Gender-related Impacts of Improved Agricultural Technologies: Identification of Indicators from a Case Study

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'With' and 'without' technology situations were compared in relation to the package of groundnut production technology introduced by the Legumes On-farm Testing and Nursery Unit (LEGOFTEN) program of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in the late 1980s. The introduction of technology resulted in the emergence of the following indicators with strong gender implications: (a) labor and time allocation patterns, (b) decision-making behavior with regard to the resource use of crop products, and (c) differential perceptions of users, with implications for technology development.

The allocation of time to various activities, particularly by women, was significantly influenced by the introduction of the technology. The decision-making patterns indicate the gender-related segmentation of market and domestic activities; and men gaining greater control over market-related activities and women over domestic activities. Differences in perception regarding technology do exist between women and men in farm households. Women not only perceive technology in terms of its workability but also consider aspects of drudgery, while men are mostly concerned with financial viability. A research and development agenda which incorporates an analysis of gender disaggregated farmer perspectives is likely to lead to a more appropriate and acceptable technology which will gain further and wider adoption.

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It is increasingly being recognized that 'gender' is an important socio-economic variable that shapes and designs improved technologies in agriculture and traces the welfare gains derived from their adoption. However, it has remained unclear how gender-related impacts are identified and what effective indicators can be used to measure them. This article draws from the findings of a systematic analysis of gender-targeted case studies in exploring directions for the development of key gender-related indicators that can provide directions for measuring the effects and benefits of improved agricultural technologies and identifying situations where gender is a likely constraint to technology adoption and its impact.

On-farm survey results from a gender-targeted case study were used to identify and analyze key indicators of gender-related impacts of improved technologies in agriculture. Specific 'with' and 'without' technology situations were studied in the context of a groundnut production technology (GPT) package introduced to farmers in the late 1980s through the Legumes On-farm Testing and Nursery Unit (LEGOFTEN) in Maharashtra state in western India.

Background

The case study presented in this article deals with an *ex post* situation. It was conducted by ICRISAT (International Crops Research Institute for the Semi-arid Tropics), in collaboration with CRIDA (Central Research Institute for Dryland Agriculture), and Indian Council of Agricultural Research (ICAR) research center which examined a technology package developed in 1987. This was on the request of the Indian Union Ministry of Agriculture to ICRISAT to help in their transfer of technology program for increasing the production of legumes in India. ICRISAT's response was the establishment of LEGOFTEN. ICRISAT acted as a catalyst in the transfer of technology, while extension work was done by Indian national programs including ICAR, agricultural universities, state departments of agriculture and agricultural development agencies (LEGOFTEN, 1987, 1991).

The first phase of the LEGOFTEN program entailed the development and extension of a package of groundnut production technology (GPT) suitable for the irrigated summer groundnut crop. Under the LEGOFTEN initiative, the technology options advocated for groundnut production for the region consisted of various components covering

improved varieties and an improved package of practices. The comprehensive package included technology options and recommendations about land preparation, dosages of manure and fertilizers, seed rate, seed treatment, plant spacing, weed control, pest and disease control, irrigation and harvesting.

A major recommendation in land preparation was the shaping of land, after tillage, into a raised-bed system. In particular, the broad-bed system was recommended for growing crops with sprinkler irrigation. Improved varieties were also recommended under the program, including cultivars developed at ICRISAT, which were either released or likely to be identified for release for cultivation in India. Detailed explanations and justifications (see LEGOFTEN, 1987, 1991) were offered for each recommended technology option.

The initial adoption of this technology in parts of Maharashtra resulted in substantial gains in groundnut yield and positive employment effects. The successes of the technology in certain villages of Maharashtra were identified, and provided an ideal case study for an in-depth analysis of consequences resulting from technology adoption (Kolli and Padmaja, 1996: p. 3).

Methodology

The analysis of gender-differentiated impacts follows the dynamics that emerge within and among farm households after technology intervention. It is hypothesized that the introduction of new technology affects different members of the households in varying ways, and these consequences are empirically verifiable. Evidence based on two village-level studies is examined to clarify as well as draw implications for appropriate technology design from the differences in the roles, access and benefits among men and women.

Two surveys specifically targeted for gender analysis are used in this study. These were designed to compare 'with' and 'without' technology situations and to analyze changes in intrahousehold relationships as a result of the adoption of improved technology options.

Two villages, Umra and Karanji, within Kinwat taluk of Nanded district in Maharashtra were selected for qualitative and quantitative surveys conducted during the period 1992–94 (for details see Kolli and Padmaja, 1996: p. 4). Umra represented the 'with' technology situation, where the GPT package was taken up successfully by

groundnut-producing farm households. Karanji, on the other hand, represented the 'without' technology situation, where GPT technology diffusion had not taken place. These two villages were carefully selected after considering their socio-economic characteristics, agro-climatic environment and cropping patterns (Figure 1).[1]

Figure 1
Village Profiles: Umra and Karanji, 1991–92

Characteristics	*Umra*	*Karanji*
Percentage of households to total number of households		
Farm households	54	51
Agricultural labor households	39	33
Others	7	16
Total	100	100
Percentage of farm households growing groundnut in summer	37	20
Soil type	Black to deep black	Medium to deep black
Annual rainfall (at taluka level) in mm	817	817
Sources of irrigation	Well	Well
Major crops grown	Cotton, sorghum (HYV), groundnut, pigeon pea, wheat	Cotton, sorghum (HYV), groundnut, pigeon pea, paddy, wheat
Major sources of income	Crops, wage labor, livestock, trade and others	Crops, wage labor, livestock, trade and others

Source: Data for Figures 1 and 2 is from Gender Analysis of SAT Technologies Census Surveys.

Note: HYV is high-yielding variety.

A sample of 26 farm households was randomly chosen from each village. These two samples were drawn from farm households that own or hire land for cultivation. Household census surveys were first conducted for both the villages in order to obtain a list of households growing groundnut and a list of those that have adopted improved technology. A similar sampling frame was developed for Karanji (without technology), where households cultivating groundnut since 1987 were enumerated. An additional sample was drawn from the population of agricultural wage laborer households from the two

villages (15 from Umra, 21 from Karanji) to analyze the employment patterns that may have changed as a result of technology adoption (see Figure 2).

Figure 2

Village Characteristics and Sample Size: Umra and Karanji, 1991–92

Characteristics	*Umra*	*Karanji*
Farm households	54 (92)	51 (143)
Agricultural labor households	39 (66)	33 (93)
Others	7 (12)	16 (45)
Total	100 (170)	100 (281)
Farm households growing groundnut	48 (44)	27 (39)
Farm households growing groundnut in summer	37 (34)	20 (29)
Groundnut-growing households adopting LEGOFTEN groundnut technology	91 (31)	–
Groundnut-growing farm households adopting LEGOFTEN groundnut technology selected as a sample	59 (26)	–
Groundnut-growing households not adopting LEGOFTEN groundnut technology selected as a sample	–	66 (26)
Labor households selected as a sample	23 (15)	23 (21)

Note: Figures in brackets indicate the number of households.

Gender-related Impacts of the Adoption of GPT

Farm Household Activity Pattern

The activity pattern of men and women in groundnut crop production (see Figure 3) shows cooperation among men and women in certain activities, but a large amount of specialization in all other activities.

Cooperation is noted in activities like transportation of organic manure in the village of Umra and field cleaning and clod crushing during land preparation, sowing and harvesting in the village of Karanji. Task specialization was also observed, where men were found to be concentrated in activities like ploughing and harrowing, soil-bed preparation, application of organic manure, seed treatment, irrigation, intercultivation, purchase of inputs, micronutrient application, spraying of pesticides, packing and transport, collection, stacking and

Figure 3

Activity Pattern of Summer Groundnut Crop Production: Umra and Karanji, 1991–92

Major Activities	*Sub-activities*	*Umra*				*Karanji*			
		Percent of Households which Reported Participation by:				*Percent of Households which Reported Participation by:*			
		Males	*Females*	*Joint*	*Total*	*Males*	*Females*	*Joint*	*Total*
Land preparation	Field cleaning	–	100	–	100	4	64	32	100
	Clod crushing	12	7	81	100	11	–	89	100
	Ploughing	100	–	–	100	100	–	–	100
	Harrowing	100	–	–	100	100	–	–	100
Soil preparation	Preparation of broad-bed and furrow/ridges and furrow	100	–	–	100	100	–	–	100
Transportation and application of manure/fertilizer	Transportation of organic manure	–	–	100	100	–	–	–	–
	Application of organic manure	100	–	–	100	100	–	–	100
	Chemical fertilizer (basal)	38	58	4	100	91	–	9	100
	Chemical fertilizer (top dressing)	4	96	–	100	15	85	–	100
Seed treatment and sowing operations	Seed treatment	100	–	–	100	100	–	–	100
	Sowing/dibbling	–	100	–	100	–	90	10	100
	Seed drill	–	–	–	–	20	40	40	100

Irrigation	Irrigation (sprinkler/ traditional method)	100	–	–	100	96	–	4	100
Intercultiv tion and hand w: ding	Intercultivation	–	–	–	–	100	–	–	100
	Hand weeding	–	96	4	100	–	100	–	100
Plant prot ction	Application of gypsum	40	60	–	100	–	–	–	–
	Application of micronutrients	100	–	–	100	–	–	–	–
	Spraying of pesticides	100	–	–	100	100	–	–	100
Harvestin groundnut	Pulling/uprooting of groundnut plants	–	92	8	100	–	60	40	100
	Stripping pods from plants	–	100	–	100	–	96	4	100
	Drying/cleaning pods	84	8	8	100	50	20	30	100
Transport and marketing	Packing and transport	96	4	–	100	100	–	–	100
	Marketing	100	–	–	100	100	–	–	100
	Purchasing inputs	–	–	–	–	100	–	–	100
	Transport of fodder	100	–	–	100	100	–	–	100
Collection, stacking and storage of groundnut fodder	Fodder collection from field	100	–	–	100	96	–	4	100
	Stacking fodder	100	–	–	100	100	–	–	100
Storage and processing of groundnut	Shelling pods and sorting kernels for seed	–	100	–	100	–	100	–	100

Source: Based on Gender Analysis of SAT Technologies Qualitative Surveys (1991–92).

transport of fodder and marketing. Women were seen to be primarily responsible for field cleaning, top dressing of chemical fertilizer, sowing by dibbling, hand weeding, harvesting, shelling pods and sorting kernels for seeds.

A scrutiny of the labor allocation pattern suggests some logic guiding the division of labor between genders in groundnut production. The activity pattern indicates that men performed activities which required the use of agricultural tools and equipment. Activities by women are performed by hand, or with the use of small hand tools like hand hoes or sickles. The reasoning behind task specialization is that men perform heavier jobs while women perform lighter jobs which may not require any tools (Kolli, 1990; World Bank, 1989). Furthermore, equipment has been designed and commercialized for the more demanding tasks men do. It is noted, however, that the tasks women perform are back-bending and time-consuming, that is, they need patience that women usually have. Hand sowing and the manual shelling of groundnut are some examples.

While division of labor is, by and large, observed in Umra (the 'with' technology village) and Karanji (the 'without' technology village), sharper differences or a more clear-cut 'task specificity' were noted between male and female activities in the latter case. The women in Umra reported a higher percentage of participation in field cleaning, fertilizer application and sowing by hand dibbling. The basal application of chemical fertilizers and gypsum application tended to be women-based activities after the adoption of GPT technology in the village. Gypsum application is a new activity created by the new technology, where women in almost 60 percent of the farm households in Umra have taken up the task.

Interesting changes were noted for harvesting activities. While the women in Karanji continued their traditional responsibility in all harvesting activities—pulling/uprooting of plants, stripping pods from plants and drying/cleaning pods—Umra womenfolk concentrated on the first two tasks while men helped in pod drying and cleaning activities. This change may have evolved due to the increase in demand for harvesting labor brought about by the significant yield gains of GPT (see Figure 4).

Gender roles remained more or less the same with the adoption of GPT technology. The new activities required were essentially divided or assigned to specific genders according to old principles, that is, supposedly heavier tasks for men and lighter tasks for women.[2] As a

Figure 4

Variety-wise Average Yield from the Summer Groundnut Crop, 1992–93

Umra		*Karanji*	
Variety	*Yield*	*Variety*	*Yield*
Improved technologies in production		*NARS/local varieties available to farmers*	
ICGS 11	7.13	SB 11	3.73
ICGS 21	8.34	Local varieties	4.30
ICGS 76	7.34		
Mean yield	7.60	Mean yield	3.51
NARS variety available before technology introduction			
SB 11	2.70		

Source: The data for Figures 4–8 and 11–12 is based on Gender Analysis of SAT Technologies Quantitative Surveys (1992–93).

Note: Yield gain due to improved varieties in groundnut production technology package:
Within the village: 490 kg/acre
Between villages: 409 kg/acre
Figures are in quintals per acre.
NARS = National Agriculture Research System.

result, tasks such as gypsum application, hand dibbling and application of chemical fertilizers went to women, while preparation of broad beds and furrows and sprinkler irrigation systems were assigned to men. Tasks tended to become gender-based. This is evident from the fact that only six activities in Umra were reported as 'joint' activities while 10 activities continued to be undertaken jointly in Karanji.

Important implications emerge from the foregoing analysis. For one, the adoption of new technologies may enhance 'task specialization' (Kolli, 1990), where activities are performed exclusively by a particular gender in order to optimize available farm household labor resources.[3] Umra women were found to participate exclusively in 12 out of 28 activities while Karanji women reported exclusive participation only in nine activities. The new technology gave Umra womenfolk added primary responsibilities for basal chemical fertilizer application and the application of gypsum for plant protection. It was further observed that activities jointly undertaken by males and females in Karanji (10 of them) were significantly more than the number of joint activities in Umra (six of them). Joint activities performed by Karanji farm households (like field cleaning and sowing)

were noted to be exclusively performed by women in Umra. The increasing tendency to specialize clearly identifies potential changes in gender roles and an appropriate consideration of these changes in technology design and development is necessary.

Another finding from the analysis is that technology development may be bypassing tasks performed by women. This matter initially came up during informal discussions with women farmers in Umra (Kolli, field notes). Hand dibbling and manual shelling of groundnuts were repeatedly described as tedious by the women, and called for improved technologies/equipment specially designed to lessen the drudgery in performing these activities. A summary of this observation from the survey is presented in Figure 13. Technology options addressing aspects of drudgery were obviously not considered while designing technology options for the GPT package.

Time Allocation for Crop Production

A comparison of the number of hours per acre for groundnut crop production in Umra and Karanji villages is given in Figures 5 and 6.

Figure 5
Use of Male and Female Labor Time: Summer Groundnut Crop Activities, 1992–93 (Village-wise)

Family Labor	*Umra*		*Karanji*	
	Hours/Acre	*% to Total*	*Hours/Acre*	*% to Total*
Male	311.43	68	285.05	69
Female	143.38	32	126.42	31
Total	454.81	100	411.47	100

Figure 6
Use of Male and Female Labor Time: Summer Groundnut Crop Activities, 1992–93 (Across Villages)

Village	*Family Male Labor*		*Family Female Labor*	
	Hours/Acre	*% to Total*	*Hours/Acre*	*% to Total*
Umra	311.43	52	143.38	53
Karanji	285.05	48	126.42	47
Total	596.48	100	269.80	100

Figure 5 shows the time spent by men and women in groundnut production within each village, illustrating the differences in total labor allocation for groundnut production among the two villages. Figure 6, on the other hand, points out the gender differences in labor allocation between the two villages. This figure is drawn mainly to highlight the fact that Umra women spent much more time than Karanji women in groundnut production. The adoption of recommended GPT technology options in Umra may have increased labor requirements by more than 42 hours for the entire summer crop: about 26 hours increase in labor requirement for male labor and 16 hours increase for female labor.

Operation-wise, labor time allocation shows that the demand for men increased significantly for transport, the application of organic manure and spraying pesticides/chemicals. Female labor demand is significantly higher for certain operations (i.e., shelling pods and sorting kernels for seeds) (see Figure 7). These changes, which reflect a

Figure 7

Two-tailed t Test on the Mean Time Spent (Per Acre): Summer Groundnut Crop Activities, Umra, 1992–93

Criterion	*Activity*	*Sex/Village*	*t. Value*	*D.F.*	*Level of Significance*
Family labor: village differences (activities disaggregated into specific tasks)	Transport of organic manure/ tank silt	Male (Umra) (K2.42, U8.54)	2.11	42	*
	Application of organic manure/ tank silt	Male (Umra) (K1.14, U3.06)	2.18	42	*
	Spraying chemicals/ pesticides	Male (Umra) (K3.10, U9.93)	2.52	42	*
	Shelling pods	Female (Umra) (K3.10, U16.43)	3.41	42	**
	Sorting kernels for seed	Female (Umra) (K0.76, U6.45)	2.54	42	*

Note: Figures in brackets indicate the mean values for Karanji (K) and Umra (U). D.F. = degrees of freedom; * = significant at 5% level; ** = significant at 1% level.

Grouped activities were disaggregated into specific tasks for carrying out the tests (e.g., plant protection, including application of gypsum; application of micronutrients; spraying of pesticides/chemicals and crop watching).

one-crop situation, have important implications for farm households that have to reallocate their time from other activities during the season. For the rest of the operations, there was a marginal change of male and female labor time allocation, which has remained broadly in line with the traditional activity pattern.

Use of Hired Labor

Hired female labor constitutes an important component of groundnut production in both Umra and Karanji. It comprises the highest component among the different types of labor defined in Figure 8 (i.e., 40 percent in Umra and 37 percent in Karanji). The adoption of GPT technology induced a significant increase in the importance of hired labor—especially female hired labor—in Umra. Drawing a comparison of the 'with' technology and 'without' technology villages, a significant difference in female hired labor requirement is indicated (397 hours per acre in Umra versus 328 hours in Karanji).

Figure 8

Use of Male and Female Labor Time: Summer Groundnut Crop Activities, 1992–93

Labor	*Umra*		*Karanji*	
	Hours/Acre	*% to Total*	*Hours/Acre*	*% to Total*
Family				
Male	311.43	31.58	285.05	32.59
Female	143.38	14.54	126.42	14.46
Hired				
Male	134.78	13.67	135.35	15.48
Female	396.69	40.22	327.75	37.48
Total	986.30	100.00	874.57	100.00

Application of chemical fertilizers, hand sowing, application of gypsum, micro nutrients, harvesting operations and shelling of groundnut are operations for which female-hired labor hours in Umra were found to be higher. A comparison of this pattern with the activity pattern of women family labor indicates that the requirement for hired women increased for exactly those operations for which female family labor use increased. This, once again, proves the significance of gender specificity in performing certain activities. Female hired labor was found to be complementary to female family labor. This complementarity was found to help female family labor to compensate for

the extra labor required for GPT adoption with hired labor. The use of male hired labor remained more or less the same in both villages.

A rapid appraisal of a sample of labor households in Umra indicated that 20 percent of female laborers in the village are absorbed in groundnut crop employment within the village. In comparison, female laborers of Karanji found only 13 percent of their employment in groundnut crop activities. More men from labor households were also absorbed in groundnut production in Umra than in Karanji, although in lesser proportions (see Figures 9 and 10).

The wage rates for women in groundnut crop activities were noted to be more or less similar in both villages. Wages paid to women hired labor for groundnut activities were also noted to be higher than wages paid for other crop activities.

Figure 9

Employment and Wages of Family Members in Labor Households, Karanji, 1991–92

Activity	*Male Members*		*Female Members*	
	Total Working Days	*Average Wage/Day (Rs)*	*Total Working Days*	*Average Wage/Day (Rs)*
In the village				
Groundnut crop activities	55	16.60	687	8.60
	(1)		(13)	
Other crop activities	1,186	17.00	4,297	6.66
	(19)		(80)	
Other activities	2,255	10.76	233	11.10
	(36)		(4)	
Outside the village				
Groundnut crop activities	6	25.00	–	–
	(0.10)			
Other crop activities	297	16.35	146	7.42
	(5)		(3)	
Other activities	2,433	25.12	32	13.00
	(39)		(1)	
Total	6,232		5,395	

Source: Figures 9 and 10 are based on Gender Analysis of SAT Technologies Employment and Wage Surveys, 1991–92.

Note: Figures in brackets indicate percentage of total working days.

Other activities include well-digging, fencing, construction work, grazing animals, road work, hotel work, cutting and selling firewood, housework, helping in shops, and catching fish.

Figure 10
Employment and Wages of Family Members in Labor Households, Umra, 1991–92

Activity	Male Members		Female Members	
	Total Working Days	Average Wage/Day (Rs)	Total Working Days	Average Wage/Day (Rs)
In the village				
Groundnut crop activities	125 (2)	13.85	884 (20)	8.44
Other crop activities	622 (12)	12.40	3,068 (68)	7.42
Other activities	4,523 (84)	10.50	373 (8)	11.16
Outside the village				
Groundnut crop activities	–	–	–	–
Other crop activities	–	–	–	–
Other activities	120 (2)	25.83	180 (4)	10.10
Total	5,390		4,505	

Note: Figures in brackets indicate percentage of total working days.
Other activities include well-digging, fencing, construction work, grazing animals, road work, hotel work, cutting and selling firewood, housework, helping in shops, and catching fish.

For men, the wage rates in Umra were less than in Karanji. The responses revealed that the wage rate in Karanji was historically higher than the male wage rate in Umra. Men in Karanji had opportunities to find employment outside the village. Hence, they drew higher wages from other different demanded activities.[4]

Interviews with wage laborers in Umra revealed an overall appreciation for GPT in two respects. First, both men and women felt that the adoption of the technology package had generated more employment within the village. Second, women stated that they also got higher wages, compared to their situation prior to technology adoption (Kolli, field notes).

The positive response to GPT with respect to increased labor employment was balanced with other consequences of the use of technology options. In particular, women from farm households indicated that although they appreciated the remunerative returns of the new technology, they looked forward to further interventions that could help mitigate the extra burden that this technology imposed on them.

For example, hand dibbling and manual shelling were two activities which they found particularly 'tedious.' According to them, though they could substitute some of the labor requirement with either hired labor or by diverting their own labor from other activities, they still felt that this technology had imposed an extra workload on them per se. This suggests that specific technologies, including appropriate tools and implements, are required for taking care of women's needs.

Non-labor Resource Allocation

The adoption of GPT created a demand for new seeds, micronutrients, gypsum, sprinkler sets, chemicals for seed treatment, and so on, along with changes in land preparation, sowing, crop protection and irrigation methods. The responses from the surveys brought out interesting aspects of decision-making with respect to resource/input use within the households.

Decision-making behavior was examined by calculating the percentage of men and women involved in deciding various aspects of household decisions. Measurement was facilitated by asking household members whether a particular decision was made individually or jointly.

The decision-making behavior of households reflected intrahousehold gender relations. A comparison of the decision-making behavior of the households in 'with' and 'without' technology situations gave an interesting indication of possible change in gender relations with technology adoption, or how men and women in farm households decide about resource re-allocation to facilitate the adoption of groundnut production technology (Kolli, 1996: pp. 7–8).

One striking observation with respect to decision-making on resource use (i.e., cash, credit, fertilizers and chemicals) is that women generally do not have exclusive decision-making power in both village situations (see Figure 11)—that is, men generally take more exclusive decisions with respect to resource use. For example, exclusive decisions were made by 63 percent of the men in Umra while, in Karanji, men made exclusive decisions in 47 percent of the situations.

Another interesting observation is that the men and women in Karanji jointly decide on their resource allocation in 53 percent of the situations while only 36 percent of the Umra households decide jointly. More exclusive decisions were made by men in Umra with respect to special chemicals, farmyard manure, pesticides, sprinkler sets, and tools and implements. The highest percentage (73 percent)

Figure 11
Decision-making on Resources Required for Groundnut Production, Umra and Karanji, 1992–93

Resources Required	*Decisions Made (Umra)*			*Decisions Made (Karanji)*		
	Exclusively Male	*Exclusively Female*	*Joint Decisions*	*Exclusively Male*	*Exclusively Female*	*Joint Decisions*
Cash	50	0	50	77	0	23
Credit	27	0	73	0	0	100
Seed	45	0	55	42	0	58
Farmyard manure	75	0	25	27	0	73
Special chemicals (gypsum/ micro-nutrients)	86	0	14	–	–	–
Pesticides	76	4	20	73	0	27
Sprinkler sets	53	0	47	–	–	–
Tools and implements	81	0	19	50	0	50
Total (%)	63.22	0.44	36.33	47.43	0	52.57

Note: Exclusively male = decisions taken exclusively by male members of the household.
Exclusively female = decisions taken exclusively by female members of the household.
Joint decisions = decisions taken by women along with male members of the household.
Figures are percentages.

of joint decisions was reported for credit, which is considered an important resource for technology adoption in Umra. A 100 percent joint decision was reported among the men and women in Karanji. This suggests that as improved technology creates a greater demand for market-related activities, men maintain or increase their control over these activities by virtue of traditional assignments of market-oriented activities. In a way, the adoption of GPT contributed to reinforcing stereotyped gender roles and, in the process, reduced the control of women over resource use.

The Distribution of Benefits

Ideally, the adoption of new technology options improves the welfare of farm households as they realize higher incomes than what they

have been getting from existing production technologies. Furthermore, 'equity' considerations also dictate that households will be better off if the intrahousehold distribution of benefits is effected in such a way that no one member of the household is left worse off in the process.

The distribution of welfare gains among members of the farm household may be examined by referring to information on who makes decisions regarding crop products and their use.

Distinct decision-making differences with respect to crop utilization are noted among the men and women of Umra and Karanji. First, more extensive joint decisions are made regarding the utilization of the main product in Umra than in Karanji. Specifically, the decision to save pods as seeds has become a shared decision in Umra while it is exclusively a male decision in the households of Karanji (see Figure 12). This increased share in decision-making may directly relate to increased product output due to the use of improved technologies and women's major responsibility of shelling pods after harvest.

Second, the women in Umra tended to make more exclusive decisions (45 percent for the main products and 30 percent for the by-products) while the women in Karanji made exclusive decisions only for 27 percent of the activities concerning the utilization of the main products and none for the by-products. Women apparently gained control over the use of certain products of the crop like the use of main products (pods and oil) for home consumption, and the use of by-products as fodder and fuel.

Clearly, higher yields resulting from the adoption of GPT options allowed the households in Umra to diversify the use of the products of the groundnut crop. In this process, women gained control over those products which were retained for household use. Though this is a definite gain for the women of Umra, as compared to the Karanji women, one has to note that the quantity set aside for sale in the market was more than 80 percent of the total main product. Considering the significant volume of the product marketed, men tended to maintain control over a considerable portion of the value of the crop.

These observations indicate that as technology interventions are likely to convert traditional farming systems into more entrepreneurial systems, it becomes important to examine more closely the balance of efficiency and equity implications on the benefits derived by each member of the farm household.

Figure 12

Decision-making on the Benefits Obtained from the Groundnut Crop, Umra and Karanji, 1992–93

Resources Required	*Decisions Made (Umra)*				*Decisions Made (Karanji)*			
	Quantity (%)	*Exclusively Male*	*Exclusively Female*	*Joint Decisions*	*Quantity (%)*	*Exclusively Male*	*Exclusively Female*	*Joint Decisions*
Main Products								
Sold as pods (market/seeds)	82.3	32	0	68	89.90	39	0	61
Pods for home consumption	4.41	5	77	18	3.75	14	50	36
Pods saved as seed	5.74	11	32	57	0.79	100	0	0
Oil for home consumption	5.91	0	69	31	4.23	10	60	30
Total %	**	12	45	43	**	41	27	32
By-products								
Fodder for cattle	77.95	70	0	30	75.25	69	0	31
Used in manure pit	14.97	60	20	20	4.23	50	0	50
Sold as fodder	6.86	50	0	50	18.72	71	0	29
Used as fuel	0.21	0	100	0	0	*	*	*
Total %	**	45	30	25	**	63	0	37

Note: Exclusively male = decisions taken exclusively by male members of the household.
Exclusively female = decisions taken exclusively by female members of the household.
Joint decisions = decisions taken by women along with male members of the household.
* = not used as fuel, so not computed.
** total percentage may not add up to 100 as the residual percentage of the product was used for other purposes, like gifts, for which decision-making was not reported. Hence it is not included in the figure.
Figures are percentages.

Perception of Benefits and Constraints

GPT technology was introduced as a package of high-yielding groundnut varieties and recommendations for crop management practices. The farm-level consequences of the use of this comprehensive package is usually measured by yield gains, increased income, input saving or reduction in unit cost (Bantilan, 1996a: pp. 32–34). Important data on welfare gains, added in this study, is the 'gender perspective' information of benefits and constraints.

Figure 13 provides a summary of the perceptions/reactions to the technology package by both men and women members of the farm households.

Both genders were found to be in agreement on specific desirable traits of the components of GPT. The perceptions that are distinct to

Figure 13
Summary of Perceptions of Men and Women on Groundnut Production Technologies, Umra

Common Perceptions of Men and Women about the Groundnut Technology Package	*Perceptions of Men only about the Traits of the Groundnut Technology Package*	*Perceptions of Women only about the Traits of the Groundnut Technology Package*
1. Crop yields	1. Kernel yield	1. Ease at shelling
2. Taste	2. Percentage of hollow pods	2. Ease at uprooting
3. Oil yields	3. Shelling percentage	3. Ease at weeding
4. Seed requirements	4. Taste of fodder	4. Ease at harvesting
5. Plant population	5. Small leaf size	5. Big pod size
6. Germination	6. Fertilizer management	6. Tediousness
7. Crop duration	7. Cost of cultivation	7. Drudgery
8. Disease resistance	8. Seed recycling	8. Task hazards
9. Water management	9. Cash and manpower requirements	9. Weak stem
10. Irrigation potential	10. Extra care for seed management	10. Post-harvest drying time
11. Pod formation		11. Additional burden
12. Fodder yield		12. Women employment
13. Soil conditions		13. Irrigation (sprinklers) (*a*) ease at handling (*b*) dislodging of pests and eggs reduces crop damage
14. Capital requirement		
15. Labor requirement		

Source: Based on Gender Analysis of SAT Technologies Qualitative and Quantitative Surveys, 1991–92 and 1992–93.

'gender' are highlighted, and explanations for the criteria for the different perceptions are provided. Responses from men revealed perceptions of increased household income after technology adoption. Women, on other hand, had concerns about the merits and practical difficulties with the adoption of technology. It also revealed their levels of comprehension and understanding of the processes of technology development.

The summary of the perceptions of men and women on GPT clearly shows that men's concerns were founded on issues related to the economic viability of the package. These include kernel yield, shelling percentage, percentage of hollow pods and cost of cultivation. Women, on the other hand, emphasized the workability of the technology, including physical feasibility and drudgery. In essence, their evaluation revealed the importance of the following criteria: ease at shelling, ease at weeding, weak stem, employment prospects, tediousness and task hazards.

From the point of view of the distribution of welfare gains, the perceptions of men and women with regard to what they gained from technology adoption will add another dimension to impact apart from pure monetary considerations. This dimension is viewed from whether men and women members are compensated well for the extra efforts they have put in to facilitate the adoption of technology options. To achieve this objective, it was decided to record the perceptions of men and women of the households regarding their hypothetical share in the household income as a compensation for their greater efforts in technology adoption. These perceptions were obtained from both the 'with' and 'without' technology situations. Men and women from Umra claimed a 50 percent share each; Karanji men claimed 42 percent while women claimed a 58 percent share of the income from groundnut production (Kolli, field notes). Though their labor hours increased, the women in Umra claimed a smaller share than the Karanji women. Their assessments were based on their labor allocation, and share in decision-making power with respect to resource use and crop utilization. This shows that women did not personally feel that they had gained more than men. It shows that women are not worse off after technology intervention.

Summary and Conclusions

As mentioned at the outset, this article illustrates the gender-related consequences of the adoption of a technology package on intra-

household labor activity patterns, decision-making and the distribution of benefits. It uses a mix of gender-differentiated quantitative and qualitative information, which holistically captures the effects of technology intervention in terms of efficiency and its equity consequences.

An important finding of this study is that gender-related differential effects stem from culturally-defined labor specialization among men and women. In other words, traditional tasks guided by the principle that 'men do heavier jobs and women do lighter jobs' have varying consequences for decision-making power, labor and household resource use and product utilization.

The analysis of intra-household labor allocation clearly indicates who did what after technology intervention. It also indicates the employment prospects of the new technology. The contrasting picture of two categories of women—women farmers and women wage laborers—where the former's workload has increased while the latter's employment prospects have increased, is notable. The new activity patterns after adoption suggest that technology intervention may have strengthened the 'task specificity' of genders, which are consistent with a conventional division of labor. This raises the issue of whether stereotyped gender roles are desirable and/or should be maintained in line with the goal of satisfying each household member's strategic needs in agriculture (Moser, 1989: p. 1799).

The gains from the adoption of new technology options were viewed differently by men and women. Men were mostly concerned with financial viability while women were found to perceive the advantage of the new technology options in terms of workability and implications for drudgery and occupational hazards as well.

The analysis of decision-making patterns in the context of the two Maharashtra village cultures indicates that gender roles are segmented into market and domestic activities, where men gain greater control over market-related activities and women over the domestic realm.

The findings of this study suggest that the achievement of men's and women's effective involvement in agriculture calls for a more se-

the farming community. User-oriented perspectives are an important feedback for the design and development of technology options, which supposedly target wider acceptability/adoption as well as the

achievement of enhanced welfare gains to each member of the farming community.

NOTES

1. 'With' and 'without' technology situations described in the article refer to *ex post* and *ex ante* technology situations. The characteristics of these two villages were considered to be homogeneous, as in many ways they are similar (as evident from Figures 1 and 2). It was practically impossible to find closer similarities than this case, as our field experience proved. Finding 'with' and 'without' technology situations in Umra village (technology adoption was 90 percent and most suitable for study) was not possible as almost all the groundnut farmers of the village had adopted this technology at some point of time.
2. While we do not deny the fact that wage differentials could be one of the factors that led to a gender division of labor (which was empirically proved by many), we find that the old principle (heavier tasks–lighter tasks) contributes to perpetuating this division. New technology certainly created new tasks, which could easily fit into the old pattern: tasks without tools and tedious tasks went to women and tasks which required tools/equipment went to men.
3. The assumption here is that households first consider using their own labor, to a point, beyond which they consider using hired help. The analysis shows that the households by and large distributed their labor on the basis of a traditional division of labor. But this does not mean that this optimization is done at a desirable level nor can it confirm that women had a choice in selecting their activities. Discussions with women revealed that they had to take up tasks on the lines on which tasks were allocated traditionally. The optimization process may carry gender biases but it may not prevent households from stopping short of optimization. The wage differentials between genders simply reinforces the rationale for a gender-based division of labor.
4. It is possible that neighboring villages like Umra and Karanji can also have slight variations in employment opportunities. Figures 9 and 10 reflect these small differences, which could have been the basis for wage differentials. However, we do not think these differences contributed to changes in the pattern of 'gender division of labor,' though it can make a difference in the quantum of employment in crop production. For the purpose of study, comparisons between the gender division of labor were drawn only from groundnut crop production in both the villages, while isolating the other factors. Other factors were considered mainly to explain the wage differentials between the villages rather than the gender division of labor.

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