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Gender-Related Impacts and the Work of the International Agricultural Research Centers

Janice Jiggins



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**Gender-Related Impacts and the Work of the International
Agricultural Research Centers**

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Janice Jiggins

The World Bank
Washington, D.C.

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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research organizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

Janice Jiggins, a citizen of the United Kingdom residing in the Netherlands, is a rural development consultant.

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Abstract

The satisfaction of aggregate food needs implies not only that the work of the international agricultural research centers (IARCs) lead to the creation of an output surplus but also that the distribution of food and income be such that malnutrition and hunger are reduced. It is becoming increasingly evident that these goals cannot be achieved if women's roles in production and food systems are not taken into account.

Neglect of gender issues in agricultural research and technology development holds output and welfare below potential. Major structural change is leading to widespread modification of patterns of household formation and income-earning, resource allocation and division of responsibility within the family and society as a whole. Normative views of appropriate male and female roles are challenged by evidence of the preponderance of households headed by women among the urban and rural poor, the necessity of female income for family survival, and the scale of women's participation in agricultural production, food processing and trading, food preservation and preparation.

Within industrial agriculture, very close attention is paid to the demands of commerce, trade and the food industry for specific varietal characteristics which fit particular user or consumer markets and the requirements of post-harvest technology. Although the IARCs have paid some attention to, for example, commercial milling quality, in general the demands of domestic post-harvest technologies in the processing, preservation and transformation of food and of crop/stock by-products have received scant attention in the determination of research agenda and the selection of characteristics.

There is a growing volume of documented examples of gender-specific varietal preferences, determined by the particular

roles, tasks and responsibilities of men and women. Little effort has been made by the IARCs to determine women's seed or stock selection criteria, varietal preferences and existing genetic resources or the experimental variables tested by them. Further, by focusing on monocrop production of edible yield from food commodities traded on world markets, the role of multiple use of biomass to supply employment, income and use values has been undervalued.

In addition to methodological weaknesses built into current research programming, insufficient attention has been paid by agricultural researchers to the institutional barriers which inhibit the exchange of relevant experience and information between women, agricultural researchers and extension agents. The IARCs' staffing and training practices tend both to exaggerate and to reinforce existing barriers.

Technical change in agriculture, both direct and indirect, has had a differential impact on men and women and on women in different income classes. The impact has not been uniform across all societies, nor in respect of all tasks typically carried out by women -- for example, a woman might benefit as a consumer from falling food staple prices but lose as a wage-earner or as an unpaid laborer within the household. However, data from a variety of sources allow tentative conclusions to be drawn with regard to the impact on women in three geographical regions: Asia, Latin America and the Caribbean and Sub-Saharan Africa.

Acknowledgments

The decision to make a separate study of the work of the international agricultural research centers and the impact of technical change in agriculture on women was a belated one but one that was recognized subsequently by Impact Study sponsors and collaborators as both necessary and useful.

The support of the Impact Study director, Dr. Jock Anderson, has encouraged the author to bring together as a monograph the various pieces prepared as background documents for the study. His comments and the substantial contribution of female professional colleagues throughout the world who generously contributed material and insight into their experience of working within the CG system are gratefully acknowledged.

Abbreviations

CIAT	International Center for Tropical Agriculture, Colombia
CIMMYT	International Center for Maize and Wheat, Mexico
CIP	International Potato Center, Peru
CRSP	Collaborative Research Support Program
FAO	Food and Agriculture Organization
FSR	Farming Systems Research
GE	Genotype-Environment
IARC	International Agricultural Research Center
ICARDA	International Center for Agricultural Research on Dryland Areas, Syria
ICRISAT	International Crops Research Institute for the Semi- Arid Tropics, India
IFPRI	International Food Policy Research Institute, U.S.A.
IITA	International Institute for Tropical Agriculture, Nigeria
ILCA	International Livestock Center for Africa, Ethiopia
IRRI	International Rice Research Institute, Philippines
ISNAR	International Service for National Agricultural Research, The Netherlands
MV	Modern Variety
NARS	National Agricultural Research System
RD	Recommendation Domain
VVA	Volta Valley Authority
WCARRD	World Conference on Agrarian Reform and Rural Development

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1 Why Do Gender Issues Matter?

When the first IARCs were established, it was thought that their work would help developing countries meet their aggregate food requirements. Since not everyone was nor could be a self-sufficient food producer, that expectation implied two goals: the creation of an output surplus and a distribution of food and income such that malnutrition and hunger would be reduced. It was the belief of some that the latter goal could be secured through carefully targeting and guiding the process leading to the former. It has proved difficult to satisfy the original expectation in a way which keeps the two goals in harmony. The argument of this monograph is that there will continue to be disharmony as long as women's roles in agricultural production and food systems are ignored or underestimated. Section 1 summarizes the main points of the argument.

1.1 Neglect of Gender Relations in Agricultural Development Programs and Projects Is Inefficient

There is increasing evidence from agricultural project and program evaluations that insufficient attention to gender issues tends to increase or reinforce gender inequities in ways which hold productivity and welfare below the potential (Carloni, 1983; Dey, 1983; Jones, 1982; Pradhan, 1983a). Neglect of the gender relations of production is inefficient.

Field studies indicate that the inefficiencies which arise occur not only where women are themselves engaged directly in primary production, on their own account or as unpaid family workers, but also where innovation is associated with change in

employment markets and the intrahousehold distribution of labor, income and expenditure obligations between family members.

1.2 Socioeconomic Change Is Assigning New Roles and Responsibilities to Women

Major economic and social transformations are occurring which, whatever the culturally ideal position of men and women in society may be, are changing household formations and patterns of obligation rapidly and substantially. Three related indices of the magnitude of these changes are: the scale of differential male and female migration; the proportion of households headed by women; the concentration of single-adult households headed by women among poorer income classes and the more remote, more rural dryland areas (Recchini de Lattes and Wainerman, 1982; Jiggins, 1985; Safilios-Rothschild, 1982).

Differential migration does not have the same impact in every case. In addition to inter-country differences, there are marked regional patterns associated with particular agrarian histories and resource endowments. It may result, as in the majority of Latin American countries, in a high proportion of women becoming solely responsible for low income urban households; or, it may result, as in Lesotho, in over 70 percent of farming households being headed de jure or de facto by women; or as in Bangladesh and Maharashtra, it may result in from a quarter to a third of all applicants to, respectively, Food for Work and Employment Guarantee schemes being women who are permanently or seasonally responsible for themselves and their children.

Male outmigration from rural areas in some instances is strong enough to suggest a process of "feminization of agriculture" or perhaps more accurately, of self-provisioning food farming. Data from areas as far apart as the dryland rice farming areas of Colombia and the Dominican Republic, and Malawi (where over two-thirds of those working full time on food farm-

holdings are now women), all suggest that major structural change in smallholder agriculture is occurring, irrespective of culture, which has something to do with the specifics of the nature of technological and organizational innovations.

Local studies from different countries are providing convergent illustrations of the social and economic symptoms of migratory stress, such as an increase in female agricultural wage labor and diversified part-time production by rural women with non-farm cash incomes (Omvedt, 1981, for examples from the sugar-producing areas of Maharashtra, India), agricultural/horticultural/small stock, fish and poultry enterprises owned and managed by women (Obbo, 1980, for Ugandan examples). The reversion to less labor demanding food crops (cassava rather than coarse grains in Central Africa, for example), and to less complex crop mixes and rotations in areas where male labor has migrated, would appear, on present evidence, to be other characteristic symptoms.

Households headed by women now form on average in developing countries (excluding China) between 20 to 25 percent of all rural households, except, notably, in strongly Islamic societies. In pockets in many areas and in a few exceptional countries, the percentages range up to 60 or 70 percent. They tend to be less well served by agricultural and other services and to have lower access to factor and non-factor inputs than households headed by men (Staudt, 1985, for a Kenyan case from the mid-1970s).

Not all households headed by women are poor but comparatively few achieve security through remittances from wage-earning menfolk. Remittances tend to be erratic in value and timing, low in volume and are often earmarked for expenditures which pre-empt the resource allocation decisions which consideration of present welfare would indicate.

Taken together, the indices reveal patterns of household formation such that the image of the model poor rural households as male-headed, of men as household breadwinners and of farming as a male occupation, is due for a substantial overhaul.

1.3 Women Have a Key Mediating Role in Household Welfare and Nutrition

Gender issues matter because of the central roles women play in the mediation of household welfare and nutrition, both through their own-account income earning and through their participation in the "4 Ps" -- the production, processing, preservation and preparation of food (FAO, 1977).

In some regions such as North India and Bangladesh (and there is some indication in China also) rising household income does not apparently translate into better welfare for females. Even in households in quite high income classes, girls and adult women are worse fed, with higher rates of morbidity and mortality, than boys and adult men (Schofield, 1973; Levinson, 1974; Chen et al., 1981).

The record more generally suggests that higher "household" incomes do not necessarily result in higher levels of nutrition or welfare for all members or all members proportionately, partly because of male-specific expenditure preferences and partly because of divisions of responsibility and obligation within households. An increase in income directly under women's control, on the other hand, (1) tends to be spent mainly on household welfare; (2) the nutritional status of the vulnerable (pregnant and lactating women and very young children) is improved; and (3) women's personal security, and hence the security of children, in poverty-stricken households is less vulnerable to the hazards of family disintegration. On the other hand, where female income is won through employment rather than production, if declining real wage rates for women mean they have

to work longer hours or, if the timing or location of employment means they are absent from their children for long periods, the welfare particularly of the young may be adversely affected (Kumar, 1978; Carloni, 1984).

In societies in which women are responsible for feeding the family and maintaining young children, where agricultural innovation leads to the reallocation of family labor and the assignment to men of complete control over output and income, without associated changes in the allocation of obligations, welfare and nutritional status may actually decline (IFPRI, 1983).

1.4 Female Production Is Substantial but Undercounted and Undervalued

As unpaid laborers and own-account producers within family enterprises, as independent farmers as polygamous wives and as head of households, as urban and rural home gardeners and small stockkeepers, women are major producers, in terms of value, volume and hours worked (FAO, 1983, 1984, 1985; Pradhan, 1983b). Neither their total output nor their productivity is necessarily low: for example, in Bangoukire in the Songhai area of Niger, although women are reputed to be only marginally involved in agriculture, a 1981 village survey found that 95 percent of the women carried out rainfed rice cropping in gardens ranging in size from 0.25 ha to 1 ha or more, producing a total of 17 tons of rice, or 441 kg/woman (Bisilliat and Presvelou, 1985).

Since most of this production is not captured by routine agricultural surveys and censuses, it is impossible at present to give even a rough order of its global magnitude. Estimates of the income and welfare gains to households associated with modern varieties probably overstate the benefits by undercounting any costs incurred via reallocation of female labor between crops.

between farm and non-farm activities and between domestic and public domain roles.

Generalizations, such as "women produce mainly for home consumption," the lack of potential implied by much that is written (but not studied) concerning home gardening, the comparative lack of organized research support for crops, stock and varieties grown especially by women, the neglect of their roles in germplasm conservation and seed selection, all hinder further recognition and more accurate measurement of the scale of women's contribution.

In one case, Botswana, because of the marked spatial separation of arable and livestock farming and strongly sex-specific allocation of farming responsibilities and tasks, it has been possible to estimate the relative investments to and returns from male and female farming (Fones-Sundell, 1984). Analysis of 1984 production data shows that, while women contributed almost 70 percent of the value of arable production, they received the benefit of less than 15 percent of government expenditures made to that subsector.

1.5 The Organization of the Innovation Process

Women's participation in direct production and in food systems raises three special questions for the organization of the innovation process.

- (1) Agricultural input and farmgate pricing policy, often coupled with adjustments to input supply, production services and marketing institutions, has been widely used to provide producer incentives in support of technical innovation. Researchers and planners so far have more or less neglected the consequences, for pricing policy and adoption, of wholly or partially separated male and female budgets; of male control over the output produced in whole

or part by unpaid female labor; and, of the effective barriers to women's access to (subsidized) institutionally provided inputs and services.

- (2) One of the most widespread and consequential barriers is agricultural extension, through which so many innovations and services are channeled. In addition to the pressures which encourage field-level extension staff to work with larger farmers rather than smallholders (Leonard, 1977), the fact that most extension staff are male has meant that, for any farm size or income category, extension agents have tended to work with male farmers rather than female farmers (Swanson, et al., 1985). A technology development process which is so structured that technical innovations in food cropping simply do not reach a major portion of the farming community makes very little sense.
- (3) While coordinated international research resources have been mobilized for production technologies, the task of raising the returns to skills, capital and labor employed in other aspects of food systems, especially the domestic processing, preservation and preparation of food, has received only scattered and underfunded support. While the characteristics required by industrial post-harvest processing, preservation and preparation have to some extent been taken into account in seed technology development (e.g. milling quality), the relation between seed characteristics and domestic post-harvest processing technologies has received relatively little attention. Incompatibility between cropping and post-harvest technical requirements is often cited by female non-adopters as the reason why they have rejected a particular cropping technology.

1.6 Questions of Bias

Gender issues deserve particular consideration in the

special sense that so much that passes for objective socio-economic research and technology development would appear to be biased on a priori assumptions: what is measured is determined by researchers' fields of observation and perception of what it is important to record. For example, ICRISAT decided not to record backyard production in its village studies, even though one of its mandate crops, pigeonpea, is an important backyard crop. A project formulation mission undertaken in 1979 by the FAO/World Bank Cooperative Program in Northern Sierra Leone failed to distinguish in its data collection, analysis or presentation, the preponderant role of female rice farmers and traders in several of the northern chiefdoms (FAO/World Bank Report of the Sierra Leone Integrated Agricultural Development Project - North - Phase II, 1980). In fact, about 80 percent of small rice traders in these areas are women (Safilios-Rothschild, 1982).

It was argued strongly by some individual researchers during a visit by the author to IRRI and ICRISAT in the course of the CGIAR Impact Study in September 1984, that to give prominence to gender issues would undermine the legitimacy of research and destroy confidence in its results. Such attitudes surely reveal failures to perceive women - over half the world's population and important to technology development as producers, workers and consumers - as clients of, or as forming an important constituency for, agricultural research. It also surely reflects an unwarranted hesitation in exploring the common ground with national research and agricultural policy-makers, many of whose governments have subscribed to the commitments entered into at such fora as the WCARRD in 1979 with respect to women. That such explorations can be fruitful is shown by the recognition given to women in rice farming systems in the Memo of Understanding outlining collaborative research programming between IRRI and the Chinese Academy of Social Sciences, 1984-85.

Although much that is currently known about women's roles is circulated within networks outside the mainstream circuits of

agricultural information exchange and dissemination, these are not inherently difficult to tap into. But to do so requires a more positive effort than hitherto has been made by international and national agricultural research. And although it is true that female producers, traders and consumers at present have few strong representative bodies through which their views could be expressed, there are in almost all countries organizations and individuals in the government or non-government sector with expertise in agricultural technology development and an understanding of women's economic contribution to agriculture and food systems. These organizations and individuals are only rarely contacted by scientists, researchers and study consultants and so bias tends to be perpetuated.

The record of the IARCs with respect to gender issues has been in general a conservative record of hesitation and cautious exploration stimulated largely by donor-financed initiatives outside of core budgets and implemented by temporarily attached staff. Moreover, there is much in the way the research process is organized and research criteria are derived which stands in the path of more substantive efforts. These technical and methodological questions are explored in the next four chapters, followed by an attempt to trace some of the consequences (chapters 6, 7 and 8).

2 Seed Technology and Gender Issues: What Are the Questions Which Arise?

It is commonly said that gender issues are relevant to agricultural research only as downstream considerations, that they have little place in discussions of how research is organized or the methodologies which are used. However, if interactive genotype-environment (GE) relationships matter at all in crop breeding, then human intentionality in the socioagricultural environment matters. To the extent that women play a role in the socioagricultural environment, gender issues necessarily enter the technology development process itself. Thereby arise important questions for seed technology development.

The IARCs have been criticized for failing to give due consideration to interactive genotype-environment effects in breeding research (Simmonds, 1981) and for exposing materials more to the selective pressures of research station environments than the "agricultural realities" experienced by the majority of poor producers in non-irrigated areas (Chambers and Ghildyal, 1984). The criticism raises three sets of gender-related questions, relating to women's roles in seed selection and vegetative propagation and in food systems.

2.1 Home Gardens and Germplasm Collection

Home gardens fall largely under women's care because of their role as "keepers of the hearth." Research studies from Grenada, Zimbabwe, West Africa, Jakarta, Southeast Asia and Peru emphasize the importance of these gardens as providers of early-maturing varieties to carry families over the hungry season till main crops mature, as reserve sources of plant materials should main crops fail, as conservation sites for special or preferred varieties and as testing grounds for new varieties or practices (Brierley, 1976; Callear, 1982; Eijnatten, 1971; Evers, 1981; Ninez, 1984; Stoler, 1978). Because the function of home gardens

in farming systems differs from that of fields, selective pressures in the two environments are likely also to differ. (In the case of livestock, for example, gentleness might be considered an important selection criteria.)

If during germplasm collection the effects of these kinds of GE interactions on performance are not recorded, then what are the consequences for conservation and retrieval? Take, for example, seeds sown in the same planting hole (e.g., beans/maize and intercropped with curcubits); the seeds will have been selected for their compatibility rather than their individual performance and if they are grown out as single stands, then that compatibility is not likely to be evident. It is unusual for IARC seed collectors either to gather materials from women's home gardens or to record from women the husbandry and utilization information which would provide insight into performance characteristics affected by GE interaction.

2.2 The Relation between Seed Characteristics and Domestic Post-Harvest Technologies

If crops are not only grown within household enterprises but processed, stored and preserved, and prepared as food within the household using domestic rather than industrial technologies, what are the consequences of the technical characteristics of these processes for seed or vegetative selection? The inter-relationship at the domestic level between the technologies of production and the technologies of post-harvest operation are scarcely researched. There are a number of reasons why this might be so: the time lags between production and final consumption, the sectoral and disciplinary gaps between agricultural research, appropriate technology and domestic science or home economics, the non-monetized nature of much domestic work, the cultural gaps between male agricultural researchers and housewives.

The relationships are not usually simply, say, questions of the relation between the skin toughness of beans and length of cooking time. Where cooking equipment and diet vary with the seasonality of water supply and types of fuel available, the relation is much more complex (Ashmore, 1982, for a Lesotho example). Varietal preference for brewing cassava is not simply a question of "taste" per se but taste with respect to the product of specific brewing equipment and processes. Among the IARCs, CIP's recent consumer preference studies in South America and Rwanda and its integrated production-consumption research programming are exceptional in the linkage they establish between production and domestic post-production technology in varietal selection. Even so, failure to determine at the outset women's own priority problems led to a focus on faster ways to dehydrate potatoes for *papa seca* when, as it later turned out, women were interested in more labor-efficient methods of potato cutting and peeling. Rhoades (1984) records the comment of Shaw, a CIP researcher:

We were again designing postharvest technology from a distance. Since we were dealing with a dehydrated product, the problem seemed one of solar drying. We knew about peeling and cutting but since these were labor intensive they were thought of as desirable and not as problems (Rhoades, 1984, p. 31).

The IITA's recently announced intention to work more closely with the African Home Economics Association also gives promise that the interdependencies will receive attention. (Staff at other centers, such as ICRISAT, from time to time have studied domestic processing, storage and cooking technologies but the links between these studies and breeders' programs appear to be tenuous.)

2.3 Livelihoods and the Utilization of Biomass

The IARCs have concentrated on grain (or root/tuber starch) yield, no doubt correctly if an increase in aggregate supply is the only desideratum. Nonetheless, questions arise concerning

the nature of the fit between higher-yielding modern varieties (MVs) and the utilization of biomass, both by producers and by artisans and employees, in rural economies only partially supplied and employed by modern "transformation" industries and agribusiness. To many a small producer, rice, for example, is not just grain: it provides straw for thatching and mat-making, fodder for livestock, bran for fish ponds, husks for fuel. These products not only have a role within the domestic economy, they are the input to often complex divisions of labor and enterprise providing income and employment to very many of the rural poor. Local varieties have been selected to meet the specifications of these multiple end-users; MVs have not.

Possibly the importance of the contribution of multiple use of biomass to poor rural economies has been obscured by the concentration on the more favored, irrigated areas where the high profits from MVs complement existing, or induce the development of new infrastructures, commercial and industrial networks and livelihood opportunities. Post-production commercial technologies transform the products and by-products and process food to the point where little further preparation may be necessary; they also have channels for signalling their technical requirements to breeders.

The ultra-small scale of domestic and local transformation activities and their atomistic nature hides them from statistical view; and virtually no channels exist for operators to signal their technical requirements to breeders. But analysis of project documentation -- for example, the loan categories of the Grameen Bank in Bangladesh -- would suggest both greater utilization of biomass at the micro level and greater hardship if these livelihood opportunities are lost, than has been recognized in the work of the IARCs.

Within this broad area of concern, women again have a central place, partly because women figure disproportionately among those who depend on such livelihoods but also, and perhaps more significantly, because of their need for fuel, home-based income opportunities and effort-reducing convenience foods.

A leggy backyard pigeonpea, for example, is often preferred because of the utility and convenience of the stalks as fuel; sweet cassava varieties whose leaves are palatable as fresh greens, which are usable raw as snacks for children and which give a low-alcohol brew for rewarding and refreshing field workers, are often planted closest to the compound; cowpea varieties with non-synchronous maturity whose leaves are palatable as greens and, as a residue on the stem, as forage, the green seed as a relish and the dried seed as a main protein source, are chosen by women as means of easing dietary management in areas where rainfall is erratic, markets are seasonally poorly stocked or high-priced or just too far away for women to find time to visit regularly; landless women will keep dairy cows or buffalo on waste land not only for the milk but also for the opportunity to make and sell dung cakes for fuel.

If the full potential of crossbred dairy cattle or buffalo can be reached only by feeding a concentrate which renders the dung less fibrous and thus makes it less suitable for dung cakes, then consideration must be given in the technology development process itself -- and not just at the point of introduction when all the fundamental choices have been made -- to the question of the milk-fodder-fuel tradeoffs. Similarly, if IITA makes no provision in its cassava breeding programs for leaf as well as tuber yield, for leaf palatability and ease of harvesting, then its high starch varieties bred for Central Africa, whose stalks grow beyond the reach of women, necessarily will continue to meet with resistance from female cassava farmers (Fresco, 1982). If the women in Bangladesh who puff rice as a compound-based income activity, require the fierce, bright heat of burning rice stalks

to puff rice using their existing heated sand technology, then if rice straw becomes less available or more expensive, consideration has to be given to alternative fuels and/or alternative puffing technologies and/or alternative income sources. It is altogether evasive of IARC researchers to leave these questions entirely to others as beyond their mandate as crop breeders.

2.4 Whose Criteria Matter?

The three areas considered above could be summed in one, key query: whose criteria matter in the design of research programming and selection of research priorities?

There are very few published cases of crop research which have taken women's criteria as the foundation of an experiment program. The successful FAO/UNDP cassava project in Zaire is one of the few (Fresco, 1982). Researchers worked closely with IITA through the project and one of the many important lessons was the profound gap which existed between scientists' priorities and choice of experimental variables and those of the women farmers. The Bean/Cowpea Collaborative Research Support Program (CRSP) based at Michigan State University provides other examples. The Bean/Cowpea CRSP supports 17 research projects in 13 African and Latin American countries, and includes the development of pest management strategies, breeding for multiple disease resistance and biological nitrogen fixation, and the development of early maturing, drought resistant varieties. Since its inception in 1980-81, training and information on gender issues has been provided to the researchers to help introduce gender sensitivity to the process of prioritizing research agendas, making farmer contacts, selecting trial variables and in evaluation (Ferguson and Horn, 1985).

It seems uncommonly hard to convince researchers that women possess skills, knowledge and experience which is not replicated in the knowledge and skills held by men and yet which is of use

to breeders in the task of setting the research agenda (Fortmann, 1981; Fresco and Jiggins, 1985). References in the literature to women's technical knowledge are many but scattered, tending to be hidden in ethnographic monographs and fugitive materials from seminars and workshops. The papers to the Women in Rice Farming Systems Conference (IRRI, 1985) provide more accessible examples concerning rice seed storage in Bangladesh (Abdullah, 1985, p. 214); the exchange of rice seeds between women through female communication networks, even across country borders e.g., between Senegal and The Gambia (Dey, 1985, p. 440); and, the enumeration by a female respondent of over 200 edible plants cultivated or gathered by her in Kalimantan, Indonesia (Watson, 1985, pp. 198-201).

To argue that gender-specific criteria matter and that women as seed selectors have knowledge of importance to plant breeders, is not to suggest that there is an untapped female army of "illiterate but skilled plant breeders ...walking encyclopedias of land, soil and vegetation" (Gay, 1982, p. 26). However, the published record and the field experience of, for example, the Bean/Cowpea CRSP researchers, does suggest that scientists have much to gain from working with women. One such record describes the Kpelle rice growers in the rain forests of central Liberia. Women use and recognize over a hundred different varieties of rice:

These rice varieties include old favourites, known to parents and grandparents as tried and true favourites, as well as new varieties some borrowed from neighbouring villages, some selected by women as they identified promising variants in the fields as they harvested the crop, and some taken from the government and private experimental farms along the motor road. There is enough diversity that a woman - for it is women who save the seed from harvest and then select what is to be planted in the new season according to the land which is under cultivation - can choose precisely what fits her tastes and the conditions of her land.

To test the knowledge of rice, I designed an experiment in which people would set back-to-back and give each other, in turns, enough information by which the receiver of the information could pick out from a set of 25 freshly

harvested stalks just the variety which the sender had in mind. There were women, generally older women who were senior wives and leaders in their cooperative work groups, who could send and receive information about rice varieties with at most 2 or 3 errors out of 25 attempts. On the other hand, some men could hardly get 2 or 3 correct answers on the same test and no men were as good as the best women.

Moreover, these women used categories which formed a clear and systematic framework for describing rice. They mentioned such features as husk and seed colour, length of hair at the tip of the rice, size of the grain, ease with which the husk can be removed, length of time required to cook, and suitability to different types of soil and terrain. They knew their business (Gay, 1982, p. 25).

There is one further question to raise and that is whether the concentration of international publicly funded research on commercial crops, traded on world markets, has helped to perpetuate the invisibility of "hidden" crops grown in urban and rural gardens and small plots for self-provisioning, local trading and agribusinesses, as well as for long distance marketing in the informal sector. Examples of such crops are: breadfruit, local green leaves, roots and tubers, sheanut, moringa oleifera, sauropus androgynous, hibiscus manihot, felfairea, quinoa, solanum macrocarpon, s. aethiopiaum, s. incanum and s. nigrum. As far as the local record of development field workers, missionaries and social scientists can tell us, many of these crops fall solely or mainly under women's care and disposal.

Neither routine crop surveys nor trading statistics give any help in establishing just how important these kinds of foodstuffs are to producers, traders and consumers, nor who grows or sells them or controls the income. Privately funded agricultural research and the technology development work of a few non-government development organizations are making some agricultural research headway with crops such as grain amaranth and quinoa; otherwise, the realizable returns to investment in exploring the potential of crops such as these are largely unknown.

The questions raised in this chapter do not suggest necessarily that the edible yield gains for widely traded food commodities should have been sacrificed in pursuit of biological or genetic solutions to much that is wrong in low income agrarian societies. They do strongly suggest three things:

- (1) that the IARCs' work would benefit from exploration of women's existing seed technologies, varietal preferences and experimental variables;
- (2) that the relevance of the IARCs' work would increase if they had a better understanding of the relation between desired seed or stock characteristics and domestic processing, preservation and preparation of foodstuffs for consumption and sale; and
- (3) that the IARCs have not given sufficient attention to collaborative investigation through the NARSs, and with other research and technology development centers on the question of how the present benefits derived from multiple use of biomass might be alternatively provided as monocropped MVs grown for yield become more widespread.

3 Questions of Methodology

3.1 Agricultural Research or Technology Development?

Broadly speaking, the IARCs exist in order that the resources of international agricultural science may be applied to the development of technologies which raise the economic output of the major food crops and stock grown in developing countries. The evidence of high payoffs to agricultural research investment is fundamental to the conviction that the IARC model is both necessary and worthwhile. Indeed, the IARCs have established a record of success which arguably justifies the investment. However, it is noteworthy that the model so far has generated outputs primarily designed for production environments whose special characteristics facilitate rapid achievement of yield and income gains.

Now that attention is turning increasingly to other environments -- those in which the majority of small cultivators and laborers live but with less productive potential in terms of inherent physical and climatic properties -- the organization of research at the IARCs and the assumptions on which it is based, are coming under scrutiny (Chambers and Ghildyal, 1984). That part of the discussion of concern here is defined by the distinction between agricultural research and technology development. The latter has no function outside a definable market or market potential and the process of meeting the needs of that market cannot be effective and profitable without the involvement of members of that market in the determination of research criteria, design, testing and evaluation, or without early consideration of promotion, sales and servicing.

In industrial country agriculture and, albeit to a lesser degree, in irrigated agriculture in developing countries, research organizations work within and for "markets" which are well-defined, well-organized and highly interactive. There are

at least four main segments of that market: farmers, who are organized and able to contribute to research programming through a variety of channels; powerful industrial organizations engaged in the business of transforming primary production into a range of consumer and industrial goods, well able to signal to researchers their own technical requirements or even, by paying for research, to determine that crop characteristics meet the needs of their own technical processes; powerful commercial organizations engaged in the business of wholesaling and retailing produce and processed foodstuffs, which are able to insist on high quality standards in defence of existing and the acquisition of new sales; and, consumers, who either through their purchasing power or through consumer organizations and lobbies, also signal their preferences to researchers.

The case is quite different in non-irrigated environments in developing countries. Producers, except perhaps for the richest, are not well-organized in officially recognized bodies nor politically powerful and have few if any links with researchers; the range of transformation processes occurs largely within the domestic domain using local technologies; wholesalers and retailers operate in fragmented and often non-competitive arenas in which the overall level of sales is depressed and quality carries no premium; and, consumers have weak purchasing power and few if any organized channels for expressing their preferences. In these situations, researchers need to reconsider their roles and the organization of the technology development process. It is not necessary that researchers passively accept as unalterable the conditions within which production presently occurs; it is necessary that an interventionist role as technology developers takes into account the characteristics of the "market" which agricultural research has to serve.

3.2 Socioeconomic Research

The IARCs have not avoided gender issues altogether in their

socioeconomic studies of impacts, nor in yield and constraints analyses or farming systems research, but there is much that is methodologically unsatisfactory about what has been measured, how it has been valued and how data have been analyzed and presented. Without any exploration of the connection between men and women's public domain and domestic activities, or a conceptual framework which integrates the gender relations of production and of reproduction, or a view of the dynamics of agrarian change which relates gender to other analytic concepts, it has proven difficult to draw out the concrete implications for technology development or impact of the anthropological and sociological data collected (for instance, by ILCA researchers within its small ruminant program (Okali and Sumberg, 1984) or by ICARDA researchers within its cereals program (Mazid and Hallagian, 1983)).

The studies have brought to light complex class and gender divisions of labor in relation to tasks, crops, cropping season and labor market opportunities and the differential impact on men and women of mechanization and new opportunities in non-agricultural employment. Using these kinds of data to make predictive assessments of likely impact of technologies in the pipeline are hazardous. Rassam's labor studies in Azaz District in Aleppo Province of four villages showed that at present 81 percent of the total work hours expended on chickpea weeding is provided by the household; 76 percent of the household labor time is provided by women and the remaining work hours by hired village women (Rassam, 1984). Assuming herbicides are not used with ICARDA's new chickpea cultivar, which responds to two intensive weedings, Rassam concludes that three outcomes are likely if the cultivar were to be introduced in the study villages:

- (1) in households which cannot afford to pay for hired labor but have female household labor available, women's labor effort would increase, possibly at the expense of other activities;

- (2) the extra weeding would increase female employment by those households which can afford to hire labor; and
- (3) households whose composition and size does not supply sufficient female labor and which cannot afford to hire labor, would be unlikely to accept the new cultivar (Rassam, 1984, p. 126).

Important and useful though these insights are, they raise policy issues at such a late point in the research process that little could be done to change any characteristics considered undesirable: the fundamental breeding choices have already been made.

Another difficulty is that much of the material is so suffused with assumptions about what women's roles are and their meaning and value within farming systems that it is untrustworthy.

A few preliminary examples are in order.

- (1) Although gender-disaggregated data were collected by Hayami and Kikuchi in their early studies of rice farming and the impact of MVs in the Philippines, the results published in Anatomy of a Peasant Economy: A Rice Village in the Philippines (IRRI, 1978) presented only genderless farmers and laborers, although, by matching their published data to other sources which record male and female hours worked and wages by task, it might be concluded that the impact must have been very different for men and for women. One of the avowed purposes of their later Javanese studies was to show how harvesting changes had brought traditional harvesting wages (in fact, for work carried out by women) in line with the prevailing market wage rate, defined as the wage earned in land preparation (work carried out by men). Leaving aside the issue that their analysis implied a degree of

integration of male and female wage labor markets not confirmed by other research, their published text and tables refer only to "laborers" and nowhere do they refer to the gender basis of wage and task differentials (An Asian Village Economy at the Crossroads, IRRI, 1981).

- (2) The series of studies of labor market behavior, labor availability, participation rates and the absorption capacity of alternative technologies, carried out by ICRISAT staff over a considerable number of years, fail to integrate analytically domestic domain labor and market labor, apparently on the assumption that the hours recorded as worked by women in the household at the time of the studies, are the hours required to carry out domestic tasks (Godake and Ryan, 1980, 1981; Ghodake and Kshirsagar, 1983). There is no appreciation of the dynamic interdependency of the two domains, mediated by the strict gender-specification of particular tasks within and without the domestic domain, nor of the absolute constraints to availability imposed by the performance of tasks essential to the daily maintenance and reproduction of the household (Gosh and Mukhopadhyay, 1986). Since availability is defined as the residual after deducting own-farm and domestic work hours, the conclusion with regard to the probable labor impacts of alternative technologies cannot be accepted with any confidence.
- (3) Econometric analysis of agricultural wages and farm productivity has been used at ICRISAT to explore the relation between physical capacity, health, productivity and wages for men and women. But the analysis becomes circular, as indeed it must, since it fails either to consider the possibilities of male and female physiological adaptations to prolonged and systemic feeding and health care bias or to related wages and productivity to the gender-determined limitations to task and job mobility (Deolalikar, 1984).

Nor have the IARCs always been careful to state the empirical or theoretical grounds for the common practice of counting female labor units as a fraction of units standardized to adult males. Researchers in CIMMYT's East Africa Economics Program have been more scrupulous than most in questioning the convention and establishing accurate measures related to task and crop. Relatively little use in the past has been made at the IARCs of time allocation studies as a basis of comparison (FAO, 1983).

Further, economic analysts at the IARCs on the whole have not been active in exploring how to develop economic models of the household economy which give a more accurate assessment of intra-household work than opportunity costs determined by market wage rates. It is patently unsatisfactory, for example, to value female intrahousehold work at female market wage rates if, when a "female" wage opportunity appears in the market, a woman leaves the household to work, her menfolk take over her intrahousehold tasks and the opportunity cost of that work is then valued at the (higher) male market wage rate.

The conventional use of opportunity cost calculations has persisted in the face of field evidence. Researchers at the IARCs -- even those working in Sub-Saharan Africa where most of the food produced for domestic consumption and local trading is produced by female farmers -- have been slow to recognize or accept the implications of partial or complete separation of male and female food budgets and/or financial budgets within "family farm" enterprises. As a study of irrigated rice production in North Cameroon concluded, where female farming is partially independent of "family" farming and male and female obligations are distinct and non-transferable:

resources will be allocated not necessarily to the most productive activities regardless of who actually controls the income streams, but to those activities which best enable individuals to fulfill their obligations given the existing intrahousehold rate of remuneration. It is the intrahousehold rate of compensation and not the market

opportunity cost of labor which determines the productivity of women's labour and the intrahousehold pattern of income distribution (Jones, 1982, pp. 11-12).

A related and equally persistent, pervasive and damaging convention used throughout the IARCs is the assumption of a "farm" as an undifferentiated, harmonious enterprise managed by a sole decision maker and representable by a single production function. It is only in the most recent years that, mainly through female sociologists and anthropologists on temporary appointments, the IARCs have been confronted with data which establish, as a phenomenon much more common than assumed, the role of female decision making in family farm management.

As recent detailed field studies in the Andes and in Nepal have shown (Deere and de Leal, 1982; Acharaya and Bennett, 1982), a substantial female role in decision making in farm management, investment and sales, is not confined to Sub-Saharan Africa, although there their major roles as food farmers render their decision making more visible. The studies record the economic basis for potential intrahousehold conflicts of interest between men and women in farming households and the individual calculus of "maximum returns to resource investment" which influence their respective behaviors. The question of how researchers are determining research criteria once more arises.

Take the case, for example, of stock-owning men and milk-disposing women among settled Fulani in the subhumid zone of Nigeria (Waters-Bayer, 1984). Neither full dairy specialization nor beef specialization is acceptable within prevailing Fulani intrahousehold arrangements, not least because: "Investments in milk production which may appear profitable if calculated on a household basis could encounter cash flow problems on account of the decision making patterns and largely separate financial spheres of men and women within the Fulani household" (Waters-Bayer, 1984, p. 10). Since they do not own the stock, women are reluctant to invest in, for example, fodder inputs which would raise milk yield, while men cannot deny women rights to milk (and

in any case appreciate milk in the family diet) for fear of divorce.

Or take the case of the alley farming proposals developed by ILCA's small ruminant program based in Nigeria. At two research sites not far from Ibadan, trial researchers failed to recruit many women despite particular efforts to do so. The heart of women's reluctance to participate centers on customary land use rights which allow women to farm food crops between tree crops owned by men. Both men and women make most money out of the tree crops, men by production and sale, women by processing and trading the processed product. The most important aspect of alley farming, in researchers' eyes, is that it makes possible through the planting of rows of frequently pruned leguminous trees, continuous cropping at moderate yield levels while also providing browse for small ruminants and firewood (Youdewei, 1984). But since women control most of the food crops, men have little direct interest in planting trees which mulch women's crops or in feeding women's sheep and goats. Men who own their own sheep and goats, on the other hand, have no direct incentive for allowing women to cut the trees for browse.

3.3 Farming Systems Research

A systems approach to research is an appealing though by no means new concept or practice which has been given a great boost by the interest the IARCs have shown in developing its theory and application and in training national researchers in FSR methodologies. Insofar as these methodologies integrate socioeconomic and cropping variables, FSR viewed as a process of research management offers the potential for gender-sensitive technology development. However, insofar as the assumptions and inadequacies noted in the previous sections have been replicated within the IARCs' FSR programs, gender bias has tended to be perpetuated and institutionalized, not only at the IARCs them-

selves but, through their training programs and other forms of professional support, in national agricultural research.

Specifically, the various experiments in "downstream" FSR, as practiced by the IARCs, have tended to perpetuate gender bias in four areas: definition of recommendation domains, diagnostic surveys, on-farm trials and evaluation. It might be that the bias has tended to persist in these areas, despite the increasing exposure of researchers to farming realities, owing to the fact that the majority of FSR researchers are male and to the lack of any systematic conceptual and informational preparation within IARC FSR programs which might sharpen researchers' perception of gender and its implications for technology development.

The definition of recommendation domains (RD) is an activity somewhat equivalent to market research in industrial technology development practice. As such, it might be thought that "objective" statistical data, secondary information and the experience of "key informants" would be adequate to indicate the scope and nature of the contribution that women in any economic category were making in the sphere of production, consumption and exchange of food crops and the relevance of this information to the definition of domains. Unfortunately, this is not the case because these sources of information tend themselves to be conditioned by gender bias: for example, male dominance in the gathering of statistical information may limit enumerators' access to female respondents; secondary sources -- including most agricultural censuses -- usually do not present information disaggregated by gender; the decision concerning who constitutes a "key" informant may itself be conditioned by gender.

A concrete example is provided by an early experiment in the definition of RDs in Zambia, conducted with the guidance of CIMMYT's East Africa Economics Program (MAWD/CIMMYT, 1979). The zoning of farming systems drew heavily on the lists of farmers maintained by the extension service. These lists in fact at the

time registered only those male heads of household who participated in the government's hybrid maize program; they excluded all those farmers (male and female) growing only coarse grains or traditional maize or tubers and, hence, many of the poorer farmers, as well as excluding most of those female farmers growing hybrid maize, since the male agricultural officers at that time hardly perceived female producers as farmers at all (they were spoken of as villagers).

While this particular source of bias was subsequently corrected, FSR researchers at the centers are only slowly becoming aware of the need to look for others in the definition of RDs. For example, the focus on the household as the sociological unit of analysis may lead to serious misunderstanding of female roles and the interdependency of rural-urban livelihood systems in rural areas of high male outmigration (Behnke and Kerven, 1983). In the absence of any attempt at making the potential for bias explicit, it has evidently proven difficult for researchers either to identify and record segmentation variables which are not gender biased or to use the information available to define RDs in ways which do not pre-empt women's later access to new technologies nor compromise their capacity to derive benefit from them.

The controversy within center programs concerning the proper emphasis to give to FSIP -- farming system infrastructure and policy -- has revealed a tendency on the part of researchers to assume that, as far as women are concerned, questions of access and capacity lie outside the realm of an international center. While this view is consistent with a concept of FSR as a set of practices which enables researchers to carry out better crop science, it is not compatible with a view of FSR as an improved technology development process which draws its strength from the delineation of homogeneous and stable producer and consumer categories and the specific economic circumstances within which they gain their livelihood.

Diagnostic surveys conducted by center staff carry many of the biases already listed. In addition, since typically interviews are conducted with a few farmers who are visited only once, unless steps are taken to ensure women are not excluded, they are likely to be under-represented. The structure, timing, and staffing of diagnostic surveys guided by IARC staff -- whether of the rapid rural appraisal, the sondeo or more conventional type -- rarely take account of possible sources of bias such as the following: women's heavier time schedules, reluctance in talking to male researchers, silence during public meetings, separate spheres of operation and responsibility.

Center researchers do not routinely use, during the diagnostic phases of FSR, instruments (such as "quick and dirty" time allocation studies) to check whether diagnosis is being carried out with the right person concerning any one task or crop or is omitting a critical labor or resource constraint or is overlooking a potentially high payoff intervention by disregarding a part of the system. The place of snack foods (e.g., green cowpeas from non-synchronous varieties) in household food management, for example, might be undervalued if male respondents are unaware of its value or if male researchers do not appreciate its importance within women's sphere of responsibility (Jiggins, 1986).

During **on-farm trials**, the crop and the variables chosen for testing, how and whose fields they are tested, the decision of whether to also test post-harvest characteristics, necessarily tend to be conditioned by the sensitivity -- or lack of it -- to gender during earlier phases of FSR. Since the choice of the site, the design of the trial and the form of farmer participation and management all affect the kinds of results a trial generates (Ashby, 1984a), it matters a good deal if gender issues are addressed at this stage. Where no explicit instruction is given to FSR practitioners to include women farmers in trials (where this would be appropriate), it is likely they will be

"forgotten" in the site selection process. For example, the on-farm cropping systems research handbook published by IRRI (Zandstra, et al., 1981), gives no explicit guidance, although the handbook serves the Asian Cropping Systems Working Group, which includes countries where women are wetland rice farmers in their own right or responsible for important production and post-production technologies.

Whether or not women are responsible in any sense for the crop under trial, it still may be important to include women directly in discussion of the trials if their labour input or control over output is involved. Researchers working with the Farming Systems Analysis Section in Malawi, for example, discovered (fortunately in time) that one woman among the households participating in on-farm trials would have used treated composite maize for feeding her family when planting was delayed owing to the failure of the rains, since she had not been informed that the treatment made the seeds dangerous to eat (Hansen, et al., 1983). Nor can it be assumed that accurate and complete information about the management or purpose of a trial will "trickle across" between men and women within households or that, for example, additional labor required by a particular trial management regime will be forthcoming from women in the household unless they are involved from the outset in discussion of the trials (Evans, 1981).

With respect to **evaluation** within center FSR programs, while a few IARCs have made some effort to include women in evaluation panels of eating and cooking characteristics (for example, CIAT, ICARDA, IITA and ICRISAT have included women in tasting panels -- but only after the fundamental characteristics of the improved varieties have been set), little effort has been made in the past to include women directly in the evaluation of on-farm trials, although there is a rich ethnographic and anthropological record of the different criteria men and women (and, women in different

economic categories) may apply when judging the value or benefit of new varieties or management practices.

3.4 Policy Research

Policy research is carried out by all the IARCs, but pre-eminently by IFPRI and, with its special concern for assisting NARS to translate policy commitments into institutional capacity, by ISNAR. As far as its published country reports (to mid-1984) indicate, ISNAR has not taken any steps in its "manpower" studies and projections of staffing needs and availability to collect gender-disaggregated data nor to initiate discussions with African host governments concerning the implications of trying to develop female food farming with predominantly male extension and research staff. IFPRI, on the other hand, has hosted or participated in a number of workshops which have specifically considered the connection between the domestic domain and public domain distribution of food and the implications of these connections for policy. However, in two important respects, the IARCs' policy research has avoided looking very deeply into the implications of gender for food availability and technology development: pricing policy and population policy.

Both policy areas are complex and subject to academic and political controversy but this is not the place to analyze the controversies in any depth. A few brief points will suffice. With regard to pricing, neither the separation of male and female budgets nor the typically differentiated access of female Producers to subsidies and official input and output channels has received much attention from the IARCs. Yet, in developing and industrialized countries alike, the benefit to the family of increments to household income and of subsidized foodstuffs often depends on who, in the family, receives or disposes of the income or is entitled to food or income supplements. Furthermore, if incentive pricing is used as a policy instrument to stimulate production, its effects will be blunted if female food

farmers have low access through male extension workers to subsidized inputs and restricted access to official marketing channels because of administrative and institutional conditions which in practice limit their participation (AFRACA/FAO, 1983; Jiggins, 1984).

The effects of modern varieties on population growth have scarcely been studied at all; neither the statistically apparent causal linkages nor apparently associated phenomena such as trends in dowry or brideprice payments and household composition, are well-documented. The general picture, cautiously stated, would seem to be that the effect of MVs on employment and participation rates has been swamped by population growth; the general picture clearly hides significant local variations in female labor absorption or displacement as well as the effect on family formations of migration. The relationship is an important one for agricultural technology developers because the access of women to a paying livelihood does seem to be closely correlated with population growth (Safilios-Rothschild, 1985).

4 Research-Extension Linkages

4.1 Three Areas of Concern

The subject of research-extension linkages is one that, over the past decade in particular, has displayed significant shifts in thinking and practice. The IARCs, as international bodies, have devoted much thought to the appropriate and effective linkages they could or should form with national extension services in the course of their own scientific research and training work and to the review of existing linkages between national research and extension structures. These developments are not the concern of this chapter except in so far as they form the background to discussion of the consequences for the utilization of the IARCs' research output, researchers' linkages with extension in FSR programs and center training of extension officers.

There are three main areas of concern: gender-based barriers to female farmers' access to extension services and the inputs supplied through extension channels; gender-based differentials in male and female professional agricultural education and training; and, the tendency for knowledge about women's roles in food systems to flow through channels which presently lie outside normal research-extension channels (Ashby, 1981).

4.2 Extension Barriers

The first has to do with the staffing of research and extension services and the field methodologies used by extension field workers. Taking developing countries as a whole, the majority of the staff of agricultural research and extension services at every professional level are men (Swanson and Rossi, 1981). A few countries employ a few female extension workers -- Botswana, Japan, Sri Lanka, Zambia, Malaysia and Nigeria, for

example -- but here they are a fraction of the total. Only in the Philippines, where about half are female, and in Thailand, where about a quarter are female, are substantial numbers of female extension workers employed.

A larger number of countries employ female home economics field staff but they are mostly confined to working with women on nutrition, domestic and horticultural problems rather than field production problems. They often have problems of status and competence vis a vis male extension workers, and, they are often confined to office-based work rather than field postings (Zimmerman, 1975; Downes, 1970; Cebotarev, 1980; Abdullah, 1982; Benjamin, 1982).

Large numbers of female field staff do not guarantee that female producers in any income class will be contacted at the same rate as men. For example, although Thailand has both substantial numbers of female field extension staff and large numbers of women engaged as producers in irrigated rice cultivation, most of the contact farmers recruited under the Training and Visit (T & V) system and the members of the associated contact groups are male farmers (pers. comm., Thai participants in the International Course on Rural Extension, Wageningen, 1983, 1984, 1985). Male extension workers, on the other hand, on the whole are less likely to contact female producers than male producers (Fortmann, 1979; Bettles, 1980; Garvey, 1981; Staudt, 1985). The reluctance of male extension workers to contact female farmers may reflect class as well as gender pressures (Fortmann, 1984). Since female farmers tend to have more restricted access to the factors of production (or, access to lower quality or an inadequate mix of factors), they tend to be concentrated among the poorer economic categories. However, neither the practice nor the output per acre of female farmers is necessarily different from that of men in the same economic category, though men may derive higher net profits per acre (Moock, 1976; Fortmann, 1984).

The inadequate contact between male field workers and female producers is the more damaging, the more that access to inputs (seeds, fertilizer, chemicals, finance) is channeled through extension workers (AFRACA/FAO, 1983). Similarly, if research-extension linkages are mediated through extension services which have little contact with female farmers, researchers in turn will continue to receive limited or distorted information from the field and a biased picture of agricultural realities.

In addition to class bias, the field work practices of male extension staff can militate against information reaching female producers. The assumption, for example, that information and skills communicated to men "trickles across" to women in a household is not substantiated by research which suggests, to the contrary, that the information reaching women through male household members is partial, distorted -- or simply is never conveyed at all (Zeidenstein, 1979, Smith 1978). Communications based on reading or writing skills are less relevant to women than men in so far as rural female literacy and numeracy rates in most countries are significantly below those of rural men. Where young wives are instructed in farming by elder female relatives and mothers-in-law, it may be difficult for them in any case to implement practices they have learned in primary school (Potash, 1985). The timing and location of meetings tend to be scheduled for the convenience of men rather than women. All these kinds of bias are susceptible to remedy, perhaps most easily where strong, organized women's groups exist (Muzale with Leonard, 1985).

Researchers at the IARCs, particularly those working within farming systems programs, have attempted to circumvent existing weaknesses in, or as in CIMMYT's Eastern Africa Economics Program, to strengthen national research-extension linkages by working directly with farmers and by involving extension field staff in the identification of recommendation domains, the management of on-farm trials and in pre-production and production programs. Since national researchers and extensionists often

regard IARC researchers as role models for their own professional attitudes and practices, it is of concern that the IARCs have paid scant attention in discussions of research-extension linkages to the difficulties outlined above.

4.3 Agricultural Education and Professional Training

The IARCs conduct professional training on a substantial scale: approximately 3,000 trainees a year pass through the centers. Although it has proved impossible during the Impact Study to obtain figures for the numbers of all trainees, by country and type of training, who are female, the proportion for IRRRI between 1962 and 1981 was 8 percent and it is considered likely that this represents the upper end of the range for the centers as a whole.

As Table 4.1 illustrates, the figure is significantly below the percentages of women receiving agricultural training in national institutions at various levels (Sigman, 1983). Though female enrollment in agricultural training is slowly rising, it is on the one hand restrained by continuing barriers to girls continuing their education beyond primary levels and to obtaining adequate science training at secondary levels and, on the other, by the lack of encouragement to them to continue in a professional career. Again, the IARCs do not present a very good record: their small numbers of female staff are concentrated in technical, secretarial and administrative posts and they employ few female professionals in any grade, the numbers dropping markedly with seniority. Until recently, there were no women Board members.

Although men undoubtedly could equally well play a leadership role in ensuring that research-extension systems do not remain gender-biased, it is equally clear that the presence of larger numbers of female professional staff at the IARCs encourages open discussion of the issues and determination to

Table 1. Percentage of Male and Female Students Enrolled in Agricultural Studies at Intermediate, Degree and Postgraduate Levels in Africa, Asia and Latin America

	Intermediate	Degree	Postgraduate
	(Percent)		
Africa			
Male	90	77 (87*)	85.6 (90.5*)
Female	10	23 (13*)	14.4 (9.5*)
Asia			
Male	84	73	80.4
Female	16	27	19.6
Latin America			
Male	91	83	72.8
Female	9	17	27.2

* Excluding Egypt

Sigman (1983) based on preliminary analysis of 55 percent of all institutions surveyed. The mean figures are distorted due to heavy female enrollments in some countries and practically no female enrollment in others. For example, of 253 intermediate level agricultural schools, 105 reported no female enrollment. Tanzania, Ethiopia, Tunisia and Nigeria accounted for 60 percent of the total intermediate level enrollment in Africa; Venezuela and Brazil reported 75 percent of the intermediate female level enrollment in Latin America and Thailand and Korea accounted for 75 percent of all female intermediate level agricultural enrollment in Asia.

find solutions to difficulties (pers. comm. from present and former female center staff and trainees, 1984-85).

Of all the IARCs, ISNAR is particularly well-placed to offer encouragement to female professionals. In ISNAR The Early Years, it is emphasized: "Since ISNAR's work is essentially with people, rather than developing new cultivars or agricultural technology, the importance of manpower planning, personnel development and management training cannot be overstressed" (ISNAR, 1984, p. 6).

4.4 Research-Extension as a Knowledge System

Neither the concept of "knowledge systems" or its application to agricultural technology development is new. The IARCs certainly recognize their role as part of a knowledge system which encompasses national research and extension organizations as well as colleagues in academic and commercial sectors and have taken the lead in establishing and supporting information exchange and networking between members of scientific knowledge systems.

However, in a number of respects the ways in which the IARCs are seeking to strengthen interaction have the effect of building systems which are neither knowledgeable about women's roles in agriculture and food management nor readily accessible to individuals and organizations which are.

The centers have few library publication exchange arrangements with institutes, networks or organizations which generate and publish relevant materials and the center libraries, not excluding the smaller accessions of economics and FSR units, have no systematic collections of relevant materials. For example, at the request of the CG Secretariat, in 1983 the staff of IFPRI assembled a "substantive bibliography containing more than 450 entries covering different aspects of the impact of agricultural

research" (IFPRI, 1984, p. 21) but only a handful of these contain any reference at all to impact on women. Although IITA is in the process of adding two thousand new entries on women and agriculture to its computerized references and IRRI has acquired a small collection of materials following the Women in Rice Farming Systems Conference in 1983, if an IARC researcher wanted to inform himself of the issues and data in any detail, he would not be able to do so from the centers' own information resources.

It is all the more important then, that researchers should be aware and make use of alternative sources of information and expertise. There are many reasons why they do not routinely do so, either when they are traveling or when they are working at their home base. Their travel schedules are crowded, they have their regular network of contacts and colleagues and, not always being easy with the subject matter, they may find it difficult to understand why they should seek out female professionals who are likely to be occupying posts in unfamiliar institutes or government departments (such as community development rather than agriculture). (Indeed, all these "difficulties" were encountered in the course of the CG Impact Study itself.) IRRI is unique among the IARCs in developing, with the support of its partners, a Women in Rice Farming component to the Asian Cropping Systems Network.

However, the IARCs, working almost exclusively through government organizations, have not been effective in linking their expertise to that of non-government research and extension organizations. The practical knowledge and experience of NGO field workers is often unsurpassed in its depth and sensitivity to local production constraints and opportunities. A number have been particularly concerned to develop low cost agricultural research and technology development methodologies which exploit natural variability in genetic resources and management practices to raise productivity over quite wide areas involving some thousands of farmers (e.g., World Neighbors, based in Oklahoma

and working principally in Latin America and Sub-Saharan Africa); others are carrying out station-based and on-farm field trials and establishing living collections and seed banks of indigenous materials (e.g., Talavaya, based in New Mexico, working principally with maize, coarse grains and curcubits). Those with an explicit commitment to respect for the autonomous knowledge systems of cultivators themselves tend to appreciate more readily the function of female roles in food systems. Moreover, they tend to pay a lot of attention to the management of the interface between scientists' and producers' knowledge systems, a concern whose importance some station-based scientists scarcely seem to recognize.

There is an expanding and remarkable literature concerning the management of the interface. A call by The Population Council in 1985 for papers touching on the subject, produced 72 responses; 8 of these will be published as case studies in 1986 under the Intrahousehold Dynamics and Farming Systems Research and Extension Case Studies Project.

5 Measuring Impacts

5.1 What Is the Debate About?

Measuring impacts on women of technical change in agriculture is a more than usually contentious exercise, not least because there are those who believe it to be divisive and in a sense analytically meaningless. Nor is it easy -- or perhaps desirable -- to separate normative and ascriptive definitions of what is an acceptable outcome for women from other measures, against which positive or negative impacts might be more "objectively" estimated.

So it is necessary to clarify what the debate over the impact on women of technical change in agriculture is -- and is not -- about. It is not contended that all impact over the past five decades has been adverse for women nor that all adverse impacts have been the result, direct or indirect, of the innovations developed by the IARCs nor that all adverse impacts have been uniformly bad for all women irrespective of class or other considerations. On the other hand, the evidence is strong that technical change in food cropping, associated with higher capital intensities, greater mechanization of production and post-harvest operations, the introduction of exogenous knowledge, and the development of crops and varietal characteristics geared to the requirements of commercial commodity production, has been accompanied by changes which women experience in unique ways; that some of these changes seem to have done little to augment their livelihoods, however greatly the aggregate data show "household" or "family" welfare to have increased; and, they may in certain cases have undermined women's livelihoods or made them harder to bear.

The uniqueness of women's experience lies in the central recognition that in general (1) women's access to resources and income is constrained in nature and intensity by additional

factors which do not affect men; and (2) women's roles in production, consumption and exchange are linked to family welfare and survival in ways which men's are not; and it follows (3) that women shape and respond to production, trade and consumption opportunities which only partially overlap with other family members' opportunities. Given these differentials, it would, indeed, be surprising if technical change in agriculture were to have a similar impact on men and women.

Yet if there are factors which permit discussion of general impacts on women qua women, there are others which suggest careful discrimination is needed between women in differing circumstances. Still at a high level of aggregation, it might be useful, for example, to distinguish between impacts on women as wage earners, cultivators and consumers or, geographically, on women as wage earners in Asia, on women as producers in Sub-Saharan Africa and on women as urban residents in much of Latin America or, if the focus of the debate is the alleviation of poverty, to distinguish between impacts on women in landed and landless households, noting that women are over-represented among the poor and, as a corollary, that the lower the income class, the higher the incidence of households headed by women. Within categories such as these, it is probably useful to distinguish further between the following kinds of impact: those which have come about through opportunities foregone; direct effects linked to the specifics of varietal characteristics; indirect effects mediated through women's positions within household and family structures; and, indirect effects mediated through the position of women in the wider society.

5.2 Presumed Effects of Omission

In as far as it is justifiable to presume that not doing something will have had consequences, the following effects of past insensitivities to gender can be postulated:

- (1) production foregone in household and backyard gardens, through neglect of their present and potential contribution to output, livelihoods, and income,
- (2) production and added value in processing foregone through neglect of foodstuffs which are not world trade commodities but which reach urban consumers through informal markets or which are consumed mainly within producing households or local neighborhoods,
- (3) loss of knowledge concerning women's seed and stock selection criteria, husbandry practices and environmental management, storage techniques and transformation of biomass into edible food, and
- (4) opening of new or widening of existing gaps in the productivity of male and female labor and in the capitalization of male and female labor power, partly through inappropriate design characteristics of machinery, partly through the choice of tasks to be mechanized, and partly through gender bias in research and extension contact, training and the allocation of tools and equipment.

5.3 Direct Effects

Direct effects flow from the characteristics of plant material and livestock. The following examples illustrate these kinds of effects:

- (1) In Malawi, almost 30 percent of all farm households are headed by women, over 40 percent of all farms of half a hectare or less are operated by women and over two-thirds of all full-time food farmers working on their own holdings are women (Kydd and Christiansen, 1982). The major thrust of improved genetic technology, extension, farmer training, input supply and marketing support has been on hybrid dent types of maize yet only slightly over 3 percent of the cropped area is planted to dent hybrids (approximately 3.5 percent of all maize plots), which are grown mainly as a

cash crop. The major food staple is made up of traditional flint types which produce a fine white flour and are easier to process than dent hybrids using domestically available technology.

- (2) In Ethiopia, a dairy cow breeding program had as its objective higher milk yields through better feed conversion, allied to new feedstuffs. One consequence was that the texture and composition of the dung changed, making it less suitable for dung cakes, the main local source of cooking fuel and an important source of female income.
- (3) In parts of the Northern and Luapula provinces of Zambia, where cassava leaves are the main and sometimes the only dark green leaf vegetable, women are well-acquainted with the suitability and seasonal palatability of local varieties as a fresh leaf vegetable, the leaf drying qualities, and ease of harvest (related to height). Exotic varieties promoted for their starch yield are tall in stature, do not provide comparable leaf yields nor are the leaves considered as palatable as local varieties.
- (4) MVs usually have uniform maturity: the displacement of staggered harvesting usually increases female labor peaks relative to male labor peaks and, where markets and incomes are inadequate and seasonal, make year-round food management less easy.

5.4 Indirect Effects Mediated through the Household

The rules governing the intrahousehold allocation of resources and outputs, the nature of production and consumption of goods and services within households and the different modes of interhousehold and market transactions carried out by men and women are poorly documented but the following example illustrates how these might interact with technical changes in agriculture.

Recommendations calling for additional labor input for tasks which are female-specific, in landed households are likely to increase unpaid female labor and increase women's working hours/day, sometimes at the expense of women's own production or income opportunities. If then they do lead to a relative increase in income received by the male head at the expense of income received by women, they may be associated with a loss of family welfare. In laboring households, such recommendations may lead to increased market demand for female labor (which may entail less adequate performance of domestic duties and/or longer female working days), loss of production potential as female labor peaks sharpen, or the rapid substitution with (male-operated) machines or chemicals. Or they might simply not be followed, with consequent waste of genetic potential (Shapiro, 1978).

5.5 Indirect Effects Mediated through the Wide Society

Because women's roles, status, responsibilities and life experience are uniquely different from men's, the following kinds of indirect effects can be anticipated:

- (1) Access to and the incentive structures provided by production and post-harvest services are usually experienced differently by men and women in any income class, e.g., where marketing cooperatives demand land titles as a condition for membership; where banks demand the security of a male guarantor before women are eligible for loans; where women as the chief operators of an enterprise such as dairying would prefer distribution of dairy cooperative profits in the form of higher milk prices but men as shareholders or office holders in the cooperative would prefer distribution in the form of higher dividends or salaries.
- (2) Production and adoption incentives are often misdirected, e.g., where higher yields can be obtained in irrigated rice

by correct depth of planting and hired women provide most of the planting labor but (a) training in planting technique is provided to men as tenants or landowners and (b) planting labor is paid by the number of seedlings or area planted; where incentive prices are paid out to male heads of household registered with the marketing organization but most or all of the work is provided by women in the family; where information and advice is provided through male extension staff to men in areas in which women are producers in their own right or important performers of key tasks.

- (3) The social organization of production often is modified, as in settlement or irrigation schemes, to take advantage of scale economies and crop specialization and to maximize marketed output but may lead to: loss of female rights to land use, driving female household heads onto marginal or fragile land; loss of female income in male-headed households; increase in the insecurity of women vulnerable to divorce or loss of spouse; less varied household diet; increase in unpaid female family labor.

5.6 Statistics and the Black Box Approach

Researchers at the centers, in common with many others, have taken a "black box" approach to households, collecting and analyzing data on ceteris paribus assumptions that the household or family is a homogeneous unit with no significant internal differentiation between members. Recent research has shown, however, that women, and not only men, make individual maximum returns to investment calculations within the household and that negotiating models might provide a more accurate picture of domestic domain production and consumption relations (Jones, 1982; Burfisher and Horenstein, 1985).

Furthermore, until recently, neither differential impacts on individuals within the household nor intrahousehold variations as

a source of production variation have been perceived as important to the task of technology generation and innovation. Researchers have been encouraged in their black box approach by the under-enumeration of women, as cultivators, laborers and decision-makers, in official censuses and surveys (Buvinic and Youssef, 1978; Recchini de Lattes and Wainerman, 1982).

Researchers have relied on survey and census data as representing objective quantities (within known degrees of accuracy). The claim of such statistical instruments to objectivity has been challenged by analysis of the wording of questionnaires, definitions, measurement and evaluation tools and of implementation procedures, all of which typically are gender-biased to the extent to which they are nominally gender-neutral (ICRW, 1980). The relative exclusion of women from the public domain and male normative values clearly have played and continue to play their part (Ay and Nweke, 1984; Benaria, 1980).

However, although much of the publicly available evidence of impacts is not readily accessible and some is of dubious provenance, it is by no means so inadequate or unreliable that no summary estimate can be made. Here is not the place to attempt a thoroughgoing review and exhaustive citation of sources; what is presented are the points on which there would appear to be an emerging consensus with reference to key material. Within this limitation, it is still necessary to point out that since the participation of women is extensive, many-sided, highly variable in its details across geographic and social boundaries and usually poorly recorded in routinely collected statistics, the picture which emerges is far from simple or complete.

Moreover, unequivocal composite measures of negative or positive impact are especially hard to construct, partly because women do not form a homogeneous category and may have conflicting interests, partly because women's multiple roles as producers, unpaid family laborers, wage workers and food managers may mean

that change has varied impacts in each sphere, and partly because changes in their access to and control over resources, outputs and income may be masked by broader adjustments over time in the domestic and social organization of production, trade and consumption.

6 The Impact of Technical Change in Agriculture on Women in Asia

6.1 Female Income and Wage Work

The impact of MVs in Asia is intimately linked to the on-going changes in employment and income-earning opportunities and the marginalization of small producers. While aggregate food security and consumption goals are being met through intensified production in areas of high potential, livelihood potentials for the poor majority do not seem to have been significantly enhanced and in certain cases may even have been undermined. Although it is often argued a priori that MVs, improved practices and mechanization of production tasks have increased female employment opportunities in Asia, both because they increase the demand for sex-specific tasks and because they allow for higher cropping intensities and the spreading of labor demand, the empirical evidence does not indicate that female incomes or wage work have been sustained at anything like a sufficient level.

The South Asian evidence, though patchy, in fact suggests that households are becoming increasingly dependent on female income, not only in the rising numbers of households headed by women (an estimated 15 percent in Asia) but also in poor landless and marginal producer households in which female income makes as large or even higher contribution to total income than male (Jiggins, 1985; Begum, 1985). In Bangladesh, certainly, rising landlessness, the severity of seasonal effects and falling real wages seem to be direct causes of increasing female labor participation, expressed both in numbers of female workers and the labor hours supplied per worker (Begum and Greeley, 1979).

Data from the Bangladesh Bureau of Statistics on labor force participation, 1975, and from the Benchmark Survey carried out in 1977-78 by the National Foundation for Research on Human Resource Development (Dhaka) provide the statistical base for a fivefold

classification of women's labor participation in Bangladesh by household type: (a) female-headed households, (b) landless households, (c) small-scale cultivator households, (d) large-scale cultivator, trader and para-professional households and (e) tenant households. Some of the women in categories (a) and (b) are destitute; they constitute about 15 percent of all rural women and are dependent on begging, casual laboring and food-for-work. Other women from categories (a) and (b) and women from households in categories (c) and (e) constitute about 70 percent of all rural women. Such households usually do not hire in labor but the women undertake agricultural work outside the household, mostly in post-harvest processing, against payment in cash or kind. Some 15 percent of the total hired female labor, however, comes from category (d) households.

In general, the percentage of women in Bangladesh entering the labor market seems to be inversely related to the level of household income; there are also strong indications that female participation in productive activities within the household is inversely related to the level of household income. However, microstudies suggest a cutoff point below which the poorest women without access to anything but the simplest household equipment may be forced into periodic distress. There are also indications that seasonality effects have different impact on women in different household categories; otherwise less active women in higher income households join in agricultural work outside the household during peak labor demand seasons, for example, while the working day of women in cultivator households too poor to hire in additional female labor is extended.

Given such patterns as these, the incidence of poverty in society as a whole would appear to be highly sensitive to changes in female wage labor opportunities. Adverse changes carry a high social cost but also have very direct special costs for women. For example, as a study of rural poverty in Asia noted for India that the nutritional levels of landless women were found to be so

low in one survey that they lost twice as many children as women from landed households (Rosenberg and Rosenberg, 1978, p. 17). In addition, intrahousehold allocative bias in food distribution and health care (Levinson, 1974; Agarwal, 1985, p. 326) in some regions suggests that higher farm productivity per se or higher household income will not necessarily lead to better diets or higher welfare for females.

To what extent have these patterns been brought about by, intensified in scale or depth, or at least associated in time with technical change in agriculture?

6.2 Impact of Technical Change in Production Technology on Women's Paid and Unpaid Work in Processing

Data from India give some indication of how the introduction of MVs might be intensifying and accelerating imminent forces of rural female pauperization. As early as 1951, the All-India Census Report drew attention to the relative lack of new employment opportunities for women as agricultural change gathered pace while more recent studies have emphasized that the increased financial intensiveness of MVs puts such a premium on money incomes that women who formerly were unpaid household workers are being sent out to work as wage laborers; as female employment opportunities continue to shrink in proportion to those seeking work, women are working longer hours and/or at lower rates of pay (Gough, 1977, 1982).

Perhaps the majority of rural women in South Asia live in households with insufficient income to command significantly better diets theoretically made available by the substantial increases in output achieved in the irrigated rice and wheat areas. They also face rural employment markets in which real wages for female labor are static or falling, the range of tasks open to them is narrowing and, despite increases in and a less seasonal pattern of demand through higher cropping intensities in

irrigated area, employment opportunities are failing to keep pace with population growth (Sen, 1982). Within this broad picture, geographic variations in production patterns and land use are associated with regionally distinct patterns in the scale and intensity of demand and supply for female labor (Sen, 1985).

At higher household income levels, although productivity gains may allow women in the family to be withdrawn from field labor for status reasons, their workload does not necessarily thereby decrease since preparing and cooking food for hired field workers and compound-based crop processing may add to rather than reduce their unpaid workload (Agarwal, 1985). On the other hand, the hiring-in of labor and mechanization may substitute for the time of women family members in ways which free them for specialization in trading or other business.

Indeed, the allocative tension between the imputed value and cost of women's labor time spent on intrahousehold agricultural work and its cash or market value and cost, for households at different levels of income, underlies much of the analysis of Asian data. Changes in post-harvest processing associated with technical changes in production provide important food for thought. Sen's comparison of female labor participation rates in paddy growing areas of northeastern and southern India suggests an interesting causal link between levels of female agricultural wage employment, the volume of the rice crop processed within the household and changes in commercial processing technologies (Sen, 1985). Village studies by Gosh and Mukhopadhyay (1986) in eastern India find that production intensity is positively correlated with female labor use but that the larger portion of increased female labor is expended in unpaid processing and storage activities in the home.

In Indonesia, mechanized rice hullers were introduced in 1970 by the government and spread rapidly, taking over from female hand-pounding; by 1978, only about 10 percent of the

harvest was still being hand-pounded, mostly for family use (Cain, 1981). The mechanized hullers process a higher throughput faster, more cheaply, and at lower operating costs and higher profit to the owner but have eliminated an estimated 1.2 million jobs for women in Java alone (Cain, 1981). The households of former hand-pounders also no longer have access to the by-products used as feed for livestock, chickens and ducks. Harriss (1978, 1979) concluded from pioneering studies in Bangladesh that large-scale displacement of female labor and income-earning opportunity is occurring in Bangladesh as a result of the spread of custom mills for the small-scale milling of parboiled paddy, despite volume increases brought about by higher production and the new possibilities for the few with capital in hand to increase domestic parboiling and drying businesses in association with custom milling. Subsequent studies (e.g., Ahmed, 1983) have tended to confirm her conclusions that the mill technology:

results in a massive reduction in processing costs and yet at the same time permits the earning of high levels of profit for its owners at the expense of all strata of society who use it. Female labour is replaced to a small extent by male labour but there is a large scale net social displacement. Those female wage labourers working in rice mills do not receive wages commensurate with the increase in productivity over hari employment which is forced upon them, and their level of exploitation inevitably increases. There is no evidence yet of viable alternative employment for those displaced from dheki milling (Harriss, 1979, p. 45).

6.3 Effects of Changes in the Social Organization of Production

The heart of the impact in question in Asia may, thus, be stated as whether or not technical change in production has led to or been associated with the creation of alternative employment and income opportunities. Three possible scenarios suggest themselves: the evolution within the food and agricultural sector of integrated commercial, industrial, sales and marketing enterprises which, schematically, would present an inverted employment pyramid resting on an ever-smaller primary production base; the growth of labor demand in manufacturing and services;

and, third, adjustment of gender-related structural distortions in female employment and levels of remuneration. There is little evidence that either possibility has been realized to a sufficient degree.

On the contrary, the worsening rural employment and income prospects, particularly in dryland areas, combined with a lack of policy, research and extension attention to women's agricultural and food system roles, would appear to be driving increasing numbers of rural women into domestic employment overseas, sex tourism and prostitution (Jiggins, 1985; Palmer, et al., 1983; Phongpaichit, 1980).

A study in the Punjab has emphasized the (by now familiar) ways in which access to modern knowledge and skills is tending to perpetuate gender-based structural employment bias. In the study area, male workers displaced by mechanization were offered training in the operation and maintenance of the new machinery but the displaced women were left to find whatever increasingly scarce unskilled jobs they could find (Billings and Singh, 1970). Kelkar (1981) concludes from Indian data, ten years later, that differential male and female skills formation and labor productivity in agriculture has tended to sharpen rather than decrease over time.

If, on the one hand, wage differentials provide incentives to hire female laborers for lower paid, unskilled, casual work, on the other hand, there would appear to be hard-to-define but certain limits to farm managers' willingness to incur the supervisory and other non-cash costs of employing female casual labor skilled in traditional tasks. The evidence of microstudies suggests that the option of employing additional skilled female labor is not one that long survives the availability of alternative crop management practices, even if these have a somewhat higher cash cost. For example, in Sri Lanka it was long the custom for gangs of skilled female rice transplanters

from the overcrowded southern wet zone to find their sole source of income in the dry zone rice areas in due season but the introduction of dry zone irrigation, after initially increasing the seasonal demand for skilled female labor, has led to a decline in skilled female employment opportunities as new management practices have become more widespread (pers. comm., L. Siriwardene, Head of Research, People's Bank, Mahaveli Division, 1984).

The MVs and accompanying practices which have made investment in the Mahaveli irrigation infrastructure worthwhile also have impacted on the intrahousehold allocation of land, labor and income, and would seem to exemplify a commonly occurring situation (Postel and Schrijvers, eds., 1980, pp. 109-118). Their study of women among new settlers in the Galnewa region of H Block found that title had been assigned to the male head of the household, not to the family, with no recognition of women's former rights of inheritance and access to land; tenancy acreages had been calculated on assumptions of "free" female labor time, so that in order to operate the tenancy successfully, women's labor had to be diverted to irrigated rice production, leaving them less time for the cultivation of their own crops; the crops identified for women's home garden production were modern cash crops, such as soya bean (rather than traditional leaf vegetables, finger millet and fruits), which did not fit well into home eating patterns and for which women had to rely on men to sell at the distant official marketing points; extremely meager provision had been made to provide women with horticultural inputs and information while most of the training in rice cultivation was given to the men; differential mechanization of male and female tasks increased women's work hours during peak demand relative to men's; the relative lack of social infrastructure -- schools, dispensaries, etc. -- and the isolation of the tenancies left women with few social contacts and extra child care duties; and no consideration had been given to additional female income-earning opportunities outside agricultural wage

laboring. In sum, the settlement generated higher marketed output and higher incomes for male producers but lower incomes for female producers, increased unpaid female labor input relative to male labor input, reduced variety of foodstuffs consumed, greater economic dependence of women on men and greater reliance on uncertain and high priced food markets for family food supply.

In Java, the introduction of MVs has increased the pace and scale of on-going change in traditional harvesting (Stoler, 1977; Cain, 1981). In order to cover higher input costs, landlords sought to recover a higher usable harvest than their customary three-fourths share. Using a small knife, women would cut individual rice stalks, leaving about 10 percent in the fields for gleaning by the poorest; the harvested rice would be divided according to agreed claims and obligations negotiated between landlord, harvesters and other laborers who had foregone wages at earlier stages of cultivation in return for a crop share. Landlords replaced women harvesters by male labor gangs hired through middlemen to whom they sold the crop. The more uniform growth of MVs made sickle harvesting feasible, sickle harvesting left little rice in the field and, since the gains were paid by harvested weight rather than by bundle of rice stalks cut, the change in practice and technique reduced the harvesting costs for the landlord to around 8 percent of the value of the standing crop. The changes decreased the person-days spent in harvesting, increased marketable output but greatly reduced female wage employment and removed the redistributive welfare benefits formerly enjoyed by the gleaners.

Differences in the rigidity of the sexual division of labor in some areas may mitigate these adverse impacts. Greater flexibility in gender roles seems to allow households to take better advantage of opportunities in the agricultural labor market with fewer costs to household welfare. For example, in parts of Thailand or Java rural women customarily look after and

market small stock and engage in trading, tasks which they can combine with their household and child care responsibilities. When the agricultural labor market offers women the better income opportunities, men may take over women's domestic domain and productive activities (White, 1985, p. 132 for Java).

7 The Impact of Technical Change in Agriculture on Women in Latin America and the Caribbean

7.1 Overview: Women's Agricultural and Food System Roles in Latin America

Ashby (1985, pp. 23-25) has summarized the evidence for women's participation in Latin American agriculture and food systems thus:

- (1) "The macrostatistical picture showing low rates of women's participation in agriculture is fundamentally misleading because of conceptual problems of measurements of women's work in agriculture."
- (2) "Microstudies indicate higher rates of participation, although quantitative estimates are few and are an inadequate basis for generalization about trends and participation rates."
- (3) "Rural women's work roles ... involve extremely heterogeneous activities."
- (4) "The sexual division of labour appears to be more rigid in estate and plantation agriculture, where women's roles are principally those of wage labourers in specific tasks, often on a piecework basis."
- (5) "In smallholder agriculture the sexual division of labor appears very fluid; women are excluded from some tasks more than others, but examples exist where they take part in almost all agricultural operations. Women's participation may be in sex-specific tasks that are interdependent with tasks performed by men."

- (6) "Women's participation in field tasks varies by social class, techniques of production in a crop, and the crop's role in the economy. Microstudies almost universally neglect to disaggregate participation rates by crop. Participation rates of women in smallholder agriculture appear to be highly responsive to labor market conditions, in particular the availability of male wage labor as a substitute for labor of farm housewives in field tasks."
- (7) "Women may contribute to a significant proportion of capital generation in farm households and may influence expenditures and investments as a result."
- (8) "Women play a significant managerial role in smallholder agriculture under certain conditions: (a) where subsistence food production managed by women is an important component of total farm production; (b) where male labor is engaged in off-farm employment and women take primary responsibility for farming decisions or participate jointly in them because their time is a critical input."
- (9) "Three distinct groups of women can be identified as potential clients or user groups for technology development and research ... but their interests diverge and may conflict."
- (10) "Certain groups of women ... face different incentive structures from men which may influence acceptance and impact of technical change because: (a) male and female work responsibilities and time availability differ; (b) male and female control over resources such as land, labor and cash differ and their preferences and benefits may differ with respect to new relations among these factors of production due to technical change; (c) access to institutional resources such as technical assistance and credit are different among men and women."

7.2 Overview: Women's Agricultural and Food System Roles in the Caribbean

Women in the agricultural labor force in the Caribbean range from 30 percent in St. Vincent to over 50 percent in Antigua, with a wide range of roles in cash and food cropping, food processing and food trading. The bulk of the food which is both produced and consumed in the Caribbean is marketed by women, operating in both domestic and inter-island export trade. A 1981 FAO survey identified 50 female hucksters based in St. Lucia carrying out the bulk of fruit and vegetable trading in the CARICOM region; 120-150 based in St. Vincent, 50 in Grenada and 200 in Dominica traded regularly with the Windward Islands, Barbados, Trinidad and Martinique.

While, as in other countries, agricultural wages for women are around one-third to two-fifths that of men, women in rural communities depend more on agriculture for their total income than men. In St. Lucia, for example, in 1971, 70 percent of rural women depended totally on agriculture for their income compared to 45 percent of the men (Knudson and Yates, 1981). High male migration and marital instability means also that many more women carry managerial responsibilities in agriculture. In addition to providing a cash income, female garden production (crops and small stock) as in other regions generates the basic household use values which are hard to substitute through cash purchase when rural wages are depressed. They also generate the raw material for backyard processing businesses, such as cassebe (cassava) bread baking, which provide important low cost snack foods for urban dwellers.

7.3 Examples from Colombia and Peru

While published sources give few examples of direct effects on women of technical change, the changing organization of production stimulated if not caused by the introduction of MVs

and improved livestock is having a far-reaching impact on women. An example drawn from the history of change in the Cauca Valley in Colombia illustrates this.

The Valley has had a long tradition of small-scale production for home consumption and the market, women cultivating their own horticultural smallholdings with a mix of income-producing tree crops (coffee, cocoa) interplanted with a variety of food crops. The complex biosystem needed little weeding, once established, and harvesting was spread out over approximately fortnightly periods throughout the year (Rubbo, 1974). Women's labor input was thus both low and fairly constant. Government encouragement of capitalist plantation agriculture permitted large-scale farming enterprises to spread into the Valley, promoting sugarcane and rice and the small-scale commercial production of annual cash crops. At the urging of their sons or husbands, backed up by plantation representatives and agricultural extension staff, women were persuaded (sometimes under duress) to cut down their trees and plant their land to annual crops for the sake of quicker cash returns. The women and their families became more dependent on the highly priced and irregularly stocked food markets and the variable cash crop prices determined by international markets. Women's total labor input increased and their status as semi-independent producers and marketeers was transformed; they became unpaid laborers on male-controlled commercial smallholdings or seasonally sub-contracted wage laborers or dependent on male access to wage labor. Many others migrated to town.

Interpreting history of events such as these is the more difficult because data from different studies are hard to reconcile; two other Colombian studies suggest "the introduction of new commercial crops within peasant units of production has involved women in the productive process. Likewise, the expansion of commodity production, as opposed to subsistence production...has not resulted in the displacement of women from

agricultural activities" (Deere and de Leal, 1982, p. 76). Data from the Andes strongly indicates that in areas where families are losing access to land and men turn to off-farm income-generating activities, "agriculture appears less as a male occupation and more a family activity. A flexible division of labor appears to be required by economic necessity" (Deere and de Leal, 1982, p. 88).

One explanation of the apparent discrepancies is that few studies have disaggregated participation rates for men and women by crop-specific tasks; others have failed to relate the disaggregation to the class effects of household income levels or to distinguish between labor inputs, operational control and control over output. Another explanation is that as men become involved in cash cropping for the market and agricultural laboring, women's unpaid labor on family farms is increasing as well as their participation in agricultural wage laboring. Both these trends appear to be associated with a decrease in the time women give to subsistence production and food preparation (Carloni, 1984).

Taken together with the very high rates of female migration to urban areas, the trends suggest a rapid change in food preferences in the direction of purchased, easy-to-prepare items. The increase in the production and productivity of rice in this respect has had important benefits for poor urban consumers, presumably especially so for working women seeking a cheap, quick-cooking staple (Scobie and Posada, 1978). CIAT's cassava program in the Atlantic Coast area of Colombia has been developing integrated production and marketing research, investigating how the introduction of new post-harvest technology might have affected women's roles as managers of household food supplies in relation to production decisions. Research showed "women's needs and preferences in terms of feeding the family could be deciding factors in achieving the main objective of expanding cassava production (Ashby, 1984b, p. 7)." One

illustration of women's pivotal influence is their role in determining the balance of associated crops or intercroppings in cassava fields as managers of the flow of foodstuffs both from the commercial cassava fields and their own household plots (Ashby, 1984b, p. 8).

Integrated marketing and consumer studies have been emphasized in response to the regional demands of the increasing numbers of poor people who have lost their self-provisioning base. Working women constitute an important category of consumers, with a high preference for easy-to-prepare foodstuffs; their preferences appear to have a significant influence on the price of different grades and types of marketed beans. Survey research among urban women from different income classes showed "they will not purchase beans which have been stored for long, as beans become discolored and hard to cook" (Ashby, 1984b, p. 9). Other CIAT studies have emphasized urban women's dislike of the inconvenience of shopping for perishable cassava, a "finding which led the cassava programme to include questions of storability and storage technologies in its research, to carry out taste and cooking evaluations with panels of urban women and to re-examine anthropological literature on the indigenous storage and preservation technologies of Amazonian Indian women" (Ashby, 1984b, p. 10).

However, gains in marketed output and productivity in rice in Colombia do appear to have been won at the expense of two other categories of women: female laborers displaced by mechanization and modern seed-fertilizer technology and women cultivating small upland rice farms who have moved into marginal rural and urban wage employment because the productive base of their small-scale farming has been eroded (Hansen, 1983).

Unfortunately, land reform may do little to restore women's access to income and productive resources and may even be instrumental in depriving them of rights which traditionally were

theirs or which they had acquired earlier through joint land purchase with their husbands on the break up of landed estates (Palmer, 1985). The case of the dairy cooperatives set up following agrarian reform in Peru is instructive. Although women formed around a third to a half of the permanent operatives in dairying, because only household heads were registered in the new cooperatives, women's membership in 15 cooperatives surveyed in Cajamarca Province was around 2 percent. They lost the right to regular employment, were discriminated against in terms of pay, and as temporary workers lost their right to social benefits (Palmer, 1985, p. 26).

The small numbers who were admitted were able to use their membership to develop a garden project which provided them with full time work and temporary employment for others (Deere, 1984, pp. 65-66). The exclusion of the majority, on the other hand, had serious consequences for dairy productivity and the health of both the cows and the milkmaids (Palmer, 1985, pp. 26-27; Deere, 1985, pp. 195-196). The male membership decided it would be more convenient if the cows were milked in the field rather than escorted twice daily to the milking sheds. They did not take into account the extra unpaid time the milkmaids would have to spend walking to the fields, nor the consequences to the milkmaids' health through exposure to inclement weather nor their difficulties and declining interest in maintaining milk and udder hygiene in the fields.

Despite this all too familiar story, Peru does in fact provide one of the rare cases of researchers explicitly setting out to incorporate women producers' views in the setting of agricultural research agendas and the determination of breeding criteria (Fernandes, 1986). The example is all the more remarkable for its focus on smallholder sheep, an area of production and trade consistently overlooked and underestimated in the past (Hecht, 1985, pp. 51-70). A team working within a farming systems approach, jointly fielded by the USAID Small

Ruminant CRSP and the Peruvian Instituto Nacional de Investigacion y Promocion Agraria, in 1983 discussed with the village assembly of Aramachay on the southern side of the Mantaro Valley a joint agreement to work on production problems identified by the producers themselves. The assembly identified a committee of ten members to work with the team; although women were active in the assembly, none of the committee members appointed were women. The team, recognizing that the main sheep producers were women, continued to seek an effective way of collaborating with the women in the community. After a protracted period in which the team tried working with existing women's groups set up for other purposes, a special meeting was called, open to all female sheep producers, focusing on their production problems. Twenty-three women (from 120 families) turned up and posed five production priorities (Fernandez, 1986, p. 9). The discussion led to the formation by the women of the Women's Livestock and Crop Production Committee of Aramachay, through which the research agenda, location of on-farm research, trial design and evaluation were determined.

7.4 Examples from the Eastern Caribbean

The Regional Food Plan adopted in the late 1970s by CARICOM member countries called for the greatest possible degree of food self-sufficiency, accompanied by a structural shift from monocropping estates towards multiple-enterprise small and medium sized farms (CARDI, 1978, p. 38). "Of an estimated 73,000 farmers in the eight Eastern Caribbean islands, most have holdings of less than 5 acres. Substantial numbers of these farmers are women, an estimated two-thirds are over 45 years of age, and the vast majority have little formal education" (MUCIA, 1979, p. 13).

Middle-aged women "constitute the majority of household heads on the small farms" (Smith, 1978, p. 46), typically growing the following range of crops for self-provisioning, domestic and

inter-island trade: yellow yams, negro yams, St. Vincent yams, lucea yams, dasheen, tannia, sweet potatoes, cassava, several varieties of beans, peas, tomatoes, calaloo, cucumbers, limes, nutmeg and ginger, carrots, leaf vegetables and herbs (Blaut, et al., 1973, pp. 47 and 50). Equipment for hillside cultivation, control of pests and diseases in the wet season and improved varieties and water management for dry season production are among the priority cultivation problems identified by women (Knudson and Yates, 1981, p. 54; CARDI, 1978, Annex G). However, agricultural research in the Eastern Caribbean historically has been mainly toward export and plantation crops grown as monocrops on large-scale commercial holdings or plantations. Programs to develop higher-yielding techniques and varieties for smallholders have not had much impact, apparently because they have been "incorrectly aligned with the constraints and objectives as perceived by the smallholder" (CARDI, 1978, p. 42).

Women have been affected to a greater degree by male migration out of what is widely perceived as a low status and unproductive occupation. Male migration out of low yield, high risk agriculture is a recurring phenomenon throughout the world. As in other areas (Palmer, 1985), women in the Eastern Caribbean respond by seeking a wider income portfolio than agriculture alone can provide (Smith, 1978). Past failure of agricultural research to develop for such areas significant alternatives to local production systems and materials which might hold men and family units on the land surely is a contributory factor to their deepening poverty.

8 The Impact of Technical Change in Agriculture on Women in Sub-Saharan Africa

8.1 Women as Small-Scale Food Farmers

The best evidence available indicates that the majority of small-scale food farmers in Sub-Saharan Africa are female. Why this should for so long have been ignored or underestimated in agricultural policy, research and assistance is a story yet to be fully written. United Nations data, based on small-scale studies and surveys of women's time use, suggest that women contribute two-thirds of all hours spent in traditional agriculture in Sub-Saharan Africa, three-fifths of hours spent in marketing and over four-fifths of the hours spent in food storage and processing (United Nations, 1975). Revised estimates of female participation rates in the agricultural labor force as a whole indicate that women form 46 percent of the labor force (Dixon, 1982). However, official statistics are far from satisfactory. Official figures in Malawi in 1972 recorded just 12 percent of women economically active in agriculture; 1977 statistics offered a revised figure of 51.6 percent. Nigerian official statistics did not record women's participation at all during the 1970s. Detailed figures for female wage employees in agriculture exist only for some countries (e.g., Mali, 1970: 15.2 percent of the total agricultural wage labor force; Kenya, 1971: 17.2 percent); female employment in non-wage food processing, preservation, trading and marketing has not been recorded in official statistics.

Their involvement typically is much higher than these figures suggest. For example, reanalysis of Ghanaian 1970 census data revealed female participation in food production as follows: 51.3 percent of producers of staple foodstuffs and vegetables were women; 36.3 percent of sugarcane farmers; 35.8 percent of cocoa farmers and farm managers; 33.4 percent of rice farmers; 26.6 percent of oil palm producers; 18.4 percent of poultry

farmers and farm managers; 11.9 percent of dairy and livestock farmers (Ewusi, 1980). Nor are women necessarily farming on a smaller scale than men. A 1978 Ghanaian survey found that 66.7 percent of the men and 63.3 percent of the women surveyed had rice farms of 1 to 50 acres; 23.3 percent of the men and 20 percent of the women farmed 51 to 100 acres; and 10 percent of the men and 16.7 percent of the women had rice farms of over 100 acres (Gbedemah, 1980). A 1979 survey of 130 women's gardens in the Doutchi area in Niger revealed that although the average garden size was only 1.6 ha, compared to the national average farm size of 6 ha, the total area under garden production per village in the three villages surveyed was, respectively, 750 ha, 477 ha and 218 ha (Bisilliat and Presvelou, 1985).

Because women and men have a number of separate agricultural roles and tasks, it follows that although in a general sense both are working to increase household welfare, food and income security, they also will be interested in optimizing somewhat different calculations of returns to resource investment. For example, because of women's greater time constraints, they might have a greater interest in income per hour worked rather than income per hectare or, an interest in maintaining dietary variability over the year in terms of seasonal food intake management rather than minimizing food intake variability in terms of quantity, once minimum needs have been met.

8.2 Women as Food Traders and Marketeers

It is a persistent image that women are engaged mainly in petty rural assembly food marketing, roadside selling, short distance and informal transportation, handling and distribution. But analysis of government attempts to control urban markets in Ghana (Ardayfio, 1985), Nigeria (Trager, 1985) and the Cameroon (Henn, 1981) and the FAO's Credit and Marketing Division's action program for female entrepreneurs and marketeers in eastern and southern Africa indicates that the image grossly underestimates

women's participation. A few examples here must suffice: at Gbo-Sime in a suburb of Lome, the goat market is dominated by women; the Accra and Yaounde food markets are organized and occupied by women; in Kenya, much of the potato wholesaling is organized and run by women. Little of these activities is handled through official trade finance and marketing organizations and much of it remains unrecorded.

8.3 Women in Commercial Food Processing and Agribusiness

Women are also engaged to a very large extent in food processing on commercial scales in the informal sector. The brewing and sale of beer is a major female agribusiness. The 1976 Rural Income Distribution Survey in Botswana demonstrated that beer sales are an important method of redistributing income. A study in Burkina Faso (Saul, 1981) traced how female entrepreneurs could build up substantial businesses, moving out of direct production to purchase brewing grains from others. In a number of countries in West Africa, gari (processed cassava) is big business for women, who may run integrated operations or specialize in production or processing. In the southern highlands of Ethiopia (Mariam, 1980) and in West Africa (Josserand and Ariza-Nino, 1982) women process and sell butter and ghee; in Lesotho, women are building large-scale egg and poultry enterprises through participation in cooperative "egg circles" (Meghji, et al., 1985); in the Ivory Coast women in peri-urban areas are developing rabbit, pig and poultry businesses.

8.4 Households Headed by Women

In addition to female farmers, traders and processors who are working within family or household enterprises, agriculture is an important resource for the high and increasing proportion of women who head rural households. In a rising proportion of cases, households are headed by women who have never married or who are divorced or permanently separated. Typically,

remittances from male household members are small, intermittent, and often earmarked for consumption goods or inappropriate farm investments. As in Lesotho or particular regions within other countries, the percentage of households headed by women may rise to over 70 percent of all rural households; it is not unusual for the percentage to be over 30. This does not necessarily signal a "feminization" of agricultural production as women farmers within family or household enterprises may work longer hours in production than women who are household heads; poorer female-headed households typically diversify their income sources in the face of severe agricultural labor constraints (Palmer, 1985).

Itself a sign of agricultural failure, the social and economic costs are high. There is evidence of a growing practice of women boarding out their children with female relatives and friends. For example, in Liberia, in the 15 to 24 year age group, 40 percent of women surveyed were found to entrust one child to the mother's family, 14 percent in southwestern Togo and 22 percent in Ibadan (year not indicated; Bisilliat and Presvelou, 1985, p. 723). Worsening income distribution, labor-displacing mechanization, declining output and a reversion to less time-demanding and more time-flexible crops such as cassava have all been reported for areas of high male out-migration.

8.5 Impact of Technical Change

The indirect and direct impact of technical change on women has been, by and large, rather destructive, not only for women themselves but for natural resources, family welfare and national development, too. There is little enough space to explore here the full range of explanations and inter-related effects but the following examples cover much of the ground.

Many of the negative indirect impacts arise because of failures to perceive or respond to differential allocation of resources and responsibilities between men and women within

farming households. Burfisher and Horenstein (1982) estimated the impact of a development project on the Tiv farming system in northern Nigeria in order to disentangle impacts on men and women within farming enterprises. The project envisaged an increase in the productivity of nine major crops (including three coarse grain crops) with the expectation of raising the level of home consumption and marketed surpluses. All the crops were already being grown by the Tiv, with established and clear demarcations between men and women of labor and income for each of the crops. The changes in labor requirements and returns which would be brought about by the proposed project interventions were estimated as follows:

The study finds that while the annual labour requirements of the total farm are expected to increase by 14 percent, a disaggregation of the total farm indicates that women's annual labor requirements will increase by 17 percent while men's will increase by 6 percent. Although increased labor requirements of the total farm are expected to be distributed favorably throughout the year, women's labor requirements are distributed unevenly, while men's labor distribution is similar to that expected for the total farm. While both sexes have the opportunity to increase their incomes, their increased labour on particular crops is not always associated with increased income from that crop. Finally, sex roles relating to other labour requirements and financial responsibilities in the farm household, in addition to those related to the farm's major crops, need to be taken into account because they can influence differently each sex's decision to adopt project technologies" (Burfisher and Horenstein, 1982).

Their analysis concludes that neither output nor productivity gains on the scale anticipated were likely to be forthcoming.

Land reform has tended to collapse female rights to land use within individual male title. Women have either lost their access to landed resources completely or, since their responsibility to feed the family and make cash purchases to meet family welfare needs rarely diminishes, been forced into cultivation on marginal land. Such trends usually have been associated with

reduction in women's control over household food supplies and, coupled with the highly seasonal nature of production in many areas, an increase in nutritional instability and increased pressure on fragile environments. Furthermore, because access to many input and marketing services and farmers' organizations is linked to land title, women's production has been poorly supported.

Three examples demonstrate these effects. In the Mwea Irrigated Rice Settlement Scheme in Kenya, rice fields were leased on life tenancies to young male household heads. Small plots for self-provisioning foods were lent to each household (or, in polygamous households, to each resident wife). But the planners assumed part of the rice crop would be consumed by the tenants and overlooked women's responsibility to feed the family out of their own production and sales; the plots were too small for family subsistence. The male tenants had little to do with the rice crop between planting and harvesting and were often absent; women shared in all cultivation tasks and did all the weeding but the crop was sold by and the cash paid to the male tenants (Hanger and Moris, 1973). Although the women received some remuneration from their husbands in the form of paddy, the women resented the extra work and the loss of control over their own food farming so they began to neglect the weeding. They also found they had insufficient cash to purchase firewood and there were no nearby forests in which to gather it. Nutritional surveys found serious indications of malnutrition among women and children.

Tenants' associations were dominated by the leading male farmers. It was not until the management became alarmed at the low rice yields and women themselves complained directly to the management that attention was paid to the issues raised by the women. Better firewood and milk supplies were organized but the fundamental questions of land use rights and income distribution were not addressed.

A careful study of irrigated rice projects in **The Gambia** shows how responsibility for rice farming and control over income and land has been reallocated to men, in an area in which women have for centuries been wholly responsible for inland swamp rice cultivation, with daughters inheriting land from their mothers (Dey, 1983). Men have become responsible for hiring mechanized equipment, maintaining the bunds and controlling the irrigation while women have been assigned the major part of the transplanting and weeding. As before, women recognize their marital obligations to work with their husbands to produce a rainy season rice crop for household consumption but have resented the project's attempt to control their labor in the dry season, during which no customary obligation existed. Three new forms of labor organizations have emerged.

Where men have little irrigated land and the household is relatively poor, a man on the whole regards the irrigated plots as land for meeting household consumption needs, thus freeing his income from his rainy season groundnut, millet or sorghum crop for his own purposes. In effect, he uses his wife's unremunerated labor on the rice plot to raise his own personal disposable income. Where households are richer or have more irrigated land, irrigated rice tends to be treated as the man's personal fields. Then he has to pay for hired female wage labor or hire his own wives and daughters at the going market wage rate. Where men have surplus land or are particularly generous, their wives, daughters or sisters may be lent a plot each for their own use.

The overall effect has been to increase men's personal cash income at the expense of women's and, through differential expenditure patterns, household welfare. Project goals and achievements have been constrained or distorted by: (1) failure to incorporate women's unique knowledge, skills and experience of water and soil conditions and rice varieties, leading to serious problems of drainage and water management; (2) the poor fit

between the project's double cropping schedule and men and women's separate production goals and time management; and (3) the higher production costs incurred by the necessity to hire female labor which had previously been mobilized through female networks at the cost of a meal.

A study by McMillan (1983) of Mossi families moving from their home villages in the Central Plateau region of Burkina Faso to the Volta Valley Authority's (VVA) resettlement scheme in the south is one of the few documented cases of a highly capital intensive agricultural modernization scheme in which women's semi-autonomous farming, after initial neglect, has re-emerged. The study also documents how the attempt to superimpose a new organization of production and cropping patterns has reduced the productivity of women's time and destabilized the family.

In 1979, McMillan found that, in the settlers' home villages, although cooperative production provided the bulk of the extended families' food needs, an average of 33 percent of the total area planted was cultivated as private fields and that 64 percent of the privately cultivated fields were operated by women. She estimated that 15 percent of the area planted to sorghum and millet and 13 percent of the total production of these crops were on women's fields which also accounted for, on average, 12 percent by area of maize, 66 percent of peanuts and groundpeas, 16 percent of rice and almost all vegetable production. Although in total representing only between a fifth to a quarter of total family production, the output was essential to the survival of the polygamously married women and their children during the dry season when output from the jointly cultivated family fields was exhausted. The women's private fields also were the source of income for paying school fees, buying clothes, medical supplies and condiments. In addition to the work on their own fields, the women contributed an average of 47.5 percent of total work hours recorded for the jointly

cultivated family fields and an average of 43.5 percent of work hours recorded for men's private fields (McMillan, 1984).

Initially, there was no provision in the VVA scheme for private fields for either men or women; it was assumed that the holdings would be jointly cultivated by nuclear families as "family farms." The agronomic recommendations were based on a six-year rotation of cotton, sorghum, cotton and legumes (peanuts and groundpeas), and again sorghum, followed by a two-year fallow on each subplot. Women suffered a sharp drop in income and an increase in their unremunerated labor input and experienced considerable hardship in maintaining themselves and their children. By the fifth year of operation, the rules had been relaxed to the extent that, on average, 11 percent of the total area planted was cultivated privately, utilizing 8 percent of the total labor available but the relaxation raised women's control over foodgrain output to only 4 percent (compared to 13 percent in their home villages) and over the cash returns from production to a meagre 3 percent (compared to 15 percent).

Over the same period, although their labor contribution remained constant relative to men's, women's work hours doubled in absolute terms. They were compensated to a certain extent for their work on the jointly cultivated fields by complex gift-giving arrangements within the extended family.

Overall, yields in the VVA scheme area rose to between two and three times the recorded production in the Mossi settlers' home villages and productivity of labor also increased, an average of 0.9 metric tons of grain being produced per unit labor. However, the organization of production on jointly cultivated rather than private fields seems to have had little to do with the increase (McMillan, 1983). The scheme was located on fertile, virgin soils; extension agents each supervised 25 families and enforced the recommendation application of fertilizer, the use of animal draft and the planting of modern

seed varieties. Net agricultural income per household rose to approximately three times previous average levels.

On the other hand, the large-scale cultivation of cotton extended the agricultural year from 7 to 10 months, straining household food budgets. The absolute number of hours worked in agriculture rose steeply and the time and effort spent on related activities such as marketing were increased by distance from points of sale. Women's household management became much more stressed in relation to seasonality, access to and variety of foodstuffs, time management, reduction in cash income, and loss of support from members of the extended family not admitted to the scheme. Their loss of status, competence, and autonomy led to an increased incidence of divorce and a declining interest in standards of nutrition and household management (McMillan, 1983, 1984).

By the ninth year (1983), the Mossi settlers had abandoned many of the agronomic recommendations, an increased percentage of the cultivated area had reverted to private fields, and families more nearly resembled the extended groupings of the Central Plateau region as additional wives and young male relatives were recruited to ease the labor burden. The traditional social organization of production was re-emerging, restoring women's semi-autonomous production.

The direct effects of technical change can be equally damaging. The National Horticultural Research Station in Thika, Kenya, backed up by donor assistance, together with the longer term assistance of the IITA, has been developing for a number of years improved bean strains which suit both local taste and climatic conditions. The Grain Legume Project (GLP) offers a good example both of (1) how the assumptions of the transfer of technology model can undermine women's roles and thus the ultimate success of the research effort and (2) how a farming systems perspective can lead to greater understanding of women's

roles and interests. Two statements are contrasted, respectively from a senior member of a commercial company which will be involved in the bulking and distribution of improved bean varieties and from a farming systems economist working on the GLP.

The commercial company officer states (Coombes, 1983):

These strains have been subjected to various tests and further selection and breeding have resulted in the release of four varieties for commercial multiplication. Parallel to the breeding, agronomy research has enabled the project to lay down guidelines for different areas and cultural practices.

In terms of achieving its research and breeding objectives the Grain Legume Project must be judged eminently successful.... If even as little as 5 percent of [the total bean acreage] was planted in any one season, the seed requirement would amount to 2,500 tonnes. Actual demand is in the region of 55 tonnes: why? ... A cost of Shs. 780 per ha is a high input cost for the average smallscale farmer. Therefore price is a constraint.... It is important that extension is presented as a package. That is to say, that farmers should be made aware of the advantages of using not only certified seed but also of the correct agronomic practices and of the relationship of beans to their whole farming enterprise including other crops and maize.... For generations subsistence farmers have retained their own bean seed for sowing in the following season and few ever experienced a total crop failure. A poor season may force a family to eat their own seed but then it would be replenished from the market. There has been little incentive to change the old system. Beans are not usually grown as a cash crop.... This situation of fluctuating demand and supply does not encourage farmers to grow beans properly.... The acceptance of the GLP bean varieties depends in the long term on marketing of the final produce and adequate extension, with subsidies having a temporary effect.

The assumption that both the farmers and the infrastructure must change to meet the potential of the new technology can be contrasted to the following perspective, which assumes that, to make a positive impact, the technology must be adapted to producer objectives and potentials. One of the GLP's farming system economists writes (Zoehl, 1983):

It is not easy to get a clear picture of the bean producing small farmer.... A comprehensive study of the bean grower in this zone does not exist.... First of all, the bean grower in the area is more often than not a woman.... Fertilizer or manure is not commonly used on beans; the small amount of manure from the **boma** is reserved for the coffee, maize or the vegetables.... The investment in planting seed and fertilizer is done for maize, not for beans! It looks as if the small farmer is well aware of what in agricultural economics, is known as maximum returns on resource investment. Certified maize seeds cost much less than certified bean seeds.... Hybrid maize responds better to fertilizer than beans do.... Beans can be bulked on the farm for planting seeds, hybrid maize cannot! ... It is my opinion that there are at least two possibilities for GLP seed. First, the farmer can plant part of her **shamba** with beans as a cash crop. Second, certified seeds are the future for developing commercial bean growing in Kenya. To start with, GLP seeds have excellent seed characteristics, and high yield potentials are very popular among Kenyans.... Most farmers are aware of the bonus of an attractive, homogeneous product and put quite some effort in sorting out and cleaning their beans for the market. It has been proved by GLP research, that, once a certified seed has been bought, product multiplied on the farm can be used as planting material for a second and third time, before the advantages of the initial seed dressing and certification have been lost completely.... Preliminary assessments of the labour needed for bean growing ... showed that bean growing is a very demanding task ... roughly half of these 100 days are needed for cumbersome weeding.... Compared with alternatives, i.e. coffee growing, beans certainly do not give very high returns. Beans need lots of care and processing after harvest, as much as any horticultural crop, yet, a hectare of field beans represents not more than a value of 5,000 Kshs. As a comparison, 1 hectare of potato with a farmer's average of 1,300 kg/ha stands for a total value of 15,000 Kshs. Two hours spent daily in milking and feeding a dairy cow generates as much as Kshs 20. Thus, growing of beans can be compared, in a sense, with the cumbersome task of fetching water or firewood.

The Kenyan government over the past few years has taken a number of steps to bring women's agricultural roles and objectives to the attention of agricultural researchers and extensionists. The special emphasis being given to the enrollment of women and women's groups within the present

Training and Visit implementation program promises to bring researchers to a closer understanding of the issues.

Research reported by Ay and Nweke (1984) demonstrates the close relationship between varieties, their production characteristics, processing and women's livelihoods. The introduction in villages to the north of Ibadan of a new cassava variety, 30572 from IITA, forced changes in processing technology and process in flour production (Ay, et al., 1983). Variety 30572 has a short maturation, high yield and vigorous growth but also a higher water content than comparable local varieties. Women specializing in cassava processing found that when they followed the usual flour processing sequence, the new variety required a longer drying period after fermentation, the flour had a grey appearance which lowered the market price and its flavor suffered. By experimenting with methods used in gari production, they found they could get better results by pressing fermented and peeled whole tubers in fertilizer bags, to remove the water content before the tubers are dried and pounded into flour. (In gari production, fermentation is done after peeling and grating.) But the additional labor time of course raised production costs and reduced profits.

Conclusions

What are the implications of the material presented here for the agricultural research agenda and the technology development process? The implications might be expressed succinctly thus:

(1) Because for most of the urban and rural poor, a part or all the food consumed in the household is processed, preserved and prepared within the household, the intrinsic links between varietal characteristics and domestic food processing, preservation and preparation technologies must be investigated and considered at an early stage of the research process.

(2) The intra-household allocation of resources (including labor time) and of obligation, is the key to predictive understanding of welfare effects, at the individual and household level, of technical change in agriculture. Women as well as men make their individual calculations of costs and returns in the light of their responsibilities and, accordingly, are likely to seek to optimize rather different quantities. There is a need to develop a process of research programming which allows these insights to influence the research agenda.

(3) Without the active collaboration of both men and women, as producers, consumers, workers, traders and processors, in the determination of the research agenda, researchers' work is liable to produce otherwise avoidable negative impacts on women. There is a need to develop a process of research programming which shifts the balance of decision-making closer to the collaborative model of commercial and industrial technology development, in which consumers and producers as well as the academic community, agricultural scientists, and the food industry have a determining voice, bearing in mind that in the majority of cases in developing countries food is still processed, preserved and prepared within the household. Within this model, special and

explicit care must be taken to ensure that the different categories among the poor are directly represented.

(4) The neglect of the multiple use of biomass in the maintenance of rural livelihoods in pursuit of monocrop commodity production is having far-reaching consequences for the mass of the rural poor who have few other sources of livelihood. There is a need for consideration with other agencies, early on in the research process, of the possibilities for coordinated action in sustaining rural livelihood potential and the implications for the research agenda.

(5) Technical change in agriculture can generate major social benefits at the same time as it generates significant costs for women *qua* women or for particular categories of women, which are different in kind or intensity from those experienced by men. Until women are recognized as social and economic actors in their own right, calculations of net social benefit are likely to continue to underestimate gender-related costs and overestimate the benefits.

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