DEVELOPMENT INTERVENTIONS AND DIFFERENTIAL TECHNOLOGY IMPACT BETWEEN MEN AND WOMEN

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The ability of technology to address the numerous development problems of today, such as increasing agricultural productivity, improving grain storage and reducing the expenditure of human energy with tools and machinery, is well recognized. Both technology access and resource scarcity interact to gain the attention of development theorists and practitioners. The U.N. Conference on Science and Technology for Development (UNCSTD) this year calls our attention not only to the uneven availability of technology in the international economic order, but also to the differential impact of technology on women and men (AAAS, 1979). Large size, high cost, labor displacement, and dependency consequences often make the industrial world's technology ill-suited for meeting development needs in third world countries. Government policies have critical effects on the size, type, and purpose to which technology is put. More specifically, government policies affect the price of labor versus capital utilization in production, the availability of resources for developing innovative technology, and the institutions which disseminate that technology, ultimately affecting who controls and benefits from technology. Often such policies and differential impacts are fostered or reinforced through development interventions by donor institutions. Since the publication of Schumacher's SMALL IS BEAUTIFUL, various institutions have promoted the development and dissemination of appropriate technology—"appropriate" in terms of cost and resource availability, local control, labor intensiveness, and social compatibility (Eckaus, 1977; Evans in Evans and Adler, 1979).

While technology itself is sex neutral, economic and political disparities between men and women affect access to and control over technology. As new technology spreads and penetrates a given society, the sexual division of labor itself is altered. Accumulating evidence indicates that tools, technology, and information are disproportionately introduced to men, who also tend to control more resources in given societies than women (Boserup, 1970; Tinker, 1976; Chaney and Schmink, 1976; Carr, 1976). Given the intra-household division of labor and income, technology introduced to male household heads does not necessarily benefit women, both in terms of labor saved or in income earned (Dixon, 1978; Muntemba; 1979). These trends appear to undermine women's economic activities outside the home, increase resource gaps between the sexes, and lower women's productivity relative to men, confining them to household work—factors which all spell detrimental consequences for realizing development goals as a whole (Boserup, 1970; Staudt, 1978). Moreover, technology only rarely or belatedly addresses women's nonmarket, unpaid household activities. The promise of appropriate technology is a responsiveness to the needs of potential users, regardless of sex. That is, the needs of women farmers, water haulers, fuel gatherers, traders, and food processers, or any one of the many occupations in which women are found, will be addressed.

The purpose of this paper is to review existing literature on sex-differentiated access to technology, and highlight key issues for policy-oriented researchers and development practitioners. The paper will then consider appropriate technology and women within one large donor organization, the U.S. Agency for International Development. Finally, the paper concludes with a review of policy-oriented research needs which go beyond assessing impacts to devising ways to assure access for women in the technological changes which occur.

I

In reviewing literature on women and technology, key issues to be highlighted include labor displacement and recruitment, nonmarket production, renewable energy, and dissemination mechanisms.

Labor Displacement and Recruitment

In recent years, development policymakers have become increasingly concerned with the impacts of policies and programs on employment. During the 1950s and 1960s period, the promotion of capital-intensive development often resulted in wholesale displacement of laborers without other means to sustain their livelihood.

A number of case studies demonstrate how new technology displaces women workers and undermines both an independent female income base and contribution to household income. In Indonesia, the introduction of a tool used by men, the sickle, displaced women laborers who utilized a small knife, the ani-ani, in harvest (Cain, 1979). Machine-ground grain mills displaced women who hand-pounded grains for an income, in Indonesia as well (Collier, in Milone, 1978). Factory processed goods

and foods are replacing locally produced female handicrafts and processed foods in the Caribbean and West Africa (Mintz, 1971; Remy, 1975). A cassava flour mill in Brazil trained men in the use of metal press machines, initially leaving women as peelers, and finally displacing even those women peelers, as electric and gas-powered presses were introduced (Campbell, 1977). Costly, refrigerated technology for storing fish is gradually displacing women fishtraders on the Ghanaian coast (Robertson, 1975-76). While inefficient or unproductive technology should not be protected simply because women are active participants, technology should be designed and introduced in ways that ensure continued female participation (Dixon, 1979, pp. 36-45).

Rather than displace women workers, another set of studies calls attention to the active promotion of a female labor force. Research on the transfer of labor-intensive industries, such as those in electronics and textiles, documents the conscious recruitment of a female labor source and the wholesale transfer of an ideology of work which justifies wage disparities and sex-typed behavioral characteristics. In a study of the electronics industry in Singapore and Malaysia, multinational corporations seek a largely female labor force, who are paid wages two-thirds of men's and sought after for their docility and rapid turnover, the latter reducing the labor benefit package. An investment brochure notes that "the manual dexterity of the oriental female is famous the world over" (Lim, 1979). A study of maquiladoras on the U.S.-Mexico border reinforces East Asia fundings (Fernandez-Kelly, 1979). A ball-point pen manufacturer in Pakistan who employs single women

remarked how women were "better with their hands in handling small parts and in rapidly assembling and packaging" his product. Wages are determined by the value of output, and because the printing, assembly, and packaging operations have low output, single women are selected because they can "take it as pocket money," whereas "a man cannot support his family on this wage." Female employment outside the home, however, may represent a significant advance (Frasche, 1979, p. 162). Elsewhere, women's skills have been upgraded in sugar processing work in Ghana (Kilmer and Sussman, 1979) and in mint farming in Thailand (Black and Piyapongse, 1979, p.326).

These cases suggest that at low levels of industrial development, women workers are displaced, while at higher levels, women are recruited for cost factors, with sex-role ideologies justifying wage and working conditions.

Technology for Nonmarket Production

Although development philosophies emphasize meeting basic human needs in food, water, shelter, education and nutrition among others, development programs are still heavily geared toward increased marketed production and cash income, in which men's work is disproportionately concentrated compared to women's. Technology is introduced to reduce the costs of production, and production outside the market economy has no obvious "cost" or "value." Consequently, labor-saving technology for women's nonmarket chores has no compelling economic rationale (Palmer, 1977).

Numerous studies of agricultural programs describe how increased technology, in the form of tractors or plows which expand land under cultivation, increases the growth of weeds, a women's job

in many agricultural economies (MacCormack, 1979, Hemmings, 1979). Unless technologies are introduced simultaneously to both male and female tasks, lags will result, with adverse effects on labor contributions and human energy expended. Small-scale industries in China move private female tasks, such as clothing construction, into public production. In the process, the work acquires a public value, and saves women's time with economies of scale (Dixon, 1979, p. 25). Nevertheless, a certain level of commercialization and cash availability is necessary to develop and sustain demand for household technology. Meeting (or creating) demands for household technology would reduce women's time expenditure in household work and release them for more productive activity if simultaneous support were available for such productive activity. In industrialized, centrally planned economies, tradeoffs between investment for household and industrial technology result in lower priority accorded household technology, maintaining the heavy double workload of women, as demonstrated in Eastern European cases (Scott, 1974).

With sufficient consumer demand and recognizable costs from energy depletion, household technology development may be sustainable. A study of the Lenore cookstove, which utilizes half the firewood of conventional open fire and eliminates heavy smoke and fire hazards, has been successfully introduced in Guatemala. Deforestation and consequent fuel scarcity provided the rationale for the development and dissemination of this new cooking technology. Cookstove builders were trained in a new trade, enhancing prospects for "self-dissemination"

through viable, small-scale businesses (Edwards, 1979).

Energy: The Fuel for Technology

In discussions of energy, it is useful to distinguish between commercial (both conventional and alternative energy sources) and non-commercial sources. The rising cost of commercial energy, such as oil, and the high start-up costs of other conventional sources such as electricity, has led to increased interest in the development and utilization of renewable energy sources, such as solar power, wind, and biomass. Nevertheless, some of these renewable sources are costly relative to the cash supply of users, many of whom have other pressing cash needs and still available (though quickly depleting) noncommercial fuel sources, such as firewood. Furthermore, some devices are still at the experimental stage, and not yet cost effective for wide-scale introduction.

Governments and donor institutions can provide resources which stimulate the development of innovative, competitive, low-cost technology which utilizes renewable energy. Yet the immediate beneficiaries of such a capitalist strategy, with its "trickle-down" assumptions, suggest certain trade-offs with equity-oriented policies, unless user beneficiaries are specified or particular development problems receive concentrated focus. The rate and extent to which benefits trickle down through economically differentiated strata, or trickle over from men to women, are empirical questions.

Noncommercial energy use predominates in rural communities of developing countries. World Bank figures for Africa indicate that 91%

of the population live in rural areas, but consume only 4% of commercial energy (McDowell, 1976 , p. 15). A UNIDO report indicated that half the total energy consumed comes from noncommercial sources in developing countries, and such energy is inefficiently used (AAAS, 1979, p. 13). Alarming rates of deforestation are reported, resulting in women walking further distances and spending more time gathering an ever-dwindling fuel supply. Both a USAID report and a study in India indicate at least one person in a family of five spend full time gathering dung, firewood, and refuse (AAAS, 1979, p. 36). Much fuel use is for cooking, an almost exclusively female activity around the world. Like technology development, energy development is also justified on economic grounds. The productive use of energy is easily measured in market, commercial activities, but women are concentrated in the nonmarket sectors, and often use noncommercial energy sources. Unless noncommercial energy sources are depleted, or nonmarket activities commercialized, women may remain invisible to energy policymakers.

Whether in the form of time, energy expended, or cash, development programs must take into account costs to users and effects on equity, both between economic groups and between men and women. Biomass energy users in Tanzania were the well-off in a community, according to one study, and questions were raised about whether inequitable access is a necessary step toward generating higher demand and ensuring a future, lower cost (Roberts, 1979). The introduction of a photovoltaic solar cell in Upper Volta to power a mill motor is expected to make mill services more widely available. Older mills were power by diesel oil, and rising costs were passed to consumers, many of whom lacked sufficient cash (Hemmings, 1979).

Dissemination Mechanisms

Differential technology impact between the sexes can be traced to differential access to information. Most societies are characterized by sex-differentiated communication structures, though they vary in the extent of separateness from one society to another. Women's access to information, dissemination, and education structures will in part determine the extent to which women use new technology or the degree to which that technology is designed for the tasks women do. Studies of the largely male-disseminated agricultural technology indicate men have preferential access, disproportionately excluding the approximately one-third of rural households which are female headed (Staudt, 1978;Tinker,1976; Fortmann, 1979; Bond, 1974; Dixon, 1978). A study in Tanzania provides data which indicates that husbands unevenly and irregularly communicate agricultural information to wives (Fortmann, 1979). Gaps between the sexes in literacy rates and educational achievements are extensive, with some exceptions in Latin America and East Asia. Until dissemination systems include an entire user clientele regardless of sex, differential access will prevail.

Follow-up studies of the Lorena stove in Guatemala, previously discussed, found that stoves were cracking, a result of inappropriate sand and clay mixes and too hot a fire. Women, who do most of the cooking, do not attend the training courses, and thus, do not learn how to build stoves (which would provide a marketable skill) or to operate them directly from trainers (Edwards, 1979, p. 191). A primary failure of water projects involves maintenance and repair problems. Reforestation projects are plagued by early uprooting of trees. If women are not actively involved or do not receive training or advice on upkeep

and repair, their labor may be relieved, but skill upgrading is withheld, creating new disparities between the sexes.

II

Since the 1973 "new mandates" policies emphasizing basic human needs, Congress has directed the U.S. Agency for International Development to reorient its development strategy from a capital-intensive approach which often aggravates inequalities between the rich and poor, to a more labor-intensive approach, designed to reach the "rural poor majority." Section 113 of the Foreign Assistance Act in 1973 required that the Agency integrate women in the development process. In 1975, Section 107 of the Foreign Assistance Act authorized that AID undertake new efforts in appropriate technology, defined as technology "which makes optimum use of available resources in a given environment."* Even prior to the mandate, AID's diversified efforts in appropriate technology included agricultural equipment projects, small industry projects, low-cost housing and roofing, simple grain storage facilities, solar dryers for timber, nonformal education, village-based food processing, and programs in low cost health delivery, among others (U.S. Congress, 1976, p. 17). As a matter of policy, "special attention will be given to the role of women throughout the program," according to Congressional intent (Ibid., p. 25).

As is evident from the description of appropriate technolcgy efforts, wide boundaries are placed around what is considered appropriate technology activity, making analysis difficult and dependent on judgments

*From the Appropriate Technology International Report, 1979. The more precise definition from the Congressional proposal includes these (abbreviated) criteria: intensive use of the abundant factor labor; economic use of scarce factors, capital and highly trained personnel; and intensive use of domestically-produced inputs; small scale, but efficient; replicable: readily operated, maintained and repaired; low cost and accessible to low-income persons; compatibility with local cultural and social environments (U.S.Congress, pp. 11-12)

of programs according to definitional criteria. Like the numerous other mandates, monitoring requires considerable staff time for consistent review practices. In order to keep track of and classify Agency projects, special codes are applied to projects and stored (along with budgetary figures) in Agency computers. Appropriate Technology (ATNL)* and Energy Technologies (ENER)**are two of twenty special concerns used to code and classify projects. The definitions lend themselves to inclusion of a variety of projects. Furthermore, projects can contain ATNL or ENER components, making it difficult to assess the proportion of total project funding attributable to those activities.

Given the definition and classification uncertainties, assessing the scope of Agency commitment is problematic. According to the internal newsletter (FRONT LINES 17, 11, June 28, 1979), $80 million has been set aside in Fiscal 1979 for AID-sponsored work in finding alternative energy sources. An internal memorandum in 1979 lists 31 appropriate technology projects (defined more strictly as "equipment and implements that can be purchased and maintained by the poor for their productive enterprises) at a cost of $31 million for Fiscal 1979. Using a more expanded definition, and including agricultural programs and other labor-intensive projects among others, would alter this figure.

*"Appropriate technologies are those technologies which require low capital per worker (labor intensive), are usually efficient on a small scale, are easily serviced and maintained, do not require high levels of education or training to operate, and utilize locally available resources...The definition of capital is not limited to equipment and machinery, but also includes investments in "human capital," e.g. education, training, etc."

**"Energy technologies include renewable energy activities directed toward the earliest practicable development and use of energy technologies which are environmentally acceptable, require minimum capital investment,are most acceptable to and affordable by the people using them, are simple and inexpensive to use and maintain, and are transferable from one region of the world to another." (Both definitions are from an internal Agency memorandum.)

Even more problematic than tracing appropriate technology and renewable energy projects or components of projects is trying to trace beneficiaries of such programs, including women. Agency evaluations are often unable to document impact on beneficiary populations, due to limited baseline data collection prior to project implementation and inadequate development of measurement indicators disaggregating those populations. Evaluation indicators are rarely differentiated by sex or sex of household head. A recent perusal of internal Agency agricultural project design sources and available evaluations concluded that there was "little or no basis by which the Agency can quantify and demonstrate the extent to which women have access to project activities," as women are subsumed in the family and projects implicitly assume benefits received by male household heads are distributed equitably. The male-staffed delivery structure, emphasis on market activities and income, nearly non-existent targeting of women or of female household heads* and the visible attention to women in less than a tenth of agricultural project narratives suggested women's agricultural activities were being undermined (Staudt, 1979).

The Women in Development Congressional mandate, Section 113 of the Foreign Assistance Act, was amended by Section 108 of the International Development and Food Assistance Act in 1978 requiring that the agency spend at least $10 million on women in development as a whole each fiscal year (The Fiscal 1980 request is $1.9 billion) The AAAS workshop in preparation for the UNCSTD recommended that AID and other donors set

*if targeting occured, it set aside 15-25% of participant opportunities for women.

aside 10% of their funding for women(1979, p.10). The Congressional budget mandate and the AAAS recommendation suggest that far less than a tenth of funding is now allocated to women. Of that, technology and energy projects represent a part, but inestimable, portion.

Given the limited data availability, it is perhaps most useful to describe several technology and energy projects, along with assessments about probable or actual impact on women.

A solar energy system was installed in Upper Volta to convert sun rays to electricity in a power generator for a water pump and grinding mill. The project was explicitly designed to relieve women from pounding grain and drawing water from a deep well. The mill, after several years, appeared to accomplish project goals. Men, however, were primary utilizers of the well, for their cattle. Furthermore, transporting water from the well to homes remained a time-consuming task for women (Hemmings, 1979). An even more critical issue is the cost of solar cells, not now cost effective and therefore prohibitive for widespread adoption. Until sufficient demand is generated to promote more effective manufacturing practices and reduce costs, solar cell use is not expected to be high. AID, however, can help generate such demand (U.S.Congress, p.47).

A renewable energy project in Tunisia, not yet funded, is designed primarily for commercial use, with the primary exception of home lighting. This project illustrates the nonmarket issue, raised earlier in Section I. While home lighting should benefit women, other nonmarket activities go unaddressed. Women may indirectly benefit from commercial activities, although the long and short-term consequences of those benefits are uncertain.

A recently funded renewable energy project in Mali includes attention to potable water supply, solar energy grinders, improved wood burning stoves, vegetable and fish dryers, among other activities The social analysis done prior to project implementation raised issues about possible project outcomes for women. In the project communities, returns from women's labor are controlled by husbands. The analyst cautions that unless women derive personal material benefits, the time released from water hauling through project activities may not be reinvested in productive agricultural work. The analyst further warns that the indigenous political and status hierarchy is controlled by older men of noble lineage and by Moslem religious leaders, and is unresponsive to women, ethnic minorities, and persons of slave descent. Unless strategies are devised to learn more of women's technology needs, such needs will not be articulated by the indigenous hierarchy. No evaluations of this project are yet available.

Economic disparities between the sexes appear to be reproduced in access to and control over technology. While government policies and donor institutions have a vast capability to alter these trends, the current effort and commitment of one donor organization suggest only a marginal alteration of trends. The political structure through which economic activity flows is one with minimal female representation, and short-term economic rationales justify projects--many of which are located in the commercialized, market sectors.

Nevertheless, existing innovative projects and the strong Congressional mandates and Agency policy tools (including those which focus on women in development) may be strengthened as resource scarcity, food crises and more cost-effective technologies grow and commercialization proceeds. Attention to women could multiply as women's activities within technology and energy spheres are increasingly perceived.

III

Although we can safely conclude, from the review of existing literature, that women have differential and inequitable access to new technology, numerous gaps exist in policy-oriented research which, if filled, would provide some guidance on improving access for women. Little systematic evidence exists on the contexts in which access for women is enhanced and the dissemination of technology to women is widespread. Policy-oriented research questions are listed in several categories below.

The Broader Context

As remarked earlier, technology and crops are sex neutral, but become associated with one sex or another at stages of the development process. What dynamics explain how and why technology and crops become sex specific? How do the organization of production and level of industrialization explain choices which affect sex disparities in technology access? How do those same factors explain resource allocation to nonmarket household technology? What policy mix alters

patterns and how? What types of economies displace women workers and what types reabsorb them? How do alternative political systems, which differ in terms of women's interest expression, compare on sex disparities in technology access?

Technology: Introduction and Organization

We need studies which compare alternative introductions of technology (who controls, who disseminates, who forms the audience) for the degree to which women user needs are addressed and for the degree of sex disparities in access. Does technology introduction come from inside or outside the society, and how does this affect adoption and acceptance? How does interaction between technology users and introducers affect the success or failure of projects? How do men and women users compare in motivations for accepting technology? Are men or women trained in maintenance and repair, and why? What mix of policy incentives affects the adoption of technology by users? What factors in the social structure (i.e., sex solidarity and communication patterns; the degree of sex disparities and economic disparities) explain the speed of diffusion and acceptance in varying introduction patterns? Following the rural sociology adoption curve perspective, how does introduction through male or female "early adopters" or through women's or men's groups, affect the rate and comprehensiveness of diffusion (broken down by different functional technology areas)?

Woman-Focused

Are there legal constraints that affect women's control over technology and involvement in a dissemination system? What are the unique constraints of women migrants, women household heads, and defacto women heads in areas of heavy male out-migration?

What are women's development priorities? How do these compare with men's? Do differences between men and women explain local technological acceptance? How does women's involvement in decision making affect technology choices? Is there a threshhold at which the proportion of female participation makes a difference?

What is the long-term effect of water piped to homes, commercialized fuel, and home technology on women's economic activities outside the home? Under what conditions do women maintain nondomestic economic activities or re-enter the larger economy? What proportion of the family budget (in-kind, labor, cash) is used for household technology, and what explains differences in different settings? How can we better calculate the value of nonmarket production, including time, energy investment, output and effect on development goals? In what contexts do women place a value on their time, and how does this affect local technological acceptance?

Concluding Implications

The commercialization and monetization processes associated with development tend to undermine women's resource base (for example, secure access to land, use of comparable technology to men) and thereby exaggerate gaps between the sexes. Over time, women are disproportionately concentrated in the nonmarket sectors, and women's work tends to be devalued, a view sometimes shared by women themselves. Women's integration into the market processes (which historically have undercut women's work and its value) would begin to address growing gaps between the sexes. Yet women's domestic work and reproductive responsibilities often remain outside the market economy, raising questions about the extent to which those gaps between the sexes will be redressed. It would appear that under four conditions, those gaps could be addressed: (1) alleviating labor burdens associated with household tasks (water carrying; fuel gathering), (2) promoting greater sharing of domestic responsibilities between men and women, (3) socializing (or commercializing) household responsibilities (e.g. the communal laundry or kitchen facilities of the Kibbutz), and (4) accelerating the productivity and profitability of women's nondomestic work through special attention and programs.

Ultimately, however, those who control, benefit from, and determine the use to which technology is put and the criteria for technology application are political decisionmakers. Given women's near exclusion from formal national and international decision-making institutions (somewhat less marked at local levels), it is not surprising that women, or women's activities, have only limited prominence in technology and energy issues (Staudt, 1979). While better planning,

policymaking, and project design can begin to address sex disparities in technology access, it is only when women users make choices and determine criteria on which decisions are made that the thrust of appropropriate technology perspectives will be realized.

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