive and which file to retrieve. The next step is to type the drive letter followed by :\LOTUSWID\RURWID.WK1, and then pressing "<------/ ". This brings up the work sheet that contains the model.

A personal computer (in fact, any computer) needs an operating system to tell it what to do. The one used in this exercise is MS-DOS. There are a few terms, symbols and commands one needs to know before one runs a computer program such as the RURWID model, that will be illustrated here. Because the RURWID model is constructed in LOTUS 1-2-3, we also will introduce a few of its fundamentals.

MS - DOS

MS-DOS is a PC operating system. It has its own language one needs to know in order to use it.

A. Terms and symbols

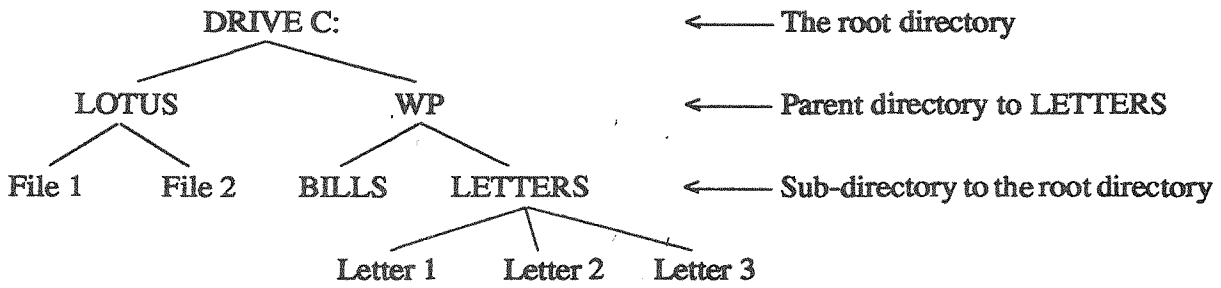
FILE. A file is a collection of related information, much like the items in a file folder. It can contain numerical data or texts. A file on a diskette needs a name, just like a file folder needs a label for identification purpose.

A file name consists of two parts — (1) a name (1-8 characters), and (2) an extension (1-3 characters). A period (.) separates the two parts. The extension is mainly for describing the contents of a file.

A file name can be entered either in upper or lower case letters. DOS automatically converts them to uppercase letters. For example, RURWID.WK1 is a file name, URBWID.WK1 is another. These two names also constitute an example in which the file names themselves indicate that the two files are related.

DIRECTORY. A directory is the table of contents of a disk. Sometimes one may want to divide the many files on one disk into groups of related files, (for example, all LOTUS files and all other types of documents such as menus, circulars, letters, bills, receipts etc.) and give a unique name to each group. Each group will have its table of contents, hence there can be more than one directory on one disk. These directories are often called sub-directories. This is often the case with the hard disk.

Sometimes a subdirectory is further divided into another level of subdirectories. Such multi-level divisions give rise to the terms "root directory" and "parent directory". The root directory is the highest level directory on a computer. The directory one level above the current working directory is the parent directory of a working directory. The following diagram depicts one example of a "directory tree":



To access a file in a directory tree, one needs to follow the "path". For example, to use File 1, the path to follow will be C:\LOTUS then specify the file name "File 1". To edit Letter 3, "C:\WP\LETTERS Letter 3" will be the command to use.

DRIVE. To use the information stored on a diskette, one needs to insert the disk in a floppy disk drive. Floppy drives are the slots at the front or side of a machine; they are usually referred to as drive A and drive B. The hard disk, which is often inside a machine, is normally referred to as drive C. A drive is activated by simply typing a letter followed by a colon, such as C: or A: etc.

PROMPT and DEFAULT DRIVE. A prompt is a symbol MS-DOS uses to let you know that it is ready to receive a command. It contains the default drive letter followed by the greater-than sign (>). The default drive is the drive where MS-DOS looks first for the file when executing a command, One has to specify the drive name before the file name when a command is given, if a diskette is placed in a drive other than the default drive. Of course, one can always change the default drive to be the drive where the diskette is usually placed. To do so, one would only type the drive letter followed by a colon and then press the "<------/ " key.

SYMBOLS. The sumbol "<------/ " is used throughout the document to represent "press the enter key." The symbol "^" indicates a space (or "press the space bar once") between two characters. Unless this "^" symbol appears, no space should be left in a command.

B. The DIR command

This is the command you use to see the table of contents (i.e., the directory) of a disk. The directory contains the names of the files, their sizes and the date they were updated last. Typing "dir <------/ " brings up the directory of the disk in the default drive, let us say, drive C. If one wishes to view the directory of the diskette placed in drive A, one either changes the default drive to A (done by by typing "A: <------/ ") then gives the DIR command or includes the drive name in the command by typing "A:dir <------/ ".

C. Copying files

(1) From floppy to hard drive

Step 1: Make the hard disk or C drive, the default drive by typing "C:<------/ ".

Step 2: Place the source diskette in drive A and close the drive door. Note that now drive A is the source drive.

Step 3: At the DOS prompt, follow the directory tree to make the subdirectory to which you wish to copy the file(s), the current directory. If this subdirectory already exists, for example with a name "SD", type the following at the prompt: CD\SD <------/ ".

But if this subdirectory is new, you have to create it first, then make it the current directory. Say we call this subdirectory NSD, you need to do the following:

MD\NSD <------/

CD\NSD <------/

Step 4: If there are no subdirectories on the source disk, type: "COPY ^ A: *.* <------/ " and all files will be copied from drive A to drive C under the subdirectory you have chosen. But if there is more than one subdirectory on the source disk, it is necessary to specify which subdirectory files you want to copy. Suppose we would like to copy all files in the subdirectory named "dn", we have to type: "COPY ^ X:\dn^*.* <------/ ".

(2) From floppy to floppy

If you wish to copy the contents of one diskette entirely to another diskette use the DISKCOPY command. It works in the following manner:

Step 1: Put MS-DOS disk in drive A and close the drive door (if you have MS-DOS on hard drive you do not need this part) then turn on the computer.

Step 2: At the MS-DOS prompt, type "DISKCOPY ^ a: b: <------/ ".

Then you will be prompted to insert the "source" diskette in drive A and the "target" diskette in drive B and close the drive doors. Follow these instructions (Remove DOS disk from drive A first, of course).

Step 3: Press any key (space bar, for instance) to start the copying process. Then self-explanatory instructions will be given by the computer. Follow them exactly.

If only some of the files on a diskette need to be copied, the steps will be the same except the file names on the source diskette (including their extensions) will have to be included in the copy command.

D. Installing or copying the program RURWID on a PC

It is very easy to install a program, since only a few steps need to be followed. In our example, the program to be installed is RURWID. Since this program is contained in a spreadsheet written in LOTUS 1-2-3, the LOTUS software will have to be installed first. Then a simple retrieve command in 123 will start the RURWID program. The procedure will be slightly different for computers with or without a hard drive. To copy the programs, you will need to create directories — LOTUSWID for the RURWID.WK1 file, and STORYBD for the ST UNWID.SH~ file. Copying should be done through DOS commands.

E. Operation of the programs

For operating RURWID.WK1 and ST UNWID.SH~, see pages 31 and 32.

LOTUS 1-2-3 (or just 123)

This is an MS-DOS based program, namely it operates in the DOS environment.

A. Structure of a worksheet and a few terms.

A worksheet is the LOTUS name for a spreadsheet. A LOTUS worksheet looks like the following illustration:

	A	B	C	D
1	A1			
2				
3				D3

The worksheet is divided into columns (indicated by letters A. B. C.) and rows (indicated by numbers 1, 2, 3). Each cell is identified by its column/row "address". For example, A1 is the address of the cell at the intersection of column A and row 1. A number, a label (string of characters) or a formula can be entered in a cell. Grouping one or more cells in a rectangle forms a range. To define a range, you must press "/", choose "Range" from the menu then use the arrow keys to specify the cells to be included and then hit "<------/ " to finish. The range will be highlighted.

B. Some useful functions of LOTUS 1-2-3

HELP. This function provides on-screen help to the users at virtually any time in 1-2-3. To get help, press F1. The "help" mode comes on. Then use the arrow keys to select topics of further help. To exit from this mode, press "Esc" key and it returns to where you left the worksheet.

MENU. Press "/" to enter this mode and then use the arrow key to move within the main menu. The menu appears at the top of the screen. The second line is a short description of the command on which the cursor (the highlighted block) is positioned. To choose a particular item, move the cursor over and press "<------/ ". At each level of command, choice selection is done in the same way.

ENTER DATA. Move the cell pointer (or the cursor) to the cell where you wish to enter the data and simply type the data. To make the entry, press "<------/ " after finishing typing.

EDIT DATA. Once data are entered, they can be edited if desired. Move the cell pointer to the cell then press the "Edit" key, F2, and the Edit mode will appear at the upper right corner of the screen. Use the arrow keys to move inside the entry and make changes. Press "<------/ " to complete.

APPENDIX 3

ITEMS ON WHICH DATA SHOULD BE COLLECTED FOR CONSTRUCTING A RURWID MODEL

It is to be noted that these items are illustrative and not exhaustive. Each researcher should design the study and topics to be investigated on the basis of the scope and focus of the study and the characteristics of the context in which the study is to be conducted. A specific reference period should be predetermined, such as the previous week or month.

I Household size and structure (those who slept in the household previous night)

1. Head of household
2. Relationship of each person to head of household
3. Personal data of each member:
   - (i) Name
   - (ii) Sex
   - (iii) Age
   - (iv) Civil status
   - (v) Educational level attained
   - (vi) Main occupation
   - (vii) Subsidiary occupation

(From the above information, the actual person to be interviewed should be selected. This person should be a female who is either head of a housefhold or is responsible for the household. She should be requested to give her own and her spouse's (if applicable) information, as well as information on the other relevant members of the household.)

4. Fertility status of the interviewee
   - (i) Number of children born alive
   - (ii) Number still living
   - (iii) Of the living, number living in the interviewee's household
   - (iv) Of those living with the interviewee, how many work, and give income to the interviewee
   - (v) Income provided by such members during the reference period

APPENDIX 4

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