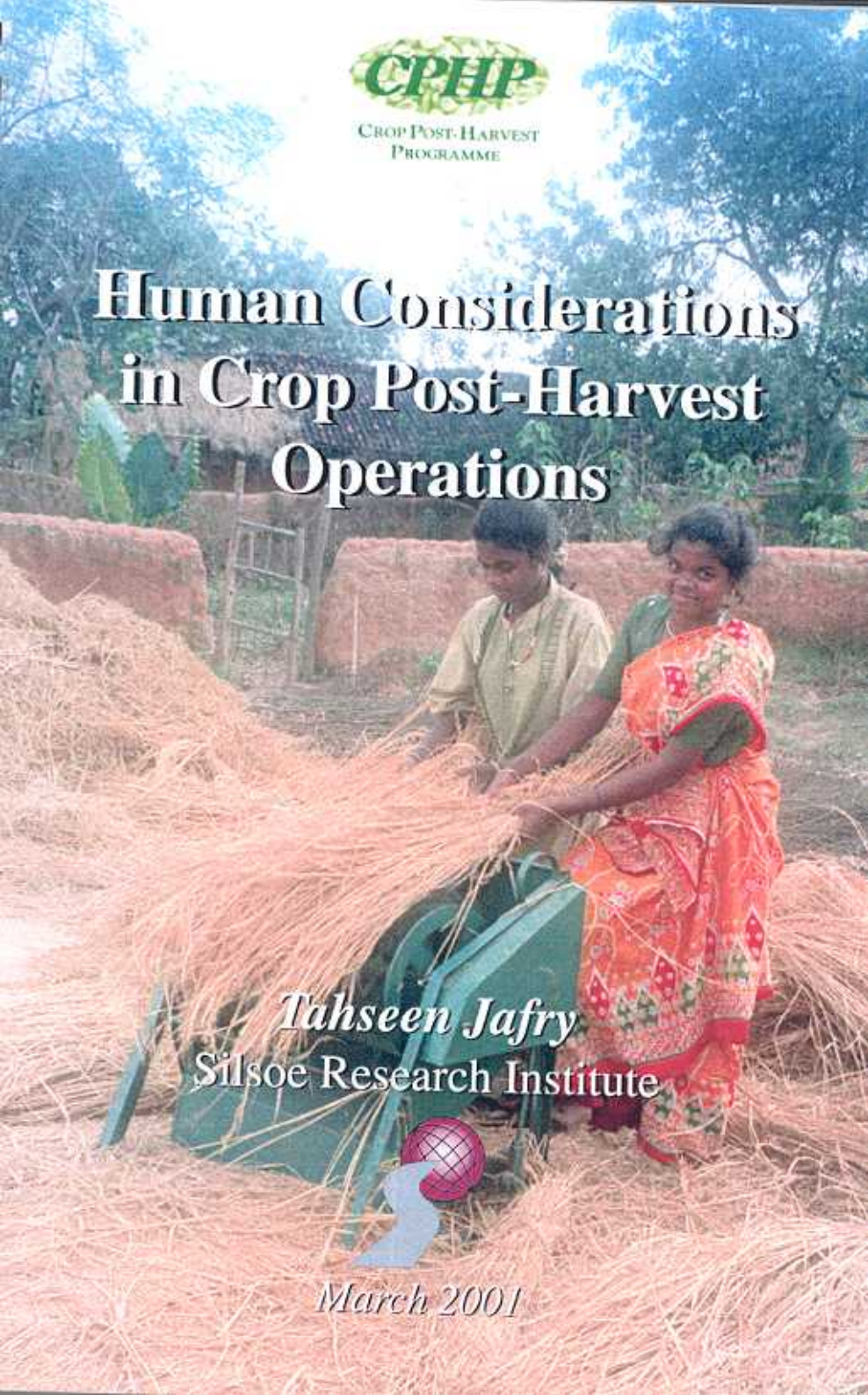
CPHP

CROP POST-HARVEST PROGRAMME

Human Considerations in Crop Post-Harvest Operations



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Human Considerations in Crop Post-Harvest Operations

Section One

Introduction

People, *the human capital*, are the most valuable resource of any country. Human capital is important and not in great shape in developing countries. If attention is not paid to the human factor in designing projects, then you risk: a) not getting the most from the limited human capital that exists e.g fatigue from overwork or b) worse still, you can run down human capital, causing injuries, taking women's time when they could be doing other activities e.g income generation. So all projects, whether they are directly involved with human capital, or not, should take into account human capital issues.

"Human Factor (ergonomics) is about developing systems and technology that can accommodate people"

Figure 1 Collecting fuel wood - a daily grind for women

Figure 2 Pounding maize - a daily necessity

Three of the more significant factors that can influence the efficiency of human work include:

- Workload and drudgery.
- Health disorders (often work-related or work-induced), accidents and injuries.
- People working with inappropriate technology.

An ergonomics framework illustrating main issues relating to the human capital, consequences and outcomes as well as potential solutions is shown in Figure 3.

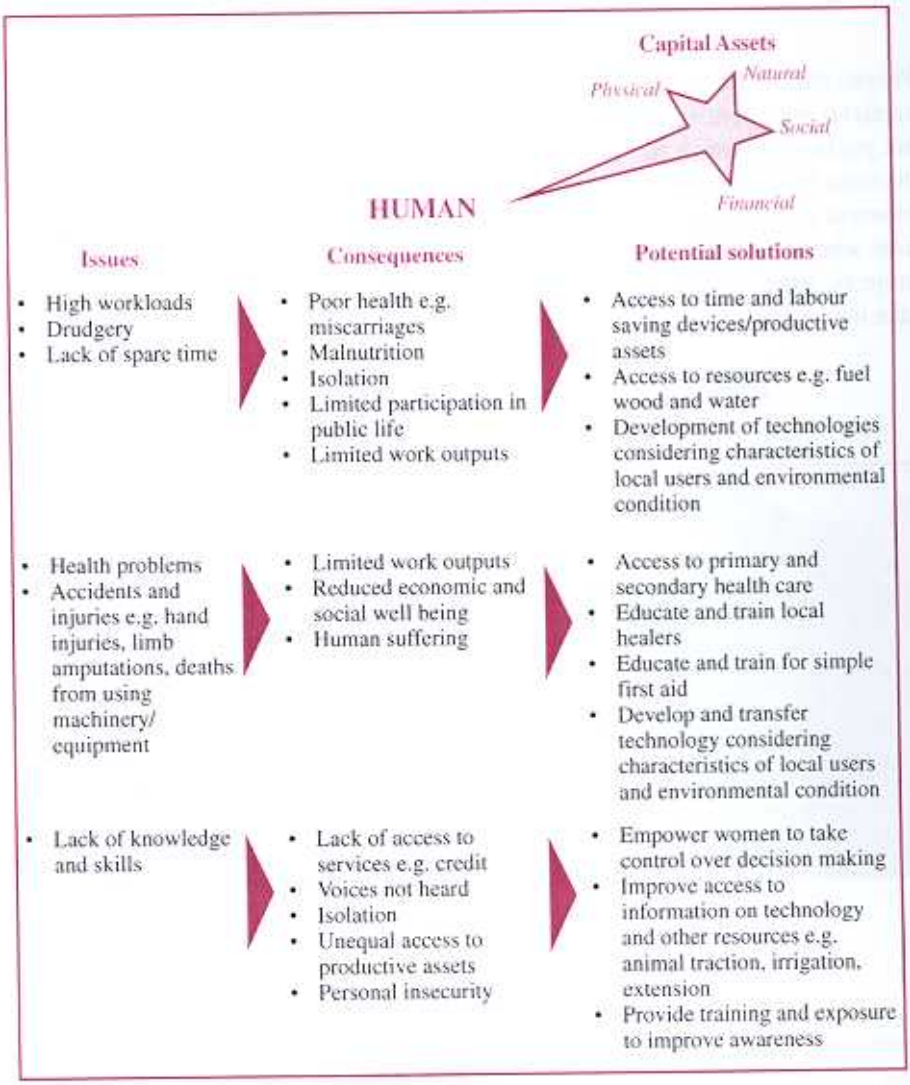

Figure 3 Understanding the human capital

Some of the human factor issues pertinent to the Crop Post-Harvest Programme are shown in Table 1.

Production System Outputs	Semi-arid (cereals)	Peri-urban (horticulture and trees)	High Potential (oil seeds, legumes and cereals)	Forest/Agriculture (non-grain starch staples)
Storage	The use of protective clothing, sprayers, communication aids such as pictograms, and operator health when looking at pest and pathogen control methods.	Human factor of workplace design to improve fruit quality by reducing unnecessary handling.	Human factor issues of handling agrochemicals when looking at storage and handling techniques. e.g. use of PPE spraying techniques.	Human factor issues of storage particularly concerning the use of pesticides and agrochemicals.
Processing	Human factor considerations in the design, safety, maintenance and sustainability of processing machines e.g. milling, oil extraction.	Processing and handling of horticulture and trees e.g. manual handling heavy logs, safe use of equipment such as chain saws.	Human factor considerations in the design of processing and handling technologies. e.g.ground nut processing.	Human factor considerations in on-farm processing equipment to improve handling, safety and efficiency.
Marketing	Human factor issues of transport e.g. in the design of carts, head loading.	Human factor issues in marketing strategies.	Logistics of developing marketing initiatives. e.g. transport issues.	Human factor issues within the existing marketing system. e.g.distance to markets, headloading, transport.

Table 1 Human factor and Crop Post-Harvest Programme

This booklet explores further the main human factor issues that are highlighted in Table 1.

The four main themes discussed are:

- Transport and Marketing
- Designing Processing Equipment
- Designing Workplaces for Storage and Handling of Produce
- Working Environments - Focus on Agro-Chemicals

The booklet concludes with a human factor decision tree which has been developed in consultation with crop post-harvest project leaders. Some examples of practical application are also provided. References for further reading material are given at the end.

This booklet is designed as a practical guide for project proposers, project leaders, programme management and advisers.

Section Two

Transport and Marketing

Key Question

The issue of load carrying is of concern to those projects in which marketing produce is a primary focus. Marketing produce is essential for generating income, especially for women. But the question is **what** can be done to reduce the transport problem? The key issues which need addressing are isolation and market-access, health (implications of load carrying) and time constraints.

Transport and development

A lack of means of transport can cause isolation particularly for those who live in the areas most deprived. These people are usually distant from any markets and limited in what they can sell by what they can carry. Also, time and energy has to be spent in transporting goods. People are often so busy that they do not have time for themselves or their families so the burden of transporting goods just adds to their problems. If transporting goods places such demands on people's time then there is a clear case for reducing the transport burden to save time and energy. This can then be spent on improving health, cultivation, education or income generation. Reducing the transport burden can make life easier for people and it therefore has a key role to play in improving the overall health and quality of life of people.

Gender & transport

The problems of access and mobility of women in rural areas usually receive little or no attention. The goal of increasing economic productivity has severe consequences for women. The tasks of collecting water, fuel wood, subsistence agriculture and health care are so demanding that women have no time or energy left for increased commercial agricultural production and marketing. Reducing the transport burden then becomes not just a women's issue but a crucial issue for food security (IFRTD 99). Research in Asia also shows that a lack of access to transport restricts women's capacity to expand their economic enterprises reducing household incomes and overall national productivity.

Women and Transport in Uganda (Iga 99)

The central Ugandan district of Mpigi is situated on the northern shores of Lake Victoria. The main economic activities carried out in the district are agriculture,

fishing, forestry/lumbering and trade. Forty-six percent of the households are engaged in subsistence agriculture. Women play a major role in providing labour for these households. They carry out most activities from land clearing, ploughing, planting to child caring, cooking and domestic work.
Bicycles, motorcycles and taxis (boda-boda) are used for personal transport and movement of goods. However, for many rural women, these transport options are not feasible. The taxi service is only for social and religious visits and cultural restrictions apply to riding bicycles and motorbikes. Transporting agricultural produce is a daily task. Women walk with loads on their heads to market places because they have no other form of transport. In addition to their heavy agricultural and domestic responsibilities carrying produce to market is yet another exhausting task. If women do not manage to get to the market it severely hampers their income and also their ability to purchase any transport assets thus locking them in a situation where the transport burden cannot be alleviated.

Human factor issues

Lack of adequate or suitable transport in developing countries means that many people are forced to carry loads (often more than 30 kg) on their heads, shoulders and backs (Dennis and Smith 1995). Figure 4 illustrates women carrying produce to market near Karatina in Kenya. Carrying loads is associated with high rates of musculo-skeletal injuries, especially to the back. The common types of injury are deformation of the spine, slipped discs and broken neck (Curtis 1994). Strains and sprains to limbs and joints also occur. These include cranial depression and neck strain, which usually happens because of overexertion and may be disabling (Curtis 1994, Dennis and Smith 1995).

What can be done?

Lifting and carrying loads are unavoidable but measures can be taken to reduce the risk of injury and lessen the burden to the person responsible for carrying the load. There are a number of interventions available that can reduce the transport burden of load carrying. Some of these include:

- Suitable carrying aids e.g back-mounted baskets, shoulder poles.
- Basic vehicles e.g wheel barrow, handcart.
- Bicycle-mounted devices e.g racks, panniers.
- Animal-based transport e.g donkey, cattle.

Marketing and transport work hand-in-hand

It is usually not possible to think about marketing without considering transport issues. To get produce to a market quickly and efficiently usually requires a 'set of wheels'. Improving the transport system to subsistence farmers can help them to harvest and market crops more easily, reduce drudgery and by facilitating

communication, help stimulate social integration and improved quality of life. Therefore, any marketing initiative should also consider any transport intervention that may be needed. Three of the basic criteria that should be remembered are:

- The physical strength and capability of the people at the centre of the marketing initiative.
- Cultural and societal constraints in which the initiative is to be introduced.
- Socio-economic characteristics and needs of the target areas.

Figure 5 illustrates the transport requirements for a typical small householder (Gebresenbet *et al* 1997).

Figure 4 Load carrying near Karatina, Kenya

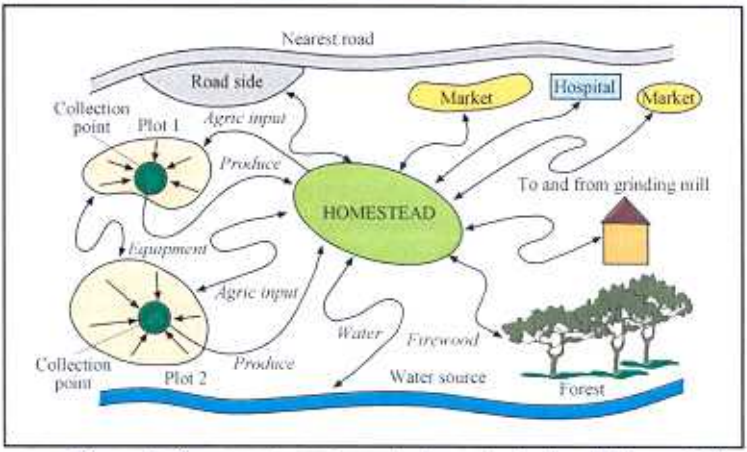

Figure 5 Transport requirements for a typical small householder

Options to consider if transport interventions are not feasible?

Whilst it may not always be feasible to improve transport strategies in projects concerned with marketing of produce, some issues that could be explored during project design and development are:

- Who is responsible for the marketing activity and what is the scope for changing their working routine?
- Promote awareness of rural travel and transport issues through local government and policy makers.
- Exploration of the possibility of introducing village development committees for the management of savings and credit schemes and access to larger loans so that people can share the cost of purchasing transport interventions e.g donkeys or handcarts.

Donkeys for Transport

In Homa Bay, Intermediate Technology in Kenya and a Kenyan NGO called Future Forest worked with women's groups to expand their existing savings and credit scheme to provide donkeys for women. By owning a donkey women are able to increase their incomes by ksh.420 per month. During times of food scarcity the donkeys are used to transport soda ash to trade for grain, helping with food security. The project helped women to develop their savings and credit scheme to access larger loans. The women now own the donkeys and the understanding that they are the property of the women's group restrains men from exerting control over their use (IFRTD 97).

Handcarts for women in India

The burden of doing domestic chores is extremely time consuming. Carrying water and fuel wood are the most essential jobs that need to be done in any household. Women and girls are usually responsible for these tasks. The weights carried vary between 5 and 40 kg and the distances travelled range between 2 and 10 km each day. The DFID East India Rainfed Farming Project (a DFID / Government of India aid project in Bihar, Orissa and West Bengal) introduced a "wheels for women" initiative. Initially, a wheel barrow was introduced to a group of women in *Uruguttu* village (Bihar) as an alternative to head loading. The wheel barrow was used extensively and the women also established a hire scheme because the men showed keen interest in 'a set of wheels'. Although, the wheel barrow generated a lot of interest, the design was not suitable for women. The problems were that it was too heavy, of low carrying capacity, the handles were too far apart and the single wheel made it difficult to balance. In order to rectify this, an alternative prototype was designed and developed through participatory discussions with women. The prototype was taken to the field and used by the women. Initial reaction to the hand cart was extremely positive. Many women came forward and were eager to try and use it. The women tried it

in the field, on village roads and on the main road. Operating the cart in the field proved to be difficult but not for all households. Many fields have rural roads which lead up to them making it possible to use the cart. The cart can also be used for other jobs, such as taking vegetables to the market, carrying paddy from the threshing floor to the homestead, transporting manure and collecting water.

The development of a handcart is a new and exciting concept for women. However, initially the women were prepared to be laughed at. After this initial reaction, women felt that others would come to inquire about how to obtain one. With some encouragement it did not take the women too much time to overcome the initial response they faced by other members of society when they started using the handcart. The problems they faced in their day to day existence of carrying heavy loads were such that they welcomed any initiative that would alleviate this burden. The fact that they were not completely isolated and were supported by the Project community organisers allowed them to flourish. This example shows how the women advanced through their collective work and their organisational strength. One encouraging success of this work was that the organised women's groups, although initiated from outside, put most of the decision making for use of the handcart with the women. This points to the fact that equal participation in groups, organisation and solidarity are key elements in helping women to overcome the initial hurdles of getting mobilised and economically independent (Jafry 00).

Points to remember:

- ✓ There is no easy answer to solving the transport problems of poor people. The main reasons for this are: people cannot afford transport, there is no infrastructure to support the transport needs e.g manufacture and repair facilities, and there are often cultural and social constraints.
- ✓ What can be done is to help reduce some of the burden of carrying heavy loads. This can be done by not imposing any additional load carrying burden on people that may be created by project activities (see Chapter 6) and perhaps trying to introduce carrying aids as discussed earlier.
- ✓ If you are going to introduce carrying aids always include gender issues. This could be done at the identification stage of the transport intervention or at the design stage of a transport intervention.
- ✓ Community participation is powerful. It is an instrument of empowerment, building capacity and cost sharing and is essential at every stage of a marketing/transport initiative.

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Section Three

Designing Processing Equipment

Key Question

The issue of design is of concern to those projects in which processing equipment is being designed and developed. Ideally, equipment should be designed to meet the physical capabilities of individuals. If the equipment is badly designed, there is a greater risk of human injury and reduced physical performance. The question is **how** can processing equipment be designed so that it meets the requirements of the user, does not cause a health problem and improves efficiency of the operator?

Contribution of well designed equipment to improving livelihoods

In developing countries, the health and well-being of a whole family is often dependent on its working members. If the working member (s) is/are ill or injured whilst working, it can cause a family crisis i.e food security, income loss, poor nutrition, lack of education. Many of the injuries sustained while working are the result of using unsuitable equipment (Kogi and Sen 1987). Types of injuries include amputations to limbs, eye wounds and musculo-skeletal disorders. For these reasons it is vitally important to reduce the number of work-related injuries and concentrating on making work more humane for all.

Gender issues in the design process

Women are the main food processors domestically and men commercially. Women (and children) being generally smaller than men and not as strong, raises the issue of gender compatibility in tool design (ILO 1979). Female workers' physical performance is, on average, lower than men's because of differences in factors such as muscle strength, cardiovascular function and aerobic work capacity. As a result women may have greater difficulty in operating agricultural equipment and machinery, and their risk of injury is increased.

Human factor issues

The science of measuring the size/dimensions of the human body is called

anthropometry. Some of the important body dimensions that need to be measured when designing equipment include standing height, forward reach and elbow height. These can be seen in Figure 6.

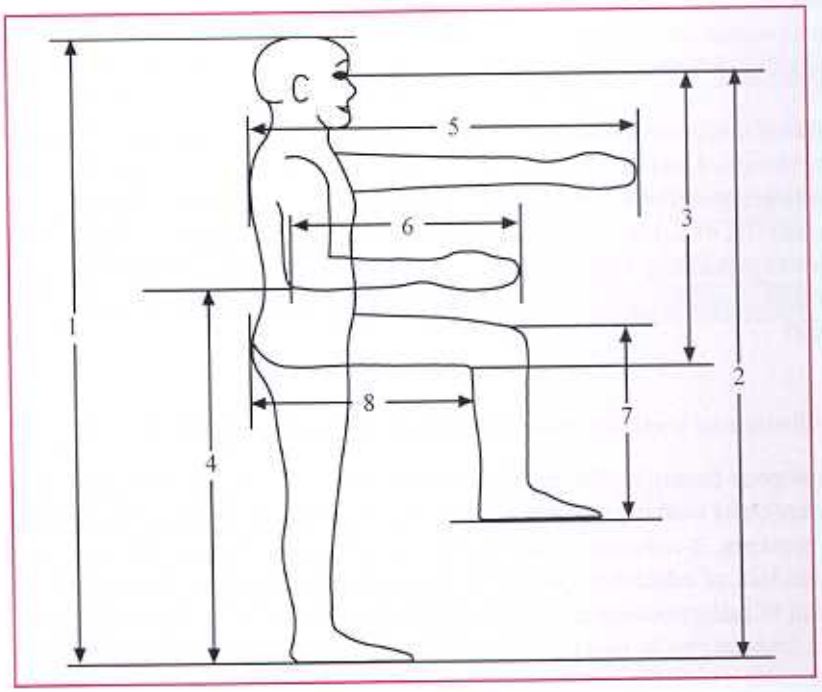

Figure 6 Anthropometric Measurements

1 Standing height 2 Eye level, standing 3 Eye level, above seat 4 Elbow height 5 Forward reach 6 Elbow to fingertip 7 Sole of foot to knee 8 Back to hollow of knee (Grandjean, 1980)

Body dimensions vary between ethnic groups living in the same country as well as between different age groups and between urban and rural areas. The measurement of limbs may therefore be required. Hand size, for example, needs to be considered in the design of hand tools and controls.

Muscular strength should be considered when designing equipment that needs to be pushed, pulled or equipment that has levers that need to be operated by pulling up or pressing down. Women's muscular strength is three quarters that of men (Chavalitsakulchai and Shahnavaz, 1990) so again the gender issues are important.

Safety is also important. Wherever possible all equipment needs to be designed in such a way that it is safe to use. Safety is not only a matter of design, it also depends on how the equipment is used. Environmental factors also need to be considered, for example, thermal stress, air quality, noise, vibration. More information on these factors is available in FAO, 1994.

A person's approach to safety can also be influenced by his or her attitude and physical state. A person who is tired, physically or mentally, is more likely to make errors of judgement or a person in a hurry is likely to take greater risks. For these reasons, it is important that equipment is designed to be safe to use; with safety guards, operating instructions and material in the users' own language and pictograms illustrating safety information that is easily understood (FAO 1994).

What can be done?

Ensuring people's participation and the use of local knowledge at every stage of the equipment design process is the best way forward. Women in particular know a great deal about processing since it is usually they who are responsible for this activity. Processing equipment is essential because it can add value to crops and gain a better saleable value. However, few women are involved in the development of processing equipment which not only undermines their technical capacity but also their confidence and belief in themselves in being able to use the equipment (that has been developed without their participation). Measures ought to be taken to utilise the skills and knowledge of women for the development of any equipment. Ensuring that people can understand what the equipment is for and providing training is also essential for its long-term sustainability.

Suitable processing equipment can also be used to promote commerce through the establishment of technology hiring schemes. The establishment of women's co-operatives and hire schemes through project initiatives can allow women to take control over technologies that can earn them money. This is ideal, especially for the poorest of the poor who are usually landless.

Processing equipment for adding value

The use of processing equipment was promoted at the DFID East India Rainfed Farming Project (a DFID/Government of India aid project in Bihar, Orissa and West Bengal). The most profitable of these was the paddy pedal thresher. This was for a number of reasons. Firstly, the women could thresh their own paddy quickly and store the grains before the onset of any unexpected rain. Secondly, the women could hire the thresher to other communities from which a revenue

could be generated and thirdly the women could earn some money as wage labourers in the time that they saved from not having to thresh paddy manually. This example highlights that women can be entrepreneurs if they are given a chance and provided with the right skills, knowledge and technology (Jafry 00).

The technologies devoted to generating income also proved to be valuable at the East India Rainfed Farming Project. The *dal* machine in particular was very successful for a number of reasons. The women in the village of *Uruguttu* (Bihar) had identified that there was a market for *dal*, not just locally but also in neighbouring districts. The women established a co-operative and processed maize with the machine that was provided by the project. Using their own initiative, the women packaged the *dal* in packets weighing different quantities. The women designed labels to put on the packets. The packets were initially sold locally and then marketed further afield (Jafry 00).

Options to consider if designing equipment using human factors criteria is not feasible?

Whilst it may not always be possible to design and develop processing equipment using human factors criteria, there are a number of options that could be explored during project design and development. These are:

- Is it possible to improve access to appropriate processing technology locally?
- Is it possible to improve access to credit schemes that can provide loans for hiring processing equipment?
- Is it possible to provide information and training to local artisans so that they can design and develop their own processing equipment locally?

Points to remember:

When assessing equipment:

- ✓ What is the equipment to be used for? It may have more than one use.
- ✓ How long is the equipment expected to last before replacement?
- ✓ Who is going to use the equipment?

- ✓ What level of back-up service and infrastructure is needed to ensure equipment sustainability?

When equipment is ready for adoption/adaptation:

- ✓ Is the physical strength required to operate the equipment within the users' capability (be aware of the gender issues)?
- ✓ Is the equipment designed to accommodate the posture and body movements required by the user?
- ✓ Are the information displays and safety information sensitive to cultural factors?
- ✓ Is any personal protective equipment required and has it been designed for the user group?
- ✓ Have the environmental conditions (temperature, humidity, air, noise, vibration, dust, fumes, gases) been considered so that they do not place any undue stresses on the health of the user; if they do, can they be controlled?
- ✓ Have personnel been trained on how to use the equipment?
- ✓ Is the equipment safe to operate? Are machine guards and emergency stop buttons required, for example, for powered equipment? (ILO 1988).

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Section Four

Designing Workplaces for Storage and Handling of Produce

Key Question

The design of a workplace can affect not only how people work but also how produce is handled. If produce is incorrectly handled, it can easily be damaged e.g bananas and yams can be bruised quite easily. To create an efficient place of work that can benefit the worker as well as limit damage to produce, it is necessary to take account of the factors that influence human performance and efficiency. The key question is **how** can a workplace be designed to accommodate these needs? Improving storage and handling of produce is of particular importance to those projects concerned with loss assessment.

Contribution of well designed workplaces to improving livelihoods

If the income of the worker is productivity-related then it makes good sense to improve the workplace so that productivity and quality can be improved.

Improving productivity and improving incomes

Women workers on coffee plantations in Indonesia use conventional methods for separating coffee beans. They use a round flat basket and separate the shell from the coffee beans while sitting on the floor. The average daily production of each worker is 20 kg. The income of the worker is productivity related. The women complain of headaches and low back pain.

The management of the plantation introduced tables and chairs which were designed taking account of human factor considerations. As a result, the working postures of the women improved and their productivity rose to 25 kg per day. This increase was reflected in their increased daily incomes. The health of the women also improved as they suffered less headaches and back pain (Priatna 1987).

Gender issues in designing workplaces

The gender issues related to workplace design are similar to that given in section 3. The important thing to remember is that women are generally smaller in stature than men and so there may be limitations to what women can do.

Human factor issues

Health problems, such as back-pain, neck-pain and other musculo-skeletal disorders are common in agricultural workplaces (Shahnavaz 1987). These problems can be caused by poor workplace design through heavy lifting and adopting injurious work postures. These factors collectively can result in fatigued workers. If workers are fatigued their quality of work output, speed, efficiency and motivation is reduced (Pheasant 1991).

Bruised bananas in St. Lucia

A study was conducted to examine the human factors issues in restructuring of the Caribbean banana industry (Jafry 1997). A key finding of this study was that fruit quality was poor due to excessive and often unnecessary handling of the fruit. In particular, the excessive handling (carrying, grabbing, shuffling, pulling, pushing) was related to the poor working practices adopted by farmers on the banana plantations, packing sheds (Figure 7), inland buying depots and at the wharfs. Poor working practice together with the unpleasant conditions in which farmers had to work caused tired and fatigued workers, who generally became careless about how they handled the fruit which also affected its quality. The emphasis was therefore placed on improving fruit quality through improving working practice through better workplace design.

A number of recommendations were put forward for improving the working conditions on farms, at packing sheds, and at the wharf. Some of these recommendations included providing tables of correct height, reducing the size of trays so that they carry less weight (of particular benefit to women), providing gloves for handling agro-chemicals, providing lifting aids, re-designing the layout of the packing sheds using anthropometric guidelines so that workers could reach and handle produce without straining their bodies and damaging produce.

The study also revealed that labour motivation was low and that this was also possibly one of the causes of poor banana quality. It was suggested that to enhance farmer motivation a number of things could be done. These included setting up farmer support groups, encouraging farmers to work together, providing education and training e.g on chemical safety, manual handling, reducing wastage etc.

But above all, getting farmers involved and helping in the restructuring process was crucial. Adopting a bottom-up approach and enouraging farmer participation is the best way to promote development and hopefully survival of the industry.

What can be done?

To create a good working environment it is necessary to design the workplace taking into account the needs of the worker. It is usually possible to identify

improvements needed and design constraints with the worker. Also considering the anthropometry of the user group is helpful so that the design can accommodate a range of body sizes (see section 3 and also Pheasant 1991). The cost of improvement is an issue. However, the cost of any improvements is normally paid back in terms of less absenteeism from work because of less injuries sustained and also better quality and quantity of work outputs (Pheasant 1991).

Options to consider if reorganising and improving workplaces using human factor criteria is not feasible?

When it may not be possible to improve the design of work places using human factor criteria, there are a number of interim options to consider. Improvements to workplaces usually occur in response to legislation, and so initiatives to make changes are usually regarded as an expense rather than an investment. Creating an awareness of how productivity and quality of produce can be improved through improved workplace design is a key to initiating changes.

Figure 7 Insufficient reach distance resulting in bananas being grabbed and bruised (St Lucia)

Points to remember:

- ✓ Discussions with workers will help to identify work constraints.
- ✓ Discussions with workers will help identify improvements to the workplace.
- ✓ Examine how the work is done. Look at the work posture required (standing, sitting, stooping) and the daily workload (light, heavy). Do workers have to adopt awkward working postures that can do them harm (e.g frequent twisting and bending)?
- ✓ Determine the weight of objects to be moved, are they too heavy, do they have to be moved frequently? (HSE 1992).
- ✓ Look at the height of work surfaces. Is there enough clearance to provide the worker with a proper view of the work while permitting movement?
- ✓ Check that there is enough reaching distance to allow the worker to be able to complete their task/s, obtain material, produce etc. Reach distance should be kept to within the reach envelope.
- ✓ Check that the worker can make appropriate postural adjustments to vary posture while working.

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Section Five

Working Environments - Focus on Agro-Chemicals

Key Question

Agricultural workers are considered to be at risk of poisoning because of their close involvement with toxic agrochemicals. Their exposure may be due to pesticide application tasks (mixing, loading into sprayers and spraying) or other agricultural tasks e.g tending to crops soon after they have been sprayed, storage or processing indoors (Rainbird and O'Neill 1994). The key question is **how** can we protect workers from chemical poisoning?

Pesticide use - key issues

- Developing countries account for only a small proportion of the world's total pesticide use but their consumption is growing (Asian Development Bank 1987, cited in Conway and Pretty 1991).
- Wide scale use of pesticides over the last decade has raised many concerns including safety of farmers and farm workers, build up of resistance to pesticides, environmental effects on soil and water, build up of pesticides in the food chain and problems of pesticide residue in food (Conway and Pretty 1991).
- The consequences of mismanaging pesticides are severe. It has been estimated that approximately 20 000 unintentional deaths from pesticides occur each year, mostly in developing countries (Dinham 1993).
- Many of the pesticides restricted in industrialised countries on the grounds of their toxicity are freely available in developing countries mainly because they are manufactured locally and because they are imported from other countries (Mohan 1987).
- Widespread availability, ready access to, little restriction of control or education about the safe use of pesticides aggravates the problem of pesticide poisoning. But developing countries have few resources to control the import of pesticides, test them under specific climatic conditions and create effective legislation on their use.
- Pesticide manufacturers claim to be taking steps to deal with the problem of pesticide poisoning through promotional literature, product labels

and advertising to ensure that the correct messages about safe use are communicated (Anon, 1984).

Human factor issues

A consequence of the high use and misuse of pesticides is an increase in the incidence of pesticide poisoning. Much of the poisoning can be attributed to the following: inappropriate transfer of pesticide technology from industrialised to developing countries, the use of spraying equipment which is improperly adapted for use in developing countries, there is no use of personal protective clothing (when it is available it is usually not suitable for use in hot and humid climates), the fact that there is usually little or no provision of suitable training on the safe use of pesticides and safety information that is available (usually written on pesticide packaging) is often ineffective because of the high illiteracy rates among users or it is written in a language that is unfamiliar to the user. If these human factor issues are not tackled, the incidence of poisoning (particularly from insecticides) will continue to increase and will result in chronic illness such as birth defects, occurrence of pesticide compounds (e.g organochlorine) in human milk, cancer and infertility.

Safe seed treatment to reduce operator contamination

Safe and effective seed treatment can offer the potential to improve substantially the production of many grain crops grown in Africa. Treatment can protect both the seed and the developing plant in the early stages of growth as well as reducing the need for pesticide use (Rennie 1993). Elsworth (1993) estimates that losses of seed and food grains during post harvest storage may be as high as 40% in African countries. In order to reduce pesticide use and operator handlling, portable pedal powered seed treatment technology was developed (Miller and Power 1996). Safety in the design of the machines was given a high priority. The basic unit consisted of a rotor housing mounted on an steel ring to which a bearing assembly was attached. The seed treatment chamber was formed from a rolled sheet of steel and fitted with a wooden lid The whole thing was supported on three legs. The pedal drive arrangement was achieved by a standard bicycle crank which was connected to a drive pulley and a drive belt was used to rotate the main rotor shaft. The seeds that can be treated with this machine include groundnuts, beans and cowpeas. The use of the pedal driven machine for the treatment of farm saved seed has leant itself to benefits including, less risk of operator contamination and less environmental contamination because the seeds are treated in an enclosed unit (Miller and Power 1995).

What can be done?

During the normal use of pesticides, some exposure of the worker to the chemical is inevitable. However, it is desirable to prevent exposure/overexposure of the

worker particularly if the chemical used is highly hazardous. For low hazard products it is desirable to avoid over specification of protective equipment use in order to prevent unnecessary expense, discomfort, inconvenience and complacency amongst workers (Carmichael 1989). Normal working clothes can offer a degree of protection. In practice this means long sleeved upper garment, long trousers, footwear and hat i.e the minimum requirement. However, whenever possible or if using chemicals of high hazard rating, it is better to use personal protective clothing (this refers to clothing needed in addition to or in place of normal working clothes). Protective gloves and eye/face protection should to be used during dispensing concentrates and mixing formulations. Overalls and respirators may be required during spraying. Protective equipment is uncomfortable in tropical conditions but it may be possible to spray stored crops during the cooler hours of the day making it more comfortable for the operator (Radley 1992).

Options to consider if using personal protective clothing is not feasible?

Although the use of personal protective clothing is one way of protecting people from chemicals, it is often not provided or it is disliked because it is not comfortable to wear in hot and humid climates or it is not affordable. Alternative measures can be taken to try and reduce the incidence of pesticide poisoning. These include:

- Educating people and creating awareness of the real dangers and on the safe use of pesticides; this includes safe storage, safe disposal, safe working practices e.g do not re-enter fields that have been treated with chemicals, checking spraying equipment is in good working condition, safe hygiene e.g not eating, drinking and showering afterwards near sprayed fields.
- Training people on less hazardous production methods such as integrated pest management, natural pest management and organic farming.
- Providing training to communities in rural areas on how to monitor and treat people suffering from pesticide poisoning.

Farmers only know half the story (Indonesia)

Farmers in Indonesia revealed that they were aware of the dangers of swallowing or inhaling pesticides/fumes but NOT of dermal absorption which tends to be the most common method of ingress (O'Neill, 1997).

The key to the success of these educational approaches is to conduct the training

in a manner that can effectively transmit technical and health information. Human beings have a finite capacity for processing information. When the need to process information exceeds capacity a situation of overloading occurs (Pheasant 1991). This creates a potential for a mismatch between how people may envisage or comprehend a situation. Language and symbols play a crucial role in training. If people cannot understand the language in which instructions and manuals are written, accidents and errors will occur (Meshkati 1989). Farmers cannot usually understand complicated illustrations and symbols which describe safe work practices to adopt while spraying (Tourneux 1994). Figure 8 illustrates a picture that farmers could not understand. Also, stereotypes are not necessarily cross-cultural. For example, whilst the colour red is universally associated with STOP in developed countries, it is not the case in developing countries. In India and China, the colour red marks auspicious events and happiness respectively (Kogi and Sen 1987). To overcome these issues, options to consider are:

- Illustrating instructions using icons and symbols that are culturally recognised and socially sensitive so that they can be properly understood.
- Providing safety and health information in the users' own language(s).

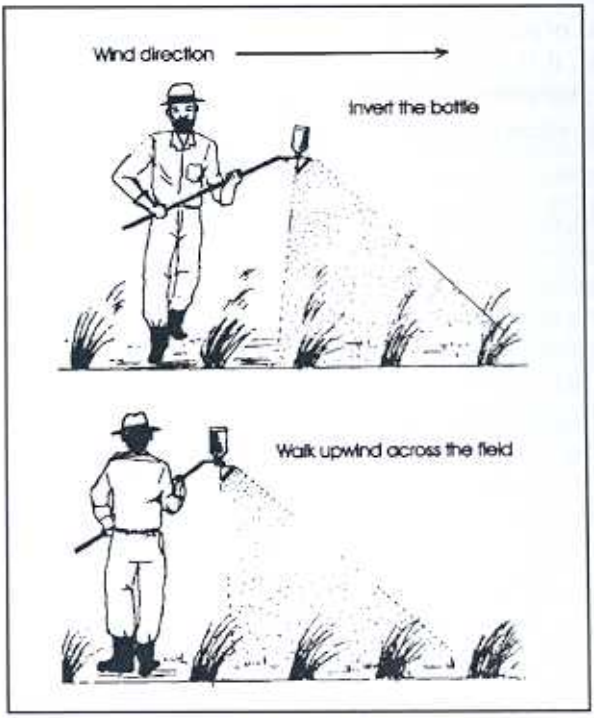

Figure 8 Pictures which describe safe working practices but are too difficult for farmers to understand (Tourneux 1994)

Points to remember:

- ✓ The WHO estimates that there are three million global cases of acute and severe pesticide poisonings per year including 20 000 unintentional deaths. It is also estimated that there are 25 million cases of lesser poisonings each year in lower income countries.
- ✓ Many of the recommendations concerning the use of personal protective clothing which are readily accepted in temperate climates are not practicable in tropical climates. But this does not mean that precautions can be disregarded. It is in these areas that most poisonings occur and where special attention needs to be paid to safety in use (Radley 1992).
- ✓ If it is not possible to eliminate using pesticides then providing training on safe use is paramount.
- ✓ Identifying alternatives to using pesticides is essential e.g integrated pest management

Lack of protective clothing in South Africa

In a survey by the Farm Workers Research and Resource Project conducted in 1989/90 in Transvaal, Northern Cape and Northern Orange Free State revealed that only 4 of the 39 farmers interviewed were supplied with protective clothing. The farm workers were mainly from maize farms. Only one of the workers knew the name of the chemical he was using.

"No, they have never given us masks...If I hadn't spoken about gloves they wouldn't have even given us that...We scoop the poisons like that, without gloves. You put your hand into the container and when you pull it out, the poison is there on your hand...they don't tell us that we have to use masks" (Dinham 1993).

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Section 6

Human Factor Decision Tree

Human factor decision tree

In addition to information provided on specific areas of concern to the crop post-harvest research programme (transport and marketing, design of processing equipment, workplace design for storage and handling produce and safety concerning the use of agro-chemicals), a decision tree (see Figure 9) has been developed to help determine whether there are human factor problems or potential problems in a project. The tree was developed in consultation with crop post-harvest research project leaders and with input from the Natural Resources Systems Programme. The tree highlights areas of concern to both social scientists and human factor specialists as well as areas of overlap between the two disciplines. The decision tree can be used by people from any discipline.

How to use the decision tree

What to look for in the design process:
The tree does not follow a stop/start process: each branch ends with a question to prompt the user to think through the issues. The tree is underpinned by three fundamental questions:

What are people doing?

How are they spending their time and energy?

Will the outputs of the project affect people, what they are doing and how they are doing it?

The decision tree is split into four main human factor/social concerns; time, labour, workload/work effort and work environment. Follow each branch of the tree until you have come to an answer that you, your colleagues, farmers/target groups are satisfied with. It may be helpful to keep a summary of responses to the various questions as you work through the tree.

The decision tree is self explanatory but key questions which may help you to think through the issues are given below. They could also be used as prompts for PRA, for more formal survey techniques or at project reflection points and reviews.

How much time is required?

- Who is expected to do the activity/task proposed (consider gender, age, [e.g. will children be involved] and timing especially where safety nets are inadequate or breaking down, for example because of migration/ urbanisation impacts)?
- What are the current uses of and constraints on people's time and what impact will the project activity have on this ?
- Will the responsible person/people have the time to undertake the activity? Will the time taken displace the time devoted to other activities?

How much labour is required?

- Is the amount of labour required to undertake the activity likely to be a constraint (consider the timing for the labour required)?
- If less labour is required, will it be a problem e.g will it displace paid labour?
- If more labour is required, is it available and affordable (consider who will provide it, gender)?

How much work/effort is required?

- Who is expected to undertake the activity/task proposed (consider gender, age, children)?
- What are the current uses of and constraints on people's energy?
- Will the person or group have the energy required to undertake the activity?

How safe is the environment in which people work?

- Might the project generate health hazards or are existing conditions hazardous?
- How will these hazards be removed or dealt with and by whom?
- Accidents and injuries usually happen when things go wrong e.g inhaling chemicals, hand trapped in machines. Can measures be taken so that people are not exposed to unacceptable levels of accident and injury hazards?

What to do next

If you come up with answers that are not satisfactory or insurmountable problems due to project activities, then further action may be required. Some questions which may help you reformulate the project are:

- Can the project be re-designed so that the problem is removed at source?
- Can the project be remoulded to keep the burden on people to an acceptable minimum (acceptable for the person/s who has to do the work)?
- Does the project require a detailed ergonomics appraisal of a specific component of the project (e.g refer to case studies, can you change the timing of activities, how will project interventions impact on people's workloads)?

Who should use the decision tree, when and where?

The decision tree can be used by project leaders, researchers, research programme managers and advisers. The decision tree has two main uses; to help in project design and development and to help in project implementation of research outputs:

✓ Project design and development

- Speed up the thinking process - think less about the issues but more of how to tackle the issues.
- Add value to projects - think about how time, labour and workload affect people's lives.
- For PRA and other survey techniques.
- Setting research priorities.
- Streamline the type of data to be collected on household and labour allocation at project reflection points for reporting purposes.

✓ Practical application

- Identify practical solutions.
- Think through the practical implementation of the research results (particularly with respect to timing of project activities) including adoption of technologies and how this may affect power relationships within a household or community.
- Help in developing adoption mechanisms for research results.
- Think about how to tackle the human effort/workload issues including implications of seasonal and labour bottlenecks.
- Think about the health issues e.g accidents, injuries, poisoning.
- Obtain ideas about the application of tools and equipment to discuss with farmers.
- Think through technology development issues.

Case Study

An example of the application of ergonomics to crop post-harvest research projects: *Development and Orientation of Cassava Chip Production in Relation to National and International Markets for Food Consumption and Animal Feed in Ghana R6506*

This project aims to develop appropriate processing systems for cassava to enable poor people to raise their income by marketing their produce to identified new markets. One of the challenges in the project was to develop a system for producing good quality dried cassava near to the point of harvest. This involved the chipping of the roots into small pieces that dry quickly.

A cassava chipping machine has been introduced into Ghana based on a design from the International Institute of Tropical Agriculture (IITA). In early on-farm evaluations with farmers, a number of improvements were made to the IITA machine (increasing the weight of the cutting blades, and improving the bearings). Despite these improvements operators still complained of fatigue and they could only operate the machine for 1-2 hours at a time. The project adopted an ergonomics approach to the redesign of the machine. An ergonomics evaluation of the equipment was undertaken. Improvements to the machine were made on the basis of focus group discussions and anthropometric measurements. The improvements were: to make the height of the machine adjustable and to add a hinged box to reduce the frequency that the operator has to bend down to pick up more roots. These ergonomic improvements significantly reduced physiological workload, pain and discomfort. Operators were therefore able to work longer. When tested with untrained subjects the use of the modified machine resulted in a 68% improvement in work-rate (McNeill and Westby, 1999).

Incorporating ergonomics into the re-design of the chipping machine has reduced drudgery and improved productive capacity. The significant reduction in physical strain and incidence of body part discomfort can be expected to reduce the risk of musculo-skeletal damage and ultimately improve health of people. The manually operated chipping machine is only one of the options that have been evaluated as part of a chip production system. Motorised chippers have also been evaluated. Other studies have been made on markets for the chips, fitness of their use in animal diets, their storability, the availability of credit to processors and the linkages between producers and consumers of the product.

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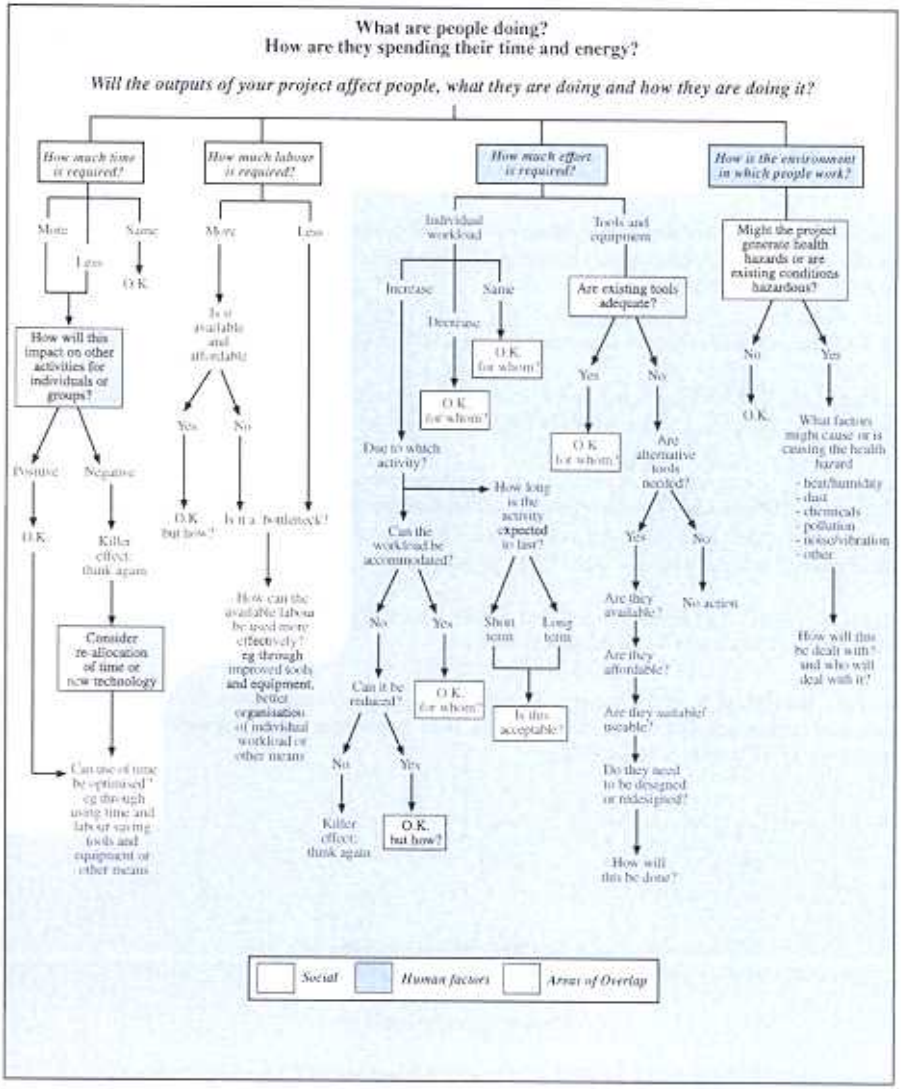
Human Factor Decision Tree

Showing areas of overlap with social science

A practical methodology for incorporating human factors into project design, development and implementation



Funded by DFID Natural Resources Systems Programme and Crop Post Harvest Programme

Figure 9 Human Factor Decision Tree

FURTHER READING

Further detailed information can be obtained from reading books which specialise in human factor issues. These are given below:

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