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Women in post-harvest operations: reducing the drudgery

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Traditional, manual food processing and preparation activities are widespread in developing countries. These processes are time-consuming, repetitive and arduous, and are principally carried out by women, sometimes with the assistance of children. This paper provides an overview of the nature and extent of these activities. It reviews experience in interventions and technology intended to reduce the drudgery.

Conclusions and research needs

Women in developing countries spend large amounts of time and energy in poorly remunerated, repetitive crop handling and food processing activities. Despite this, research focused on reducing the drudgery *per se* is inappropriate – rather, a focus on improving women's productivity is more pertinent.

- Reducing drudgery *per se* is not necessarily what women want. Saving energy is often considered more important than saving time.
- It is essential that all technology development is participatory, involving the end users in identification of the problem and a workable solution.
- A key issue in developing different technology for small holders is to design sufficiently low-cost, low volume technology. For all technical solutions, the associated cost may preclude its suitability and use.
- In some cases a drudgery-reducing technology may have an unintended and negative impact if it eliminates an important source of income for poor women.
- Urbanisation trends create opportunities for small-scale processing and improved productivity for poor women.

Post-harvest operations and drudgery

Three qualities define drudgery: time-consuming, repetitive and arduous. Post-harvest operations, including threshing and winnowing, primary processing, preparation of food and processed products, marketing, and load-carrying (where this relates to processing or marketing) are all drudgery. This paper does not seek to measure drudgery *per se*. Rather it describes the tasks (in broad terms) and identifies those that are important.

Manual post-harvest activities

The major staple crops, maize, paddy, sorghum, millet and cassava constitute a group of core crops, for which production and manual processing is significant. Manual processing of maize and paddy is likely to remain important to large numbers of women in Africa and South Asia for the foreseeable future. Production of both crops is increasing. Maize is still the only significant crop for which high-yielding varieties (HYVs) have been introduced in Africa, and rice production, although no longer increasing at the rate it did in the 1970s, is still growing in upland Asia and parts of Africa. Sorghum and millet are also important manually-processed crops in marginal areas in Africa (and in some parts of India). Traditional methods of cassava processing are widespread in Africa – and again, this is a crop that is important in marginal areas. Manual shelling of groundnuts is important in both continents. Another important activity is load-carrying – which is both arduous and time-consuming. Its post-harvest significance relates to: collection of wood fuel and water used in food processing and preparation; and taking crops or processed products to market. Milling and de-

hulling, and load-bearing activities score high on use of both time and energy (Boxes 1 and 2).

Box 1: Rural activities, comparison of time allocation by sex, Burkina Faso		
	Average time allocated to each activity in minutes	
	Women	Men
A. Production, supply, distribution	**367**	**202**
Food and cash crop production		
1. Sowing	69	4
2. weeding, tilling	35	108
3. harvesting	39	6
4. travel between fields	30	19
5. gathering wild crops	4	2
6. other crop production activities	1	47
Domestic food storage	4	1
Food processing		
1. grinding, pounding grain	108	
2. winnowing	8	
3. threshing	4	
4. other processing activities	12	10
Animal husbandry	4	3
Marketing	4	
Brewing	1	
Water supply	38	
Fuel supply	6	2
B. Crafts and other professions	**45**	**156**
C. Community	**27**	**35**
D. Household	**138**	**4**
E. Personal needs	158	269
F. Free time	77	118
Total work A+B+C+D	***577***	***397***

Source: Carr and Sandhu, 1988

Rural women often work a 16-hour day, trying to balance competing demands in agricultural production, household-focused activities and income generation. Women themselves often put a higher premium on saving energy, than saving time (they often prefer custom-milling despite the time taken to walk to, and wait at the mill, for instance).

The most widespread **energy-using** post-harvest activities are:

- milling and dehulling;
- walking with loads, especially where there is a gradient (fuel wood and water for processing, taking grain to mills, marketing);
- some oilseed processing activities (e.g. coconut and palm oil processing).

The most widespread **time-using** post-harvest activities are:

- walking;
- waiting (mills, water pumps, marketing);
- manual milling, pounding;
- selected income generating activities (eg oil processing, brewing).

What influences the involvement of rural women in manual processing activities?

Agricultural production patterns are important – since they affect the timing of peak labour demands and the nature of the tasks involved. For example, rainy season demands on women's labour in West Africa mean that some women forego income-generating sheanut processing activities, for want of sufficient time. Instead they sell the nuts raw. Where a new crop is introduced, processing demands may exceed those of traditional crops, constraining adoption despite other advantages. In Mali, for instance, although farmers and consumers have demonstrated their willingness to switch to maize, low-cost milling remains a constraint in rural areas. Sorghum and millet are easier to pound manually than maize. (In urban areas, maize is taken to the neighbourhood mill to be custom-milled). In more densely populated areas, particularly where there is mains electricity, mechanical mills can be operated at lower cost. The opportunity cost of women's labour is generally higher in these areas too – because of additional marketing and employment opportunities – so both cost and income considerations influence women's capacity and willingness to replace manual processes with custom-milling.

Box 2: Energy expenditure for different tasks for adult females, Nigeria

Task	*Workday length (hrs)*	*% resting time*	*Energy expenditure above BMR x 1.5 (kcal) inc. rest*		
			Per kg/hr	*Per hr*	*Per workday*
			(of 50 kg weight)		
Walking at 3 mph (no load)	NA	0	1.7	85	NA
As above but with 10kg load	NA	0	2.1	105	NA
Hoeing (upland rice)	4.57	29	1.9	95	434
Harvesting (rice)	4.27	9	1.2	60	256
Planting	4.36	16	1.0	50	220
Pounding (rice)	NA	0	4.0	240	74*

Notes:
NA - not applicable
* -per tiya

Calculations derived from the following values of BMR:
Fox - BMR + SDA: 1.03 kcal/kg/hr
FAO - BMR x 1.5: 1.75 kcal/kg/hr
Longhurstt - BMR x 1.5: 1.57 kcal/kg/hr

Source: Carr and Sandhu (1988)

Involvement of children in post-harvest activities

Data on the involvement of children in these activities are scarce and often contradictory. Where there is information, it indicates that rural children are more likely to be working than urban children, they start work at an earlier age (between 5 and 7 years), and they spend more of their time working. Girls are especially likely to start work earlier and to forego education. The proportion of working children between 5 and 14 years is highest in Africa (around 40%). International Labour Organisation (ILO) data distinguish three categories of child worker in developing countries:

- children working full-time and not attending school
- children attending school but working too (2/3 of girls and 1/3 of boys)
- non-economic "work" (eg domestic activities) – which may be part-time or full-time and are much more likely to be undertaken by girls.

250 million children are estimated to fall into the first two categories, in roughly equal proportions. ILO surveys found that in rural areas, around 90% of the children are engaged in agricultural or similar activities, and 20% of these are 5-9 years old. Common-sense, observation and anecdotal evidence all point to the involvement of children in the same activities as their mothers (though sometimes with different responsibilities – such as tending to animals or looking after younger children). Female-headed households are disproportionately dependent on child labour.

Urbanisation and manual processing

The use of manual processing tends to decline with urbanisation for a number of reasons; incomes are higher, the opportunity cost of women's time is higher (more women are engaged in paid employment) and convenience factors come cheaper (such as custom-milling in densely populated urban areas with mains electricity, imported rice, and industrially processed products). Urban populations tend to eat more food away from the home (especially street food) so urbanisation creates additional demand for prepared foods, and other convenience factors.

Scope for intervention

Before identifying scope for intervention, it is important to be clear about the objectives. Reducing drudgery *per se* is not necessarily what women want.

Experience with technology development, supposedly for women, reveals the following lessons:

- genuinely participatory technology development is needed to identify needs, and design innovations which are affordable, socially acceptable, suited to their skills and within their sphere of control/ influence;
- ill-considered labour-saving interventions may deprive women of an important income source;

- release from certain chores may sometimes offer little benefit to women if it obliges them to work longer hours on their husbands' plots, for instance;
- saving energy is often considered more important than saving time; however, time savings are also important - especially during busy months, or other situations where the opportunity cost of women's labour is higher;
- seasonal analysis is very important because of sharp seasonal differences in labour demands.

Without detracting from the need for participatory technology development, it has been possible nonetheless to identify some women's processing activities that are drudgery and are particularly widespread. Here, consideration is given to their amenability to technical innovation.

Cereals

Threshing and winnowing of cereals is an arduous task, mostly carried out by women and children, and estimated to account for 50% of the total labour used in small grains production (Mazvimavi, 1997). These activities are important for rice, sorghum and millets. Threshing and winnowing also apply to wheat, but since a lot of wheat is grown by higher-income farmers (particularly in Africa), in many places the process has already been mechanised. A key issue in developing different technology for small-holders, is to design sufficiently low-cost low-volume technology.

Paddy

Parboiling of paddy is not only an arduous task but produces a product of variable quality. Improvements to the process could include design of appropriate vessels from which water could be drained, thereby reducing the amount of weight that needs to be transported between operation sites.

Groundnut shelling

Almost all groundnut shelling is carried out by hand, by women and children. There have been many designs of groundnut sheller (many dating back to the 1950s and 1960s) but shellers are not widely used. A number of factors seem to explain this: cost; the social aspect of groundnut shelling as an informal group; shelling machines produce a mixture of shells and kernels which, unlike hand-shelling, needs to be winnowed subsequently; whole kernels are produced by hand shelling, but many machines produce a lot of breakage. This area seems to merit further work, however, starting with a thorough assessment of the use of mechanical shellers to date.

Cassava processing

The grating operation is usually carried out manually, but power-operated graters of various makes and models are being more widely used. Hand grating is invariably considered the most tedious and painful operation of the whole process. To hand grate one tonne of fresh peeled cassava roots generally requires 10-15 woman-days of effort.

For all the processes indicated above it is safe to say that a technical solution either already exists or has been proposed. However, there is a cost attached to any piece of hardware and this may preclude its use to overcome the problem.

Reducing the drudgery in post-harvest operations: lessons from experience

There is an extensive literature on technology development to reduce the drudgery involved in small-scale processing. It highlights a number of key issues and lessons in developing technology that is genuinely appropriate.

Affordability

For many rural women, access to mechanical processing (chiefly milling) is constrained by low incomes and processing charges. Changes in either may affect access. Affordability has many dimensions:

- in rural areas household incomes are often very low, offering little scope to pay for processes which can be carried out manually at no cash cost;
- the opportunity cost of women's labour may be very low, particularly for the economically less active household members (such as older women), or for activities fitted in around other household chores (e.g. groundnut shelling in the evening, by women and children, as food is prepared);
- willingness to pay for milling may depend on how pounding chores and time savings are shared within the compound or extended family; the husband may be content to pay for milling to feed labourers whereas he may

regard family requirements to be the responsibility of the women;
- the costs of operating mechanised technology in rural locations are often under-estimated; throughput is often lower than envisaged because of breakdowns, lower demand than anticipated, or power failures; in some places even private mills may be run at a loss (or without profit) by local leaders or politicians; high transaction costs (of acquiring spare parts or fuel for generators) are often under-estimated, particularly in remote areas.

The clear message is that the assessment of affordability depends on realistic estimates of running costs, as well as careful analysis of willingness and ability to pay, taking account of how decisions and resources are apportioned at household level. Sharply defined seasons and production dispersed over a relatively wide area can contribute to low utilisation and high costs of mechanised technology.

Group enterprises

The scope for making technical improvements that offer an economic benefit is usually extremely limited at the scale of operation typical of much traditional household-level processing. Yet in poor rural areas, there is often little evidence of private commercial capacity, to pay for and run larger-scale operations. Scarce private capital is usually concentrated in low risk operations with a relatively high return – such as milling (in certain locations), trading and sometimes transport. To get round this, outsiders seeking to promote the use of an "improved" technology often envisage that it can be run as a group enterprise. This may create additional problems:

- the group is formed just for processing – but there is no real cohesion or experience of working together
- capacity to manage the operation is weak (to access and repay loans, to calculate and charge economic fees, to assure high utilisation and minimise down-time, to properly operate and service the technology)
- groups are often very dependent on a single person or the few people able to do book-keeping; financial management is often weak or subject to abuse
- where aggregate output is significantly increased as a result of the technology, marketing problems often arise
- training and capacity-building needs are often under-estimated by NGOs or donors.

Although group enterprise seems to offer a solution to the twin problems of scale and lack of commercial provider, entrepreneurs may be absent for good reason. The problems they foresee will only be compounded for an inexperienced group operation. Groups may be able to access capital, and market or procure products, but joint operation of processing operations is often problematic.

Involving the private sector

These problems point up the importance of trying to involve the private sector. Box 3 illustrates how a technology that appeared to meet a perceived need, and which was affordable, was difficult to disseminate in the absence of commercial involvement. The initial project had focused on the development of an affordable technology, but had paid little attention to the mechanisms and incentives needed for commercial distribution.

Box 4 provides another example of the participatory development of low-cost improved technology, but it gives no hint of the costs of promoting and disseminating such technology, and how this is to be tackled. NGOs and public agencies often find it difficult, moreover, to collaborate with the commercial sector. Misunderstandings arise from:

- different motives – and a perceived conflict between the development objectives pursued by one and the profit motives of the other;
- different working cultures and a poor understanding of the institutional and financial context within which each operates.

Box 3: Improving household coconut grating in Tanzania

Household-level processing of coconuts is an important women's activity in coastal Tanzania and Zanzibar. The oil and milk is produced at home, year round, relying entirely on low throughput, labour-intensive, traditional processes. Around 10-15 coconuts are used to make 0.75 litre of oil. The return to labour is in the region of £0.10 for two hours active work. The coconut grating takes between 50 and 75 minutes and is an arduous task that causes back, wrist and arm pain.

Four technologies were demonstrated to the women processors, who were invited to try them:

- Stirrup-operated grater
- Cycle-powered grater
- Hand-operated grater
- Press for squeezing gratings.

This participatory approach produced some interesting results. The stirrup-operated grater required a table on which to mount it: this technology was rejected since few households could afford a table. Additionally it was considered immodest to use. The cycle-operated version was also rejected for the same reasons. Even as a custom-grating service the cost of the cycle option was considered too high. The press was not considered as efficient as manual squeezing and was rejected for this reason as well as cost.

The manual rotary grater was accepted with the condition that it was mounted on the traditional stool (rather than on a table). The traditional grater is normally attached to a stool upon which the operator sits to use it. Women considered that the rotary grater was easier to use, was quicker, produced more oil and resulted in less pain during use. Comparative technical analysis of the grater showed that it produced up to 20% more oil and 20% more protein (in coconut milk). The grater can be easily manufactured in country for about £5.

However although some women bought the graters from the project, the project ended before the private sector became significantly involved in technology transfer. Government researchers were uneasy dealing with commercial workshops, and suspicious of trading profits. Attempts to market the graters commercially were undermined by NGOs giving them away. The experience highlights useful lessons in giving early consideration to promotion pathways.

Box 4: Cassava chipping in Ghana – attention to ergonomic factors

Cassava is an important food security and income-generating crop in Ghana. Cassava chips are sold for use in animal feed both locally and in the EU. A widely used, hand-operated chipping machine was evaluated. Six farmers took part in the study during which physiological, postural and subjective measurements were taken. Using the machine resulted in drudgery and postural discomfort. Following an iterative process and using appropriate anthropometric measurements, an improved, adjustable prototype was developed. It was tested with the six farmers as well as six novice users. Discomfort and physiological strain were reduced, allowing a faster work-rate (with novice users). It was preferred by all users.

Time spent working, work-rate and heart-rate for a farmer using the original and modified machine

	Original	**Modified**
Total work time	174 min	204 min
Chipping time	137 min	156 min
Total chipped	276 kg	322 kg
Work rate	120 kg/hr	124 kg/hr
Heart rate	140 bpm	131 bpm

The study demonstrated how agricultural machinery developed for use in a developing country can be improved, at low-cost, by employing a participatory and iterative approach to design, paying close attention to human factors. By incorporating ergonomics into the design process, drudgery associated with the machine was reduced and productivity, user-comfort and satisfaction were increased. Improving the posture adopted to operate the machine resulted in significant reduction in physical strain and incidence of body-part discomfort, and would be expected to reduce the risk of musculoskeletal damage.

Commercial involvement is one way to tackle long-term sustainability, but all too often misunderstandings and the time-consuming nature of such collaboration, afford it a lower priority than more immediate project objectives. For many NGO and government workers in developing countries, the private sector is still viewed with suspicion, and commercialisation of a process is not seen as a basic requirement. Despite this there are some good examples – where private workshops and distributors have been involved in technology development and transfer from an early stage. The ram press, used in manual oilseed pressing, is one such example - but this was only achieved because commercialisation was accorded high priority, worthy of conscientious and long-term collaboration and capacity-building.

Genuinely **participatory technology development** is of paramount importance in both identifying the problem and a workable solution. Box 5 compares two approaches to sorghum de-hulling, illustrating a quite different development path when the beneficiaries are involved in the development phase.

Box 5: Sorghum de-hulling in Tanzania – different approaches to technology development

Motorised grain processing in Tanzania consists mostly of custom-milling whole grain, normally maize, into flour. Dehulling is normally carried out on rice, and sometimes maize – but the dehullers are not suitable for sorghum. Women walk several miles to have maize milled into flour, as an alternative to hand-pounding and grinding.

Certain varieties of sorghum on the other hand require dehulling prior to milling to produce a palatable product. Household hand pounding (using a pestle and mortar) of sorghum to remove the hull is very laborious, and carried out by women and sometimes children. Often this task falls to older women and those who are pregnant as the more able-bodied women are involved in other tasks such as working in the fields or fetching wood and water. Depending on the size of the household women may have to hand pound for between two and four hours per week to provide enough dehulled grain for their family.

In the 1980s farmers were being urged to grow sorghum as a drought-resistant food-security crop. As part of this initiative, electrically-operated or diesel-powered abrasive-disc sorghum dehullers (throughput 250-300 kilograms per hour) were introduced into the semi-arid regions of Tanzania. Twelve were imported from Botswana (where they are in common use) and four manufactured locally. Thirteen dehullers were distributed to communal villages on soft loan schemes and the remaining three were distributed to individuals or commercial organisations.

By 1993, none of the dehullers were functioning, nor had been for several years (SIDO, unpublished document). This was because:

- some were located in areas of limited sorghum production;
- in some regions farmers were growing sorghum varieties which are soft and unsuited to dehulling;
- charges for dehulling were prohibitive in many regions, so hand-pounding continued;
- most of the dehullers were underutilised - farmers only wished to process small batches;
- servicing of the equipment proved difficult with most spare parts having to be imported;
- funds were lacking for spares and maintenance - no plans had been made to meet these needs;
- there was little support or credit available to entrepreneurs wishing to invest in such technologies;
- entrepreneurial skills to profitably run the dehullers were lacking in rural areas.

A more participatory approach to sorghum dehulling was adopted in a recent project funded by DFID's Crop Post-harvest Research Programme (R6640). The village dehulling process was examined in detail and women users of the process were invited to suggest ways in which the task could be modified to relieve drudgery. This led to the development of a prototype rotary hand-operated dehuller.

The dehuller was demonstrated in five villages where groups of around twenty women and men were encouraged to try the dehuller themselves. Opinions on the quality of the dehulled sorghum and the machine itself were sought. Women users found the machine easy to use and considered the quality of the grain to be equal or superior to handpounded grain. The fact that it could be easily operated by adolescents and older people (who do not have the strength required for handpounding) was welcomed. Villagers asked to dehull pearl millet too, and were delighted when this was also successful. The comments were noted and will be taken into account in further development of the dehuller. The dehuller can process around 6 kilograms of sorghum per hour manually, but could be motorised to increase capacity.

Box 6 provides another example of how outsiders' perceptions may differ from local priorities. In Burkina Faso, where groundnut processing traditions are similar, an NGO did introduce a mechanised expeller. More oil but less income was generated because the residue was not oily enough to make the *culi culi* biscuits. The expeller was clearly not viable in this situation – a white elephant that could have been avoided had women been more involved in project design. Moreover, where women are involved in technology trials, their feedback will not necessarily provide scientists with accurate data on time or energy-savings, but it is probably a better indicator of eventual uptake. In the cassava chip example, for instance (Box 4), this would help in providing an assessment of the perceived significance of what appear to be fairly modest improvements in the work rate.

The underlying concern with any interventions of this nature is to generate additional benefits for women, and the people (particularly children) who depend on them. In some cases, however, a drudgery-reducing technology may have an unintended and negative impact, if it eliminates an important source of income for poor women. In Mali, poor rural and urban women earn important income by manually de-hulling sorghum, millet and maize for higher income women in small towns and cities. There, poor women are likely to be displaced by the introduction of mechanical de-hullers, whilst benefits will accrue to higher-income groups able to pay for de-hulling. (This parallels the experience with pre-harvest technology in Asia, where mechanisation has displaced women who worked as casual agricultural labourers)[1].

[1] This issue merits careful consideration. Manually-operated ram presses in Africa are often (but not exclusively) owned by men, and are almost always operated by men. Women pay a custom-milling fee to use these presses however – since the existence of the presses has created new opportunities for women to earn income, rather than displace activities formerly carried out by women.

Box 6: Groundnut processing in Ghana - no room for improvement

In northern Ghana, groundnut oil is widely produced using traditional methods. Groundnuts are hand-shelled and the kernels roasted over a fire on a metal sheet. They are next rolled lightly between flat stones, then winnowed to remove the testa. The roasted kernels are ground in a plate mill or crushed between two stones to form a paste. Water is added to the paste in a large bowl and the mixture is stirred and kneaded by hand. The amount of water added is gauged (not measured), but it is critical – too much or too little results in no oil release. After about 15 minutes the colour of the paste darkens and the mixture forms a more resilient paste and becomes difficult to knead. At this time oil separates from the mixture. The mixture is continuously kneaded for several more minutes – a difficult task as the paste can be formed into a cohesive ball and is of the consistency of bread dough. Oil is then poured into a separate container, ready for use.

The residue after oil extraction is rolled into long, thin rolls which are formed into rings and deep fried in the oil previously extracted. This produces a protein-rich, biscuit-like snack food called *culi-culi*. Sometimes the paste is formed into balls and fried. The fried balls are then pounded to produce flour used in cooking. The frying procedure causes more oil to be extracted. Household equipment only is used in this process: the cost is negligible. The process, however, is arduous and time-consuming. The oil extraction efficiency of the process is high at over 70%. About 30 kg groundnut paste produces some 10 litres of oil and about 17 kg *culi-culi* and/or flour.

There are several other methods available to extract oil from groundnuts. All methods, however, involve a monetary cost in terms of equipment. The manual ram press, or even a bridge-type press will extract oil but the extraction efficiency is about the same and, crucially, the option of making *culi-culi* is not available. A powered expeller suffers from the same constraints – but at a higher capital cost. There is not sufficient incentive for women to adopt alternative technologies since there is so little profit margin within the system to allow for costly interventions. In any case, the manual presses also involve some physical effort. For the time-being the traditional process best suits needs and resources.

It is not sufficient to develop improved technology for an activity in which women are involved. Their ability to benefit from the technology is determined by many other factors including access to credit, training and markets.
"The development of concepts, capacities and behaviour patterns required to bring people out of the circles of poverty in which they live, is part of a process of technical innovation." (Appleton, 1993).

This has two implications for the design of technological interventions: where necessary and possible, projects should seek to effect change in these other areas (not just in the hardware); and, where this is unrealistic, the focus should be on technology capable of delivering benefits which do not depend on such contextual changes.

Conclusions

There is no doubt that women in developing countries spend large amounts of time and energy in poorly remunerated, repetitive crop handling and food processing activities. Despite this, research focused on reducing the drudgery *per se* is inappropriate – rather, a focus on improving women's productivity is required. For some women, including many of the poorest, the drudgery involved in the work creates an opportunity to earn income.

Concern about the livelihoods of the poorest women would indicate certain foci:

- particular attention to the needs of female-headed households (which feature disproportionately amongst the poor, and account for 25-35% of farm households in Africa[2]);
- crops and processes commonplace in marginal areas (including sorghum, millet and cassava);
- reducing the drudgery in carrying fuel and water, because of its overall importance, and the worsening situation caused by population pressure[3];
- rigorous attention to how poor women earn income - such that their situation is improved, not worsened by technological innovation;
- working with innovations at household-level and in the informal sector – because this is where poor women earn income and buy services.

In addition, it is important to note certain opportunities created by urbanisation trends, namely growing demand for convenience factors in food, and for street food. In some parts of Africa this is particularly important because urban consumers are switching to more convenient imports of wheat and rice. Few countries can sustain this rising import bill, but in the absence of low-cost processing options, the crops that can be grown locally are less popular because they are less convenient.

This review also provides some clear pointers on operational considerations in research focused on women's processing activities. Genuinely participatory development is very important. Other aspects that merit explicit attention include:

- poverty impacts;

[2] The proportion is increasing because of HIV, wars and economic migration by males.
[3] Traditional fires also contribute to poor health of women and children most exposed to them. Greater use of fuel-efficient stoves would therefore provide drudgery-reducing and health-enhancing benefits.

- the wider context (including access to training, credit and markets);
- affordability;
- involving the commercial sector at an early stage to pave the way for subsequent technology transfer, and recognising that this is a long-term process[4]minimising dependence on technology targeted to groups, except in circumstances where there is strong evidence that this is appropriate.

If drudgery can be reduced so that the return to women's labour is increased, children are likely to benefit in a number of ways:

- they may also be released from some of the drudgery;
- child nutrition may improve because women spend a high proportion of their income on household welfare and family nutrition;
- studies show that when time spent fetching fuel wood is reduced, women spend more time preparing food for the family;
- despite the high incidence of child labour, education is nonetheless seen by most poor families as a way out of poverty – and is encouraged where resources permit (though this is not always true for girls).

Whilst the available data confirm that children in rural areas are heavily involved in work, they do not permit an analysis of areas which demand a special focus. More information could be generated by field research focused on this, or data collection as part of existing and proposed post-harvest research projects.

This review suggests that despite the attention this area of work has received over the last 20 years, there is still a need for further research and development. Although many areas are subject to rapid urbanisation and improvements in transport infrastructure, large numbers of poor women live in rural areas where "modern" technology is inaccessible or unaffordable. This will still be true in 2010 or even 2020 – especially in the poorest countries. Although technical innovation and adaptation are important, very many more factors affect women's ability to benefit from technological change. Women are unlikely to benefit unless research and development efforts address this nexus of technical, institutional and socio-economic issues.

[4] The introduction of the ram press in Africa is a case in point – but few would dispute its ultimate commercial success. After its initial development, it took some time before the design was modified into its current more user-friendly forms, and it took ten years before a robust approach to its commercialisation was developed, for replication in other countries.

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