Report of a Seminar

Women and Agricultural Technology: Relevance for Research

Volume 1 - Analyses and Conclusions

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Proposed Recommendations for Discussion

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I. INTRODUCTION

Some historians of agriculture believe that it was women who first domesticated crop plants and thereby initiated the art and science of farming. While men went out hunting in search of food, women started gathering seeds from the native flora and began cultivating those of interest from the point of view of food, feed, fodder, fiber, and fuel. This view is strengthened by the fact that women have been traditionally seed selectors. Even today, this tradition has continued in many parts of the developing world, as for example, in Ifugao rice culture in the Philippines.

In addition to working as farm managers and farm labor, women shoulder the responsibility of rearing children and looking after the home. Thus, the triple burden of child rearing, farm work, and household duties has fallen on them since the time the domestication of crop plants took place about 12,000 years ago.

The role of women in agriculture has changed dramatically in developed countries after the advent of science and technology in farming practices and concurrent growth in the industrial and service sectors. In such countries, this has usually led to (a) reduction of drudgery, (b) improved productivity, (c) enhanced income, and (d) diversified and flexible opportunities for productive and remunerative employment in both rural and urban areas. In most developed countries, mechanized agriculture is operated and managed by a small number of men; very few women remain in the agricultural sector, except in food-processing industries and backyard livestock and vegetable production. Japan is a unique exception. Women there account for just over 60% of the total agricultural labor force and provide about 40% of labor in rice cultivation. They operate and maintain farm machinery and play important roles in farm decision-making. Thus, diversification of income-earning opportunities rather than unemployment has been the result of modernization of agriculture in developed countries.

In contrast, the experience of developing countries has been uneven. Modernization of agriculture has provided women with better income-earning opportunities in some areas but has displaced them from their traditional roles in others. The latter is particularly serious when job destruction is not accompanied by job creation in other activities, either within a diversified agricultural sector or in non-farm employment.

Such a negative impact on employment could cause much distress, particularly to families where the total family income is small and hence

needs to be supplemented by the earnings of both husband and wife. Lack of employment opportunites for women belonging to families with few or no assets - either land and/or livestock - leads to malnutrition and undernutrition among children and women who suffer most from inadequate purchasing power of the family. In many developing countries, the female child suffers particular discriminiation, resulting in imbalances in the male-female population ratio. Therefore, there are strong linkages between the welfare of an entire family and the ability of women to enhance total family income.

Another aspect of this problem relates to technologies for tasks carried out or managed by women. In many countries, and particularly in Africa, East and Southeast Asia, women play major roles in farm and financial management. Moreover, many of their agricultural roles require considerable skills, for example, in seed selection, storage, and pre-germination testing, organic recycling, and the identification and control of pests, pathogens, and weeds. Nonetheless, many of the jobs undertaken in rural areas by women involve much drudgery and result in little income. As men's decision-making roles are more publicly visible, government policies, scientists, and manufacturers of agricultural machinery have generally tended to neglect women's technology needs. Women have also been generally bypassed by extension services. Their numbers in scientific and extension services are generally small. Consequently, they continue to remain as unskilled workers with uncertain income.

The challenge hence lies in integrating brain (technology), brawn (physical work), and bank (credit and other resources) in a mutually supportive manner so that both men and women can all play an active role in improving the productivity, profitability, stability, and sustainability of major farming systems. For achieving this goal, IARCs will have to examine their research and training programs in the context of the users' perspective.

II. RESEARCH AND TRAINING NEEDS

The following three aspects merit careful consideration:

1. Impact of new technologies on women-specific occupations

A careful study of the impact of new technologies should be undertaken in selected farming areas, taking the family as a unit. Families with assets (land and/or livestock) and without assets (landless labor dependent entirely on wage earnings) should be considered separately for measuring the impact of new technologies. Within the family, the impact on women with reference to both employment and income should be studied separately so that household data can be disaggregated for analyzing the impact of new technologies on women. The impact should be measured in terms of the additional jobs created and the jobs made redundant and thus lost following the introduction of new technologies, both at the production and post-harvest phases of major farming systems.

2. Technologies for women

There is need for compiling an inventory of opportunities opened up by new technologies for women belonging to (a) farming families and (b) landless labor families. What are the precise suggestions of scientists with regard to the technologies available for women and particulary for those seeking wage employment? A catalog of the opportunities, either present or potential, both at the production and post-harvest phases, should be prepared. It will be useful if scientists could indicate whether the technologies developed by them for reducing drudgery and increasing the energy input-output efficiency ratio could lead to a diversification of labor use and income or only to the displacement of women wage laborers from their traditional occupations. Since women will benefit greatly if there is flexibility in the timing, duration, and place of work, there is particular need for examining what efforts, if any, have been made by scientific institutions to introduce flexibility in time and place in jobs for women. Such inventories should be part of an ongoing dialogue between scientists and users so that research priorities reflect users' needs.

3. Women in technology development and transfer

Based on an inventory of opportunities for new avenues of employment opened up by science and technology, there is need to review methods of promoting the greater involvement of women, both in technology development and transfer. Existing opportunities for training will have to be carefully reviewed and appropriately modified and expanded. In particular, steps must be taken to provide women with managerial and organizational skills so that they themselves can operate new technologies such as those relating to biofertilizers, seed production, pest surveillance, biomass utilization, crop-livestock and crop-fish integrated production systems.

For gathering information on such issues, a questionnaire was circulated among all senior scientists, senior research fellows, and senior post-doctoral fellows in IRRI (Annexure A). A summary of the responses received is given in Annexure B. Examples of the studies in progress in othere IARCs are contained in the background document compiled by ISNAR. These papers give an excellent glimpse of the perception of the problem by different centers and the responses of biological and social scientists to the challenge of integrating efficiency and equity in technology development and transfer.

III. NATURE OF TECHNOLOGIES DEVELOPED BY CENTERS

The technologies generated by IARCs are not developed in isolation. They are invariably developed with the full and active participation, advice, and assistance of national agricultural research systems (NARS). The research programs of centers have both a short- and long-term time perspective. In the short term, the aim is to bridge the gap between current production and actual need for basic staples and thereby ensure the availability of food for all at reasonable prices. In the long term, the aim is to promote sustained agricultural advance coupled with economic benefits to all, regardless of gender or social status. Some

success in the first objective has been achieved in most countries of Asia and Latin America, as per capita food grain production has increased during the past 15 years. It is therefore time to look more deeply into questions of equity as judged by the relative benefits which flow to men and women, whether farmers, farm labor, or consumers. What should centers do in this regard?

There is no simple or single answer to this question. The role of women, both as users and beneficiaries of new technologies, varies widely and is influenced greatly by religious, cultural, economic, and ecological factors. Therefore, a simple prescription with regard to the policies IARCs should adopt will be both irrelevant and unproductive. There are, however, three broad areas of activity in which the CGIAR system as a whole and individual centers in particular can make a significant contribution. These are:

A. sensitization;
B. studies and surveys;
C. scientific strategies and programs.

IV. SPECIFIC RECOMMENDATIONS

A. Sensitization

"Knowledge leads to unity; ignorance to diversity." Where there is no awareness, it is futile to expect action. Hence, the first step is to arouse human consciousness of the existence of the problem.

The papers submitted to this conference clearly indicate that a great deal of information about women already exists. It is equally clear that such information needs to be more closely related to technology development and transfer. There is need to take a specific look at the implications of technologies under development for women managers and laborers. High-yielding varieties are clearly labor-using, but we do not know how different components of such technologies affect employment. For example, many labor-displacing technologies, though designed to relieve seasonal bottlenecks, may result in an increase of total annual employment. Similarly, we know that women play a major role as farm managers, but we do not know enough about what this means for technology development and adoption. Hence, issues relating to both research coverage and impact in terms of gender need careful study. A starting point for stimulating thought action and for strengthening the users' perspective in research policy making is an organized effort in sensitizing research policy makers and funding organizations, both at the international and national levels, to such issues.

Within the CGIAR, steps to promote sensitization of all concerned could include the introduction of this item on the agenda for the Centers Week presentations and discussions every year, the incorporation of equity issues in the development of research priorities and strategies by TAC, and the introduction of this item in IARC annual reports and in terms of references to the quinquennial review missions of centers. While these steps can help to sensitize the higher-level policy makers and research managers, they by themselves will not be adequate to generate the

necessary motivation and appreciation at the working scientists' level. Therefore, each institute may develop an interdisciplinary and interdepartmental working group which could continuously analyze issues of this kind and reorient research strategies and priorities to the extent necessary to achieve the objective of the well-being of the family as a whole. The Program Committee of the Board of Trustees of each IARC could play a catalytic role in this process.

IARC research is a very small component of the total research effort in progress for improving Third World agriculture. Therefore, the total impact of sensitization of IARCs on users' needs will be little, unless NARS are similarly influenced. Fortunately, IARCs are in a favorable position to accomplish this objective, since they organize periodic seminars, conferences, and monitoring tours in addition to farming systems networks. All these mechanisms of interaction between scientists of NARS and IARCs should be fully utilized in the move for achieving a greater degree of understanding of the issues involved.

B. Studies and surveys

Once there is appreciation of the concerns, the need for collecting precise data and for gaining meaningful insights into the problems arises. A carefully designed malady-remedy analysis will be necessary for assessing alternatives and priorities in technology development and transfer. For this purpose, social science institutions need to be linked up with national and international agricultural research systems. Much work on women and other types of users takes place in universities or other research institutions outside of both NARS and CGIAR. The challenge before IARCs, therefore, is the development of effective networks with agricultural researchers and social scientists in LDCs, which can help to guide scientists, extension workers, and developmental administrators on methods of combining efficiency and equity in technology development and transfer.

There is a need to develop a problem-solving approach using multidisciplinary research teams and a variety of complementary research methods. The standard surveys should be supplemented with low-cost, rapid and imaginative ways of collecting reliable and relevant data. Some IARCs have already developed innovative procedures along these lines. There is also an urgent need for developing methods of studying the problems of men and women without assets (either land or livestock). A careful study followed by an objective analysis of the data collected is essential for rational decision-making by those engaged in the development and transfer of new technologies.

Suitable survey techniques will have to be developed which can help to reveal not only the consequences of new technologies on women-specific occupations but also the constraints responsible for the inadequate transfer of relevant technologies to women. Efforts of banking institutions in the identification of credit-worthy occupations for women need study and monitoring. Public policy issues, such as those relating to land and property ownership rights, credit supply, personnel policies of R&D institutions, need particular attention. Above all, it is necessary to study the organizational and institutional aspects of input delivery and producer-oriented marketing.

C. Scientific strategies and programs

Since IARCs are primarily technology development institutions, it is essential that each research institute carefully consider its research priorities and programs from the users' perspective. For this purpose, the following questions will have to be asked:

1. Will technologies under development result in a reduction in drudgery and improvement in productivity and income?

2. Will they be labor displacing or will they result in labor diversification?

3. Will they result in equal benefits to both men and women or will they have built-in seeds of sex discrimination?

4. Will they provide some flexibility in relation to timing, duration, and place of work?

5. Will they help to make unskilled labor become skilled?

6. What steps are necessary to ensure that women managers and labor will benefit from new technologies?

The IARC social scientists should work with biophysical scientists to determine:

- the package of technology most beneficial to users, taking account of gender-related differences in needs and constraints;

- the package of services including the delivery of knowledge, credit, and inputs with reference to their relevance and benefit to women users;

- the package of government policies in agrarian reform, rural development, credit, and marketing essential for conferring equal benefits on men and women farm managers and labor.

Unless socially sound technological packages are coupled with appropriate packages of services and government policies, the fruits of scientific work will not automatically accrue to women. Appropriate women's organizations will help both to promote attention on the special problems affecting women and to ensure the flow of benefits to them.

V. CONCLUSIONS

The scientific and social dimensions of this area of research are vast. In contrast, IARCs are now functioning at a near-zero growth rate in terms of both budget and senior staff positions. Hence, there will be a justifiable temptation to take a defensive position in matters relating to user orientation in research priorities and strategies and plead that whatever each center is now doing represents an adequate response. It is essential that IARCs avoid a laissez faire approach and move positively and aggressively in the direction of assisting women dependent upon

agriculture for their well being. This is particularly important in the context of the increasing emphasis placed by IARCs on attending to the problems of ecologically handicapped farming areas and economically disadvantaged farm families. It is precisely in such situations that the value of women's labor and income to household happiness and survival is immense.

How can IARCs help in generating greater opportunities for flexible and productive employment when most of them are not concerned with post-harvest technology and the off-farm employment sector?

An effective way of responding to this challenge is to capitalize upon IARCs' single most important asset, namely access to diverse scientific institutions and political systems. By the very nature of their functioning - through networks, cooperative programs, monitoring tours, symposia and conferences, and training activities - IARCs exert an influence on national research systems which far exceeds their budget or scientific capability and infrastructure. They have equal access to the knowledge and material pool in developed countries. They can hence lead a positive movement of helping women, particularly belonging to small farmer and landless agricultural labor families, through the organization of workshops which can help to compile a portfolio of research and training tasks for each major farming system and getting interested laboratories and scientists, both in developed and developing countries, to adopt specific tasks. In addition, they can set an example in involving women scientists to a greater extent in all aspects of technology development and dissemination.

While action on the above lines is feasible and should be taken, it is important to recognize that science is not a magic wand with which gender inequalities in workload and economic returns based on gender can be made to vanish. This should be emphasized clearly as, otherwise, false hopes will be aroused about the capacity of science and technology to remove deep-seated social maladies.

In the ultimate analysis, it is only the concern, commitment, and concerted action of national agricultural research systems and policy makers that can lead to meaningful results in imparting a user's perspective in research priorities and strategies. The major role of IARCs should be to trigger a self-propelling and self-replicating pattern of involvement of NARS in R&D efforts designed to give equal attention to the needs of men and women farmers and agricultural labor. Prospects of external funding should not be the main motivating factor for the participation of NARS in networks or studies in this field. There are numerous examples to show that involvement without conviction and commitment leads to the collapse of bilaterial or multilateral donor-aided programs when the external input is withdrawn. Enduring benefits will result only when a proper blend of political will, professional skill, and people's participation is achieved within each country.

Annexure A

INTERNATIONAL RICE RESEARCH INSTITUTE
INVENTORY OF TECHNOLOGIES FOR WOMEN IN RICE FARMING

1. Name of Scientist and Department.

2. (a) Technologies already developed
Description of new technology and its relevance to the traditional occupations and skills of women employed in rice farming systems at the production phase and/or post-harvest phase. Please describe each item of new technology separately.

(b) Technologies in the assembly line
Potential impact of technologies currently under development by your group on women with regard to:
i. drudgery reduction
ii. income and employment generation; and
iii. new opportunities for quality of life improvement.

3. What additional training programs and management and organizational skills will be needed for women to derive benefit for both already available and emerging technologies?

4. Please provide any other information which may be relevant to the goal of ensuring that the jobs destroyed by new technologies in the traditional sector are more than compensated by the jobs created by the modernization process, so that labor diversification and not labor displacement is the outcome of our research designed to enhance the productivity, profitability, stability, and sustainability of rice farming systems.

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Signature

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Annexure B

INVENTORY OF TECHNOLOGIES FOR WOMEN IN RICE FARMING SYSTEMS*

A. TECHNOLOGIES ALREADY DEVELOPED

The following improved technologies are relevant to the traditional occupations and skills of women employed in rice farming systems at the production and/or post-harvest phases. They will generally need to be adapted to the specific physical, biotic and socio-economic conditions of different countries or different regions within countries. In some cultures these technologies could equally well be used by men or women: the important point is not to assume automatically that they are or should be used by men, for in many cases there are strong social reasons which suggest they could be utilized more effectively by women.

(1) Variety characteristics: Criteria for breeders and technology transfer programs.

Women often share or have complete responsibility for the selection and purchase of seeds, and for seed storage and pregermination tests. They are also involved in cultivation and do most of the drying and husking. Livestock, which are fed rice by-products, are often exclusively cared for by women. It is therefore important to consult women about criteria to be used in the breeding of new varieties and to involve women in programs for the transfer of improved varieties. Women's needs, skills, knowledge and views need to be taken into account with respect to:

- varietal characteristics, both desirable and undesirable;
- seed quality of new varieties, and methods of obtaining and ensuring good quality seed (e.g., selection of best panicles, storage on the panicle, row-sowing of seeds from each panicle separately to test the seed purity);
- varietal identification;
- interaction with weeds, insect pests and pest predators, and soil condition;
- tolerance to drought, floods, temperature extremes and low solar radiation;
- drying and storage characteristics of grain, and relation to milling recovery;

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*Compiled from a questionnaire sent to IRRI scientists on Technologies for Women in Rice Farming and from papers presented to the Orientation-cum-Training Program on Improving the Income and Employment Potential of Rice Farming Systems, IRRI, 21-30 January, 1985.

- quality of by-products (e.g., suitability of straw for animal feed, roofing, fuel requirements); and

- cooking and eating preferences.

(2) Seed production

It should be possible to involve women in seed production. Seeds of rice varieties are either not universally available, too expensive, of poor quality, or contain mixtures (or all of the above). Rice lends itself well for quick seed increase: multiplication factors of 500-1000 (grams seed harvested/grams seed transplanted) are possible.

The procedure would be similar to the final part of pedigree selection:

(a) Harvest 50 (or more) panicles, from different plants with desired characteristics.

(b) Keep panicles unthreshed and put on seedbed making sure to keep them apart from each other.

(c) Plant each panicle to one row of ± 5 plants.

(d) At maturing time, monitor the rows and reject those that are heterogenous, too tall, too short, too early, too late, or damaged by pest and diseases.

(e) Harvest panicles, go to (b).

(f) Harvest remaining seeds in bulk from those rows not rejected and use as seed supply.

This procedure could be tried in some of the sites where cropping systems/economics/sociology work has been carried out already. It could blend well with a scheme to make available small quantities of top grade breeder's seed.

(3) Soil fertility and fertilizer management

In areas where manure is commonly used, for example, in the hills in Nepal, it is generally made and carried up the hillside to the fields by women but it is usually incorporated by the men who do the ploughing. Under farmer conditions women tend to apply fertilizers less regularly than men. However in some countries, particularly in the Philippines and other Southeast Asian countries, women have considerable influence in decisions about the purchase of inputs such as fertilizers and pesticides. Women's knowledge and skills therefore need improving with respect to:

(a) Diagnosis of soil deficiencies

- to recognize common nutritional disorders of rice such as nitrogen, phosphorous and zinc deficiencies, by crop observation and the use of soil testing kits;

- to assess the fertilizer requirements needed to correct such deficiencies;

- to determine the most suitable source of these nutrients (various types of chemical or organic fertilizers, used alone or in combination; rotations with legumes, green manure crops or fallow; fish deposits) taking account of relative costs and returns, technical efficiency, availability of nutrients and the availability of labor and special skills needed for fertilizer application; and

- to improve fertilizer placement and management, and to increase the use of home-produced inputs in order to maximize profit while minimizing expenditure.

(b) Chemical fertilizers

Women are already involved to a fairly limited extent in the following applications of fertilizers, which could be extended:

- deep placement by hand of nitrogen fertilizer simultaneously with transplanting. Since this minimizes the rate of nitrogen application by as much as 50%, this can be economic in labor surplus areas;

- applying zinc to the seedbeds, dipping seedlings in zinc oxide suspension before transplanting, or applying zinc sulphate on the fields. The latter two methods are less effective and require more labor;

- general application of fertilizers on seedbeds or in the fields. Women would benefit from training in methods of application (timing, quantities, water levels, methods, etc.).

(c) Organic fertilizers

(i) Straw

Women (and men) could:

- spread straw on the land for later incorporation, instead of burning it (providing it harbors no residual pest and disease).

(ii) Compost and farmyard manure (FYM)

In countries where compost and FYM are already commonly used and where chemical fertilizers are expensive or not readily available:

- technology development and transfer programs are needed to improve women's knowledge of and skills in the production processes, handling, storage and use of compost and FYM;

- sex-related constraints in the efficient use of these organic fertilizers needed to be identified. For example,

- in Nepal women carry FYM up to the hill fields over a period of 2-4 weeks (due to labor bottlenecks and a desire to spread this very hard work over time) while the men later incorporate it when ploughing. The manure remains in piles in the fields for this period, and suffers nutrient loss. The use of women's reciprocal labor groups for carrying the manure on the day the field is to be ploughed could be a possible solution worth experimentation.

(iii) Azolla

Azolla production could provide new employment opportunities for women. Its labor-intensive processes include: maintenance, multiplication, harvesting, transporting (from multiplication place to the farm), inoculation and incorporation. Except for incorporation, all other processes can be performed by women. Since maintenance and multiplication of azolla need a lot of care and patience, women can probably do it better. Azolla technology considerably reduces the weed problem but the alternative employment created will compensate for labor displaced from weeding.

Related points are:

- training will be needed, especially for maintenance, multiplication and incorporation of azolla; and

- Azolla nurseries will be needed to ensure a continuous supply of azolla starter. Given sufficient demand for azolla as fertilizer and as feeds, a commercial starter market could develop.

(d) Green manure

The green manuring technology provides more opportunities of work for women (and men) by intensifying the cropping systems in both time and space dimensions, thus exploiting the atmospheric N for economizing fertilizer N through green manures and/or dual purpose short duration legume crops like mungbean and cowpea for grains and green manure.

(4) Raising of seedlings

Women could also be trained to raise seedlings for sale for use with mechanical transplanters. These machines require younger and shorter seedlings of uniform height. Special attention is needed to produce good quality seedlings for these machines. This would be an appropriate activity for women since it would require regular but limited hours each day for a few weeks each season and could be done on the fields nearest to the homestead. Groups of functionally landless women could rent or acquire small areas of land for this income-generating activity.

(5) Integrated Pest Management (IPM)

A number of women's farming activities particularly qualify them to play an important role in IPM: women often select, purchase and store seed;

monitor and report pests and disease while weeding; take part in decisions on purchase of pesticides, crop rotations that break pest and disease build-up, etc. Depending on the cultures, women could be involved in the following IPM technology development and transfer programs:

(a) Monitoring of pests and diseases

This requires regular field monitoring visits. Women are better placed than men to do this since they are present in the fields for extended periods for weeding. It may be necessary for women (or men) to make additional weekly visits for monitoring in between the weeding operations. This will especially be the case in irrigated areas where each weeding is often done within a few days, with hired labor supplementing family labor.

Women will require training in:

- sampling and identification of pests and diseases, their patterns of build-up and the types of damage inflicted. Where local names for common pests and diseases are not in general use, suitable names should be coined and popularized through extension and training programs.

- the diagnosis of tungro disease in ratoon, volunteer and other rice stands outside the normal cropping season. This test, which provides early warning information, is being introduced to men and women farmers and technicians by FAO. It requires iodine, which is usually easily available, and is carried out before land preparation when labor is available.

(b) Pest management practices

Women (and men) will require training to improve their knowledge of and skills in:

- different pest and disease management practices, including the use of seed resistant varieties, crop rotations, synchronous planting within a region, chemical and biological pesticides;

- the relative effectiveness and costs of these different practices, including labor implications and side benefits or hazards;

- the assessment of economic thresholds for selecting between alternative or complementary methods of control; this would be in the context of improved monitoring of farm expenses and computation of farm income. (In countries such as the Philippines where women have financial control, it is crucial that women should be informed of the economic and technical viability of IPM methods.);

- how to apply chemical and/or biological pesticides. The weight of the sprayer is sometimes put forward as an excuse for training only men, despite the fact that the women usually have to fetch the water for the sprayers! Ultra-low sprayers can be easily handled by women;

- safety in pesticide use, transport, handling, storage and disposal. Women are more concerned and responsive to safety training than men, especially when children are at risk.

(c) Biological pesticides

Important opportunities exist for involving women in the development and transfer of plant derivatives such as neem seed oil, cake and crude extracts for pest control. Ripe neem fruits are collected, depulped and processed by women and children in India. Simple processing technology is already in use and has no harmful side-effects.

Greatly expanded production by women of neem oil and cake for crop protection and dried neem leaves for protecting stored grain from insect attack and spoilage could be an important seasonal activity, particularly as a means of supplementing the income of landless women and their families. Women farmers could also be taught how to use neem products for pest control in the field and in storage.

(6) Integrated weed management

Given women's predominant role in weeding, applied research on weed problems will require on-farm trials involving women. The technical aspects of this work will not be affected by sex-related factors. However, the implementation of appropriate weed control practices will be affected by women's knowledge of and skills in:

- the identification of weeds and their interactions with water levels, soil moisture, soil type, land preparation, planting dates, other crops in rotation with rice; (i.e., to identify the weeds' habitat: where they are and why);

- the technical effectiveness and cost of herbicides, used in conjunction with manual uprooting at the second weeding;

- the opportunity cost of women's labor, affecting the choice of different methods of weed control e.g., herbicides; manual weeding; line seeding (by drills or transplanters) to facilitate weeding; appropriate water levels; azolla production or dense transplanting, to suppress weed growth; and additional crops in the rotation to break the build-up of rice-specific weeds;

- women's preferences for alternative crops in the rotation, taking into account nutritional needs, and eating and cooking habits; and

- the development of improved tools, such as the rotary weeder, which are suitable for women's physique;

- correct choice and use of herbicides. For example, granular herbicide, which is recommended for transplanted rice under conditions of good water control, can be easily broadcast by women or men. For upland rice, several lighter-weight applicators including birky and micronherbi are being tested at IRRI. These require considerably less water than other applicators and could be handled by women.

(7) Water management

(a) Increasing attention is being given to improving farmers' participation in water allocation and distribution, irrespective of sex. However, in practice, farmers' water management associations often have no or few women members, even in areas where women are landowners and/or play important roles in the cultivation and management of rice farms.

Senior administrative and training staff of irrigation schemes should play a major role in ensuring that women are (i) appointed to farmers' irrigation associations, and (ii) are given the technical, managerial and leadership training needed to overcome social prejudice against women and to ensure that they are treated with respect and as equals by men farmers and junior extension staff. Separate training courses for women should not be necessary.

(b) Few data are available on women's roles in the distribution and delivery of water and the maintenance of canals and bunds, and the technologies they use for these tasks. It is likely that extension workers have largely addressed themselves to men and some women-specific needs and problems have been overlooked.

(8) Drying

The following technique could solve some of the difficult problems facing women in drying grain in unreliable weather:

- salvaging rice from submergence and wetting in rains and cyclones by immersing wet panicles in 5% NaCl solution. This inhibits sprouting, discoloration, mould development and spoilage;

- when drying rice sheaves, covering the panicles with the straw of the succeeding bundles in an overlapping manner to protect the grain from direct solar radiation, dew, mist, and drizzle;

- practising synchronous planting and harvesting and using uniform plant population densities to ensure more even drying in the field.

(9) Agricultural machinery

A number of machines have been developed at IRRI and in other countries to increase efficiency, lower costs and reduce drudgery. They are popular among male farmers. However, they are not so often used by women farmers, partly for social and institutional reasons, and partly because they are too heavy to be operated easily by women. Testing programs are needed to assess their suitability for operation by women and, where necessary, to make appropriate design changes. Social and institutional constraints to women's use of agricultural machinery require investigation and feasible solutions. Technology transfer programs should give special training to women in the operation, maintenance and simple repairs of the equipment.

Specific examples of technologies are:

(a) For production

- manual transplanters, row seeders, row weeders (generally too heavy for women who need a higher design);
- ultra-low sprayers (suitable for use by women);
- Tapak-tapak pump (probably suitable for use by women; it could open up opportunities for women's dry season vegetable production in rice fields or at the homestead); and
- reapers and threshers (the IRRI axial-flow thresher has increased the use of female labor in harvesting-threshing activities in the Philippines. The traditional manual threshing methods were too demanding on their physical strength).

(b) For domestic work

- rice husk fuelled stoves for cooking and parboiling;
- charcoal production from straw and husk; and
- biogas cooking stoves.

(10) Extension

Extension services should:

- upgrade the skills of extension workers in these improved technologies for women;
- expand recruitment of female extension agents;
- depending on the appropriateness for specific cultures, train male and female extension staff to work with both men and women farmers and compare their relative effectiveness in this;
- improve women's awareness of new production and post-harvest technologies;
- set up village-based training courses with men and women farmers, involving practical field work;
- train women in accounting, book-keeping, and management skills;
- help organize farmers and irrigation authorities where communal action is required. For example, introducing pest control measures such as synchronous planting or a rice-free cropping season; and
- develop a two-way dialogue between extension personnel and farmers. Women (and men) farmers need encouragement and "training" to extract or demand the information they need from the extension staff.

B. TECHNOLOGIES IN THE ASSEMBLY LINE

The following technologies which are now being developed could provide new opportunities for increasing women's employment and income, and reducing their drudgery.

(1) Restructuring of puddled and upland soil

Land preparation is commonly a male activity in Asia (particularly when animal or tractor ploughs are used). However, women also play important roles in ploughing, levelling or breaking clods of earth in some areas, especially in the hills of Nepal, India, Bangladesh, Thailand, and the outer islands of Indonesia.

Methods are being developed for:

- restructuring puddled and upland soils to reduce turnaround time and increase the productivity of upland crops following rainfed lowland and upland rice. If this leads to the cultivation of additional crops after rice, new employment and income earning opportunities will be created for women; and

- reducing inputs of energy (and water) to the puddling process. This would lead to some reduction in the puddling work, though a possible increase in bund building. More efficient conservation of impounded water may give increased opportunities for fish-rice systems, in which women could manage the fish culture.

(2) Rice hull or husk

- as an energy source in parboiling, grain drying, charcoal production;
- for animal feed, after fortification;
- as a source of cement (use of rice hull ash for solid and hollow blocks); and
- for making bricks.

These products could be made by men or women for household consumption or for sale. Small processing plants could also be established on a village-basis (run by men's and/or women's organizations) to take advantage of economies of scale.

More sophisticated plants, centered on the concept of a rice refinery proposed by Drs. L. Munck and F. Rexen*, could upgrade the quality of these products and add more processes thereby creating more employment for both sexes. Examples are:

(a) Rice straw:

- feed pellets

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*See various papers presented at the Orientation-Cum-Training Program on Improving the Income and Employment Potential of Rice Farming Systems, IRRI, January 21-30, 1985.

- fuel pellets
- packaging paper
- particle boards

(b) Rice bran:

- extraction of edible oil for human use
- use of rice bran oil for manufacture of soap and other products
- use of de-oiled rice bran for poultry feed
- fortification of de-oiled bran for animal feed production and number of cropping seasons, leading to more employment opportunities for women.

(3) Hybrid rice seed production

Women already play an important role in the production and processing of hybrid seeds, for example, in China (rice) and India (cotton).

Although these jobs can also be done by men, it appears that women are particularly careful and efficient in doing the work. They need training in:

- seed production processes, i.e., clipping of flag leaves, dispersal of pollen by "rope pulling" or the "stick" method; and

- cleaning of hybrid seed and its testing for viability.

Hybrid rice seed production units would need to be set up on a commercial scale, with quality controls and an efficient distribution system. Men or women could be involved in a managerial and training capacity.

(4) Direct seeding

The Philippine Ministry of Agriculture-IRRI Program for Small Farm Equipment is planning to collaborate with IRRI Engineering in the development of a seeder which
could be used in place of the broadcasting technique for direct seeding. The potential advantage of the seeder is that it would plant in straight lines, thereby enabling weeding to be done more easily by manual labor and reducing the need for herbicides.

(5) Biofertilizers

Blue-green algae (BGA) technology can provide 20-30 kg of biologically fixed nitrogen per hectare of rice per season. When the technology has been refined for widescale release to farmers, the BGA inoculum could be easily produced by women at the household level or in larger-scale specialized production units.

The procedure is to produce algae flakes as inoculum by growing algae in shallow fields or basins. These are then applied to the rice fields. The techniques do not need a sophisticated training program but the quality testing will require qualified personnel with some technical (microbiological) background.

(6) Integrated pest management (IPM)

(a) Varietal resistance

Since women are often responsible for the selection or purchase of seed, they would benefit from training in:

- Selection of appropriate resistant varieties;

- Use of cultivar mixtures for disease control or for reducing risk in variable environments. To maintain the mixture, it might be necessary to harvest panicles for each component, and then mix these for the following planting season. Women would need training to recognize the morpho-agronomic characteristics of the seeds and eliminate those which have become susceptible to the target disease.

(b) Insecticide use

- Making mudballs with seed of upland crops, plus insecticide and starter fertilizer to increase yield and save 1 or 2 foliar sprays. This would be particularly relevant to grain legumes and maize. The mudballs could be made with a simple machine in the home and planted in the field. Training of extension workers and women (and men) farmers would be necessary.

(c) Mass rearing of natural enemies - predators or pathogens

(d) Preparation of botanically based insecticides from the fruits of locally grown trees

- For example, new technologies will be developed over the next 5-10 years for small-scale neem processing plants for pyrolysis, power generation and extraction purposes. These could be situated in rural areas, to serve a number of villages.

- New jobs could be created for women (and men) in:

  - tree planting and afforestation programs;
  - fruit and seed collection;
  - seed processing;
  - village and cottage industries based on non-edible oils; and
  - other neem products.

  Training would be needed in processing and extracting non-edible oils, soap manufacture, simple formulations, use of ULV-applicators, etc. None of these would be particularly demanding on skill or physical strength.

(7) Driers and drying techniques

The on-going IRRI program on driers and drying techniques is already working with rural women. The basic philosophy is (a) to observe how men and women farmers dry their crops now and to identify their problems; (b) to improve on existing methods, where possible using low-cost local

materials and non-conventional energy sources and (c) to devise simple equipment, so men and/or women farmers can participate in the construction process and later operate and maintain the equipment easily.

Several multi-purpose driers have been developed for village- and farm-level crop drying, using local materials (coconut and mud-rice husk bricks) and non-conventional energy (wind and agricultural waste, including rice husks). These are now being tested in the Philippines (in Mindanao, Visayas and Cotabato). Training programs will later be set up for men and women farmers.

The program is also working on methods to lessen the percentage of brokens at milling caused by the large moisture variance. This is of particular concern with the spread of new varieties which have a moisture variance of 40% compared with 15% for traditional varieties. This is a research area that will be of particular relevance to women since they are: generally responsible for husking or taking rice to the mill; encounter cooking problems posed by brokens; separate the brokens from the bran; and need to control moisture levels in storage.

(8) Agricultural machinery

There are a number of technologies currently under development which could potentially reduce women's drudgery and generate employment and income for women laborers. During the design and testing stages, their use by women should be taken into account.

Specific examples are:

(a) For rice production

- direct seeding of rice
- fertilizer placement machines
- machines for incorporation of organic materials (e.g., azolla mixers)
- grain drying
- biogass generation

(b) For other productive work

- Simple milking machines to increase efficiency and protect animals from injury (common in hand milking)
- oil extraction devices, to extract oil from sunflower, groundnuts, rape seed, coconut)
- simple machines for preserving food, fruits, vegetables.

Although excellent work is being carried out by various agricultural engineering programs in Asia, relatively little attention has hitherto been given to women's post-harvest activities. Low-cost improved technologies which use local materials, non-conventional energy sources, and are easy to construct and maintain are needed for: on-farm crop drying, winnowing, parboiling, husking, storage, handling and transporting rice and other heavy crops during these operations in the home (e.g., devices similar to wheel barrows), processing and preservation of other foods (vegetables, fruits, fish), cooking and water provisioning.

(9) Biomass utilization

Women already use rice straw, bran and hulls for a variety of purposes. The quality of these products could be improved and their uses expanded with technologies now being developed. Some examples of the potential available for immediate farm-level experimentation are:

(a) Rice straw:

- as a source of manure, incorporated with animal dung;
- as a substrate for mushroom culture;
- as a source of animal feed, the quality to be improved by subjecting it to alkali digestion and enriching it with urea and molasses;
- for paper manufacture; and
- for biogas generation and subsequent composting.

(b) Rice bran:

- for animal and poultry feed.

(c) Rice-hull or husk:

- for extraction of solar grade silicon for use in the manufacture of photovoltaic cells;

- as a source of activated carbon, an important material used for bleaching oil, glycerine, etc., as carbon filter and also used in the manufacture of pharmaceuticals;

- as a source of Furfural. By distilling rice husk with dilute sulphuric acid, the pentose present in rice husk would yield three water molecules and furfural. Here also we get important by-products like methanol and acetone. Furfural is used in different forms for manufacture of cellulose acetate, nitro cellulose, shoe dyes, synthetic resins, etc.

(10) Mushroom culture

Methods of mushroom culture using rice straw as a substrate could be introduced to women. This would improve the family's nutritional balance and would be a valuable source of income to farm and landless women.

(11) Fish-rice culture

Although fish-rice culture is traditionally practised by men and women in many Asian countries, especially China, India, Indonesia and Thailand, new technologies have in recent years very considerably improved productivity and made acquaculture a highly profitable enterprise. These technologies are being developed in particular by the Freshwater Acquaculture Research and Training Centre (FARTC) in Orissa, India (belonging to the Central Inland Fisheries Research Institute which has 11 or 12 centers scattered throughout the country), the Inland Fisheries Research Institute, Agency for Agricultural Research and Development, Indonesia, and the Fresh Water Fish Research Station, Central Luzon State University, Philippines.

FARTC already has special programs for rural, particularly landless women. Farm women are also involved in the program aimed at the farm family. These programs for women which deserve support within the Women in Rice Farming Systems network and which could be expanded in India and other countries are:

- The raising of fingerlings for sale. In some cases women purchase the fry for rearing. The fry are fed on rice bran and oil cake (e.g., groundnut or mustard). One kg of fry at Rp10 can bring a return of about Rp40-50. FARTC has also trained women to induce fish to breed by giving pituitary injections to the females. Women are often better at this than men.

- Making and repairing nets. This is a traditional women's activity in the above-mentioned countries, as well as Bangladesh. FARTC has trained women in improved techniques for these activities and set up a women's cooperative near the Center where women earn Rp10-12 a day. These activities could be adapted to other areas.

- Processing and marketing. In many Asian countries women are involved in these activities. For example, in India women do about 99% of fish marketing. There is considerable scope for improving the efficiency and hygiene standards of fish processing and marketing, from which both farm and landless women would benefit.

- The profitability of fish-rice systems can be further enhanced by adding duck and pig enterprises (if these are culturally acceptable and/or there is a market demand for these products). Women could also be trained to operate such enterprises.

(12) Livestock-rice systems

These systems are traditional yet hitherto limited attention has been given to their integrated improvement. In many Asian countries the care of livestock is predominantly and sometimes completely women's responsibility. They cut fodder, use the rice hulls, bran and straw as feed (which they have often threshed and nearly always husked), make farmyard manure, water the animals, and make dairy products such as curd and ghee, etc. Any livestock-rice farming systems program must give specific attention to women's labor, skills, knowledge, opinions, needs, constraints and potentials in these areas.

Specific areas for improvement that are currently under development in three sites of the Asian Rice Farming Systems Network (Indonesia, Philippines and Thailand) are:

- development of dual-purpose (i) rice-legume rotations (for both grain and fodder, e.g., mungbean, soybean, cowpea, pigeon pea, groundnut; some pigeon pea varieties can be ratooned for fodder after the grain is harvested), (ii) rice-cereal rotations (e.g., sorghum and maize), and (iii) rice-forage grasses;

- use of forage crops, e.g., the fodder tree ipil-ipil (Leucaena leucocephala) and Napier grass (Pennisetum purpurem) grown on rice bunds or in the homestead for supplemental feeding (ipil-ipil will also provide fencing, windbreaks and fuel);

- use of crop residues as feed (e.g., rice husk, bran and straw, after fortification with urea and molasses and alkali treatment to improve digestibility);

- combinations of different types of feeds, including molasses-salt-mineral supplements, their availability, and economic assessment;

- residual effects of pesticides and herbicides on crops or crop residues used for fodder, and on livestock watering places;

- use of animal manure for field and garden crops, after treatment;

- women's livestock management skills and problems, labor constraints, sources of technical information about improved management practices, feeds, knowledge of animal diseases and recommended preventive measures, access to veterinary services, marketing information and services, provisions to pay women directly for their livestock produce and not their husbands.

(13) Vegetable-rice systems

Women commonly cultivate backyard vegetable gardens throughout Asia. Since water is often a serious constraint, particularly in the dry season, vegetables could also be grown on the bunds of irrigated paddy fields. Vegetable production (which men rarely engage in) deserves more attention in research and development programs as an important means of improving family nutrition and providing women with some additional income.

Women would benefit from training in the use of organic materials and compost, and improving garden lay-outs and methods of establishing nurseries.

(14) Sericulture-rice systems

Although sericulture is a traditional women's enterprise particularly in the slack rice cropping season, relatively little scientific attention has been given to improving sericulture within an integrated farming systems approach. Procedures are inefficient and time-consuming and in many places women are therefore only able to produce enough for family needs and cannot meet market demand.

(15) Food processing

The following Cottage industries could be developed by women for consumption and the market:

- making noodles from mungbean, a popular crop in rice-based systems;
- drying mushrooms;
- preparing bread and cakes from blended wheat and rice flour;
- making soy sauce, pickles, chutneys, jams;
- preparing puffed rice, and savories using lentil, rice and spices.