Tools for Women's Empowerment?
The case of the forage chopper for smallholder dairy farmers in Uganda

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Dedications

To my girls, Louisa and Lynn

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Abbreviations and acronyms

AEATREC	Agricultural Engineering and Appropriate Technology Research Centre
AI	Artificial Insemination
ARIs	Agricultural Research Institutes
ARTP	Agricultural Research and Training Project
CABI	CAB International
CAQDAS	Computer Aided Qualitative Data Analysis Software
CMOC	Context-mechanism-output pattern configuration
DATIC	District Agricultural Training and Information Center
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GAD	Gender and Development
GoU	Government of Uganda
HI	Heifer International
HPI	Heifer Project International
IARCs	International Agricultural Research Centers
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IRRI	International Rice Research Institute
LGDP	Local Government Development Programme
LSRP	Livestock Systems Research Program
Lt.	Litres
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MADDO	Masaka Diocesan Development Organization
MDG	Millennium Development Goals
MDLG	Masaka District Local Government
MFPED	Ministry of Finance, Planning and Economic Development
NAADS	National Agricultural Advisory Services
NARIs	National Agricultural Research Institutes
NARKIS	National Agricultural and Rural Knowledge and Information System
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research Organization
NARP	National Agricultural Research Policy
NARS	National Agricultural Research Systems
NDP	National Development Plan
NGO	Non-Government Organization
NGP	National Gender Policy
OC	Officer-in-Charge
PARIs	Public Agricultural Research Institutes
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernization of Agriculture
SAC	Send a Cow
SACU	Send A Cow -Uganda
Shs.	Shilling (Uganda shilling)
STS	Science and Technology Studies
UN	United Nations

UNCST	Uganda National Council of Science and Technology
UNDP	United Nations Development Program
UNFPA	United Nations Population Fund
UPE	Universal Primary Education
USE	Universal Secondary Education
WID	Women in Development
ZARDIs	Zonal Agricultural Research & Development Institutes

Chapter 1 Rationalizing the design process of labour saving technologies

1.1 Introduction

In an agricultural economy like that of Uganda, where women constitute the majority of the labour force, it makes sense to seek to use agricultural interventions as an entry point for poverty alleviation among rural women. The desire to improve household food security and empower women in rural households has seen the implementation of various agricultural projects, particularly livestock initiatives targeted on women smallholder farmers (Walingo 2009). These livestock development projects generally seek to empower women by improving their incomes and nutrition, and the nutritional status of other household members. In Uganda, a number of livestock projects have supported women by providing zero grazing dairy animals, where the first beneficiary of the project passes on the first calf to another woman as a means of multiplication and distribution (Baltenweck, Mubiru et al. 2007)

In zero grazing, animals are permanently confined in a cattle shed and fed on fodder cut and carried to them daily (Baltenweck, Mubiru et al. 2007; ILRI 2008). One of the advantages of zero grazing is that more cattle per unit area of land can be kept since low yielding natural grazing areas are replaced by high yielding fodder crops (Ministry of Agriculture -Kenya 1984; Mango 2002; Kalema 2011). East African women have long played a key role in the domestic care of local cattle. Even where men are the owners of large livestock, it is women who provide most of the household labour devoted to animal care (Lubwama, Candia et al. 2001). With the introduction of zero-grazing animals, women's tasks within the livestock sector increased because they were directly targeted for this type of enterprise. Given this increased burden, it has been imperative to enhance women's access to appropriate technologies and necessary information regarding new forms of livestock husbandry. The intention of this is to maximize efficiency of scarce labour time, and to guarantee that women and their families directly benefit in terms of improved welfare.

The zero-grazing livestock production system is characterized by high feed requirements and high labour demands (Kabirizi and Nanyeenya 1998). Forage processing for zero-grazing animals requires planting and caring for forage just like the other seasonal crops, and then harvesting, transporting home, chopping and feeding it to the animals. Forage materials for zero grazing animals require chopping for ease of consumption by the animal and increased palatability. These activities are predominantly carried out by women, often assisted by their children. The high labour demands, coupled with a lack of sufficient land for forage production and forage scarcity for dry season feeding, means that available forage must be efficiently used, and waste minimised (LSRP 1999). Hand tools and head porterage are factors in the labour demands of forage production and transportation to often distant cattle stalls. Hand chopping is the common practice among majority of farmers. Additional to low output capacity and lack of uniformity in length of cut, the method is tedious, time consuming and quite dangerous to the operator.

In an effort to address some of these constraints the National Agricultural Research Organization (NARO) developed two types of mechanized forage chopping,[12] motorized and manual. The manual chopper has become more popular with farmers owning few animals since both initial and operating costs are much lower than for the motorized chopper (Lubwama, Candia et al. 2001). Drawing from the evaluation of the machine (AEATREC 2000), the improved forage choppers are able to cut grass and chop legume biomass as well as other forage supplements like banana stems into small pieces more conveniently and quickly. This increases forage intake of the animals. In addition, it makes the process of mixing forage with high energy and nitrogenous ingredients such as calliandra leaf and maize bran easier. By so doing, the nutritive value of feeds, and consequently milk yields, is increased, which in turn potentially greatly improves the livelihood of dairy farmers.

In the development of the forage chopper, it was assumed that the technology would reduce women's labour burdens in forage processing and empower them by freeing their labour for other income generating activities (Lubwama, Candia et al. 2001). This research has followed up on the different users of the forage chopper, and reveals, contrary to expectation, that realities of use and users are much more complex. The overall message of the thesis is that achieving women's empowerment with improved technologies requires much more than simply targeting them as the intended beneficiaries of a simple tool or machine.

1.2 The research issue

The emphasis on women in designing agricultural development interventions in Uganda is intended to promote women's greater access to productive resources, since they form the largest portion of the agricultural labour force (MFPED 2004). The development of labour saving technologies is emphasized by the technology development aspects of the Plan for Modernization of Agriculture (PMA). The plan places strong emphasis on gender considerations as a pre-requisite to any effort to address positively labour constraints in agricultural production and reduction of the disproportionate workload of rural women (MAAIF 2005). Targeting women in technology development was expected to bring about economic empowerment through agricultural labour saving technologies, thus freeing women to engage in other economic activities.

Although the policy's emphasis on women has indeed promoted the development of labour saving technologies (MAAIF 2005), this has not necessarily increased the efficiency of use of women's labour time. Neither has it been enough in itself to guarantee that women gain the full benefit of any labour time saved. The present study was triggered by a MAAIF review of technologies existing within the NARS (MAAIF 2005). The review showed that whereas Uganda had no shortage of improved technologies, some of these

1
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Motorized forage chopper

Manual forage chopper

Traditional chopping

technologies still remained on the "shelf" because they were not commercially developed, packaged and marketed for the benefit of the majority of subsistence farmers. This raises questions as to what extent new technologies have improved women's lives or lessened their workloads, how women can gain better access to such technologies, and whether or not women could play a greater role in the development and dissemination of labour saving technologies in order to better achieve goals of empowerment. In the development of the forage chopper, the design team assumed that taking women's roles in livestock production into consideration would guarantee their use and reduce women's labour time in forage processing. But, this (as the present study will show) was not effectively achieved. An overall objective of the present work is how to remedy this situation. It will explore whether a new approach to women and technology design is needed, and how this might be achieved.

The fieldwork described in the thesis follows up on the dissemination of the forage chopper technology in Masaka district. This reveals a number of issues beyond simply improving women's access to a labour-saving technology. The thesis will follow the development process, and show that a narrow focus on technology design did not bring about the expected change. This, I will argue, is partly because women are not a homogenous and socially isolated group, but women's lives intersect with the lives and interests of other disempowered groups. A major problem, it will be revealed, also lies in the patriarchal values of key institutions. Better outcomes for women will require not just labour saving tools but systematic transformation of certain key institutions and male-dominated ways of thinking. All the strategies of empowering women are influenced by the socio-cultural context (Narayan, Patel et al. 2000; Malhotra, Schuker et al. 2002) in which Ugandan rural women are situated. Another aspect receiving too little attention is the systematic analysis of constraints to machine use. In this thesis I thereofre argue that if the empowerment of women with labour saving tools is to be realized, the design process needs to have an integrated approach, grounded not only in engineering but also in the sociology of gender and making use of insights from Science and Technology Studies (STS).

Hence, the approach this thesis advocates for is one that moves beyond the technology itself, and the problems technological applications are supposed to solve. Instead, it sets out to understand what parties and interests are being mobilized in arriving at solutions that can increase the effectiveness of women's agency in rural development. A more integrated approach will include consideration of the gender division of labour and gender relationships in the household, careful assessment of how new tools improve women's lives and lessen their workload (if they do), and how women might play a greater role in the development and dissemination of user-friendly tools. The overall aim is a rational design approach rooted in an equal appreciation of engineering principles and insights from the social sciences.

1.3 Conceptual framework

Gender, Rama (1997) has argued, is an important socio-economic variable influencing rural welfare and productivity. However, the topic of gender and technology is about more than women's use of technology; it also involves looking at the impact of technological change on social formations. Mechanization can displace people's labour, which in many cases means women's labour. This can be positive, in the case where people are relieved of

burdensome tasks, but it could also be negative if certain people lose income or control over an activity, without finding an alternative (Schoemaker and Katja 1996). A classic instance is where mechanical weeding displaces labouring for cash by landless peasants. Hence, understanding the impact of technological change on society requires consideration of the broader picture. Gender-targeting in technological development can be a good starting point. However, simply having a focus on women is not by itself adequate to the attainment of women's empowerment, in view of the societal effects just mentioned. These societal factors need to be unpacked.

How, then, is this more integrated perspective to be attained? This is where I touch on the conceptual framing of this thesis. The approach is to set back within its social context the activities that the chopper technology was intended to enhance. I do this not by examining the design of the chopper itself, but by considering the actions it is intended to facilitate or displace. This approach to technology as embodied action was first advocated in a famous paper by Marcel Mauss on the technologies of the body, published in 1934 (Mauss 1972 [1934], as explained in Schlanger (2006)). A focus on embodied action places the emphasis on describing what women do in caring for and stall feeding cattle in rural Uganda. This requires, in short, a technographic approach. Technography can be defined as systematic description of machine or device-assisted embodied actions (Richards 2003; Kien 2008; Jansen and Vellema 2011). The primary focus is on the tool or device as an extension or projection of human agency, in a field in which other agents, employing other tools, play a significant part. In short, it is a contextual approach to technology, that backgrounds the machine as such and foregrounds its instrumentality. Here I focus on the life-worlds of female cattle carers, and how they develop various instrumentalities within a wider field of other activities and activities by others. This approach will lead to an enhanced understanding of what the introduced forage chopper could and could not do, and how it might still be improved within the gendered interplay of Ugandan rural life worlds. Issues of technography are addressed further in the section on methodology below.

1.3.1 Gender and development

Gender as a concept refers to the social positioning and expected roles of both men and women, the power relations affecting interactions between them, and the structural context creating and reinforcing these power relations. Earth (2003) defines gender as the culturally determined characteristics, roles and behavioural patterns that distinguish men and women. Agarwal (1994) defines gender relations from an economist's point of view as the relations between women and men which are revealed in a range of practices, ideas, and representations, including the division of labour, roles, and resources between women and men, and the ways in which different abilities, attitudes, desires, personal traits and behaviour patterns are ascribed. The household is frequently viewed as a primary arena for gender relations. According to Kabeer (2003) gender relations are multi-stranded: they embody ideas, values and identities; they allocate labour between different tasks, activities and domain; they determine the distribution of resources; and they assign authority, agency and decision-making power. Earth (2003) emphasizes that these social definitions bestow power differently between men and women. These different dimensions of power define gender relations. Any changes in these power dimensions constitute the gender dynamics.

Gender has become a contentious issue within the field of development practice, as institutions and communities struggle over the nature of representation, recognition and solution to problems, and appropriation of resources directed towards development interventions (Phalane 2005). One of the reasons gender is so contentious in development is that so often the focus has been on women's issues, rather than addressing the key problem of what to do about often grossly unequal gender relations. Gender is nearly universally taken to refer to the social factors shaping the realities of women and girls only (Barker et al, 2010). Yet in the process of working towards the involvement or equal participation of women, the dilemmas faced by the 'other' gender ought also to be regarded as gender issues. To date, these aspects have rarely been given proper consideration (Cornwall 1997) (except in the recent World Bank review (Bannon and Corriea 2006) of men's issues in development). This is especially an issue in rural Africa where ideas about masculinity and male gender roles are rapidly changing, touching core values about gender identity and power relations between the genders, in rural societies traditionally dominated by patriarchy.

Many writings on gender also assume that (all) men are powerful and (all) women powerless. A focus on gender in development is often perceived to imply the balance of power between men and women, thus involving a shift of power from men to women. Yet, although some men benefit from patriarchal structures, these very structures and stereotyped notions of gender also hide the increasing disempowerment of many other men in rural areas (Silberschmidt 2001). Silberschmidt (2001) even argues that socio-economic change undermines men more than women, with men's roles and identities being challenged whereas those of women have been strengthened in some ways. Unfortunately, the idea that men have a specific role in relation to achievement of gender equality has only emerged recently (Connell 2005; Bannon and Corriea 2006). Reviewing of gender roles was still resisted by men because abandoning some of their roles deprived them of their perceived patriarchal positioning. More practically, sharing or taking over some aspects of women's roles meant a reduction in their leisure time. A question was what was to be gained from this reduction. Cornwall (1997) has argued that if certain ways of being a man are culturally valued, then asking men to abandon these identities without offering anything of value to hold onto is unreasonable. Conversely, women are sometimes doubtful about delegating some part of their role since they lose valuable networking opportunities. Women's work can contribute to female solidarity and cohesion – e.g. collective weeding of farms.

Discourses on gender in Africa are now connected to demands for equal rights and access to resources. Integrating gender in development activities has been at the forefront in many development programs and projects because the process of achieving development objectives often exacerbates differentials between men and women in terms of access to resources. Gender equality has become a core development issue (World Bank 2001) because it is realized that gender balance of power affects, and in turn can be affected by the forces of development and technological change (Earth 2003). Gender and development efforts have therefore focused on addressing the gender disparities existing between men and women (Ahikire 1998), which tend to disadvantage the female gender and limit its capacity to participate in and benefit from development (Phalane 2005). For instance, women's limited access to productive resources like land reduces their agricultural productivity. This has greater economic and social costs as it limits women's

ability to improve their lives and thus the prospects for reducing poverty (Phalane 2005; FAO 2011).

Like other UN member countries, Uganda subscribes to the international, regional and sub-regional treaties, frameworks and instruments on gender equality and women's empowerment. For instance, the government has promoted women's empowerment and gender equality by establishing institutional mechanisms at different levels to mainstream gender in the formulation of policies, plans and development programs. In addition to the international and regional gender equality instruments, the government has also adopted a constitution that takes on board gender equality issues. The state support for gender equality is entrenched in Uganda's Constitution of 1995. The Ministry of Gender has been required to articulate women's recommendations and present them to the Constitutional Commission. Political will and a framework for mainstreaming gender into development thus exists, and gender equality now receives attention in the formulation of Uganda's development strategies (MFPED 2004; UNDP 2007), with gender being handled as a cross cutting issue in all development interventions. Uganda is thus one of the African countries that has undertaken a comprehensive gender budgeting initiative as a strategy to accelerate the promotion of gender equality and pro-poor equitable development (ADF VI 2008).

Uganda's progressive gender policies have had some benefits in increasing political participation by women, but these women are mainly from the elite. Political participation of women remains restricted to a few (Muhumuza 2008). A lack of voice for ordinary women is a situation that continues to reinfoce existing gender inequalities at the local level. Where gender relations are generally more oppresive than at the national level. Indeed much remains at the level of "rights talk", as propounded in policy documents. Practical implementation, affecting the lives of rural women still lags behind these discursive manifestations. Although Uganda has embraced gender mainstreaming in most of its development interventions, and even though effective institutional and policy implementation mechanisms exist, a large gap still exists between policy and practice. This is mainly attributed to the continued presence of cultural attitudes and traditional institutional practices that have not changed at the same pace as national-level policy and institutional frameworks, ineffective policy implementation mechanisms, and shortage of adequate resources to implement changes (ADF VI 2008). Barker et al (2010) argue that not involving men in public policies to promote gender equality is one cause of slow progress. They suggest that ways should be found for gender-mainstreaming policies to adequately engage men, and to change underlying social norms and institutions to support men in becoming more gender equitable.

Key to the present research is the way gender relations are framed in technology as an aspect of rural development. Gender imbalances are here noted, as in other areas of rural life. The thesis in effect asks whether this is due to entrenched ideas and attitudes, or more to the way practices are implemented. In this research, I take up the analysis of gender relations among dairy farmers to examine the extent to which the key to change lies in reshaping attitudes or in re-organizing practices. The answer will affect policy implementation strategies, especially in regard to empowering women. Existing literature already points to an important difference between policy formulation and implementation. Policy belongs to the world of ideas but implementation to the world of

practices. I explore this difference later in this thesis in order to throw light on exactly how a gender-oriented policy translates into practices of potential benefit to women.

1.3.2 Development and empowerment

International development agencies view empowerment of women as a means of advancing sustainable development and reducing poverty. (United Nations 1995; World Bank 2001; UNDP 2007; United Nations 2010). The promotion of women's empowerment as a development goal is based on a dual argument: that social justice is an important aspect of human welfare and is thus intrinsically worth pursuing, and that women's empowerment is a means to other ends (Malhotra, Schuker et al. 2002), such as poverty alleviation. However, the meanings and strategies associated with the empowerment concept vary, and the methods for systematically measuring and tracking changes in levels of empowerment are not well established (Malhotra, Schuker et al. 2002).

Oxaal (1997) describes empowerment as being about the ability to make choices, involving the ability to shape what choices are on offer. The World Bank has broadly defined empowerment as the expansion of freedom of choice and action (Narayan 2002). Kabeer (2001) defines empowerment as the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them. Bartlett's (2008) understanding of empowerment is that it is a process involving transformation, with three elements: *means*, *process* and *ends*. As a process of transformation Bartlett argues that understanding the nature of empowerment lies in the distinction between the three elements. The *means* of empowerment encompass a wide range of enabling factors (rights, resources, capabilities and opportunities); the *process* of empowerment is often seen in terms of making choices, involving a number of steps (analysis, decision making and action); and the *ends* of empowerment are people taking greater control of their lives.

Although these definitions apply to other disadvantaged groups as well as women, Malhotra (2002) singles out women's empowerment as having unique elements because female gender is a crosscutting category, intersecting with other disempowered groups. Additionally, households are a central locus of women's disempowerment in a way that is not always true for other disadvantaged groups, and women's empowerment requires systemic transformation, particularly of the institutions that support patriarchal values. In Uganda's policy environment, women's empowerment has been defined as the process of enhancing women's capacity to take charge of their own development, a process that involves enabling women to make their choices, to have a say in decisions that affect them, to be able to initiate actions for development, to enable change in attitudes, and to generate increased consciousness of equal access to and control of resources and services in order to take charge of their opportunities (GoU 2007).

These different definitions present subtle variations in views on what empowerment is. But, cutting across all of them is the issue of choice and agency. The contradiction in this is that emphasis is put on women, yet it is acknowledged that there is overlap with other groups. In the zero grazing case I am about to examine, women have been targeted on the grounds of their gender, but little or no attention has been paid to the implications of this categorization, or of women's membership in other collectivities with which the designation overlaps. In fact, programmes have targeted women as individuals, under the assumption they operate relatively independently. Some attention, it is true, is paid to

women as members of households, as the locus of their empowerment, but little consideration is given to the fact that this entity is highly variable in terms of composition and activities. In the research, I take up the issue of how women as users of developed tools are variously embedded in households, families and communities.

The strategies for achieving empowerment are as equally varied as its definition. Narayan (2000) has actually noted that the strategies will vary depending on the political, institutional, cultural, and social context, and that strategies do evolve and change over time in any given context. In other words, the concept of empowerment only has meaning within the specific socio-cultural contexts in which development takes place. Narayan (2000) adds that successful efforts to empower poor people, increasing their freedom of choice and action in different contexts, often share four intertwined elements: access to information, inclusion and participation, accountability and local organizational capacity. In other words, strategies for achieving empowerment are expected to improve or increase access to information, enhance participation, allow people to hold public officials accountable and build local organization. Likewise, Kabeer (2001) also argues that strategies for achieving empowerment should focus on three interrelated dimensions that make up choice: resources, which form the conditions under which choices are made; agency, which is at the heart of the process by which choices are made, and achievements, which are the outcomes of choices. An important aspect this points to is the need fully to understand the context of the users in assessing the empowerment potential of interventions.

Whereas empowering women has been advocated as an indispensable tool for advancing sustainable development and reducing poverty (United Nations 1995; World Bank 2001; UNDP 2007; United Nations 2010), not all action taken to this end can be described as empowerment. Uganda has had some benefits from an active affirmative action policy to reduce gender imbalances in higher education (MFPED 2004), governance, politics and management (IFAD 2005). However, increasing women's chances for education has not necessarily guaranteed the development of relevant skills for their adult life (MFPED 2004) necessary for empowerment. As noted above, increased participation in political spheres has only led to elite capture, benefiting elite women more than those at the grassroots (Muhumuza 2008), with the perverse consequence of reinforcing existing gender inequalities at the local level. Rural women's empowerment will only come, it can be argued, when these women achieve increased control and participation in decision making leading to better access to resources (such as land), and therefore, improved socio-economic status. Only when the process of empowerment is self-directed can we say that empowerment is truly taking place (Bartlett 2008).

This then leads to the question of whether empowerment can really be planned. As evidence in this thesis implies, this may be unlikely or difficult. All the strategies for achieving empowerment are influenced by socio-cultural contexts that develop and evolve, which makes it difficult to plan for empowerment. The *means* of empowerment that define the choices open to an individual are rooted in the socio-cultural organization of communities or domestic groupings. The *process* of empowerment that defines agency entails a number of steps that are also influenced by the socio-cultural context. A further complication, as noted by Bartlett (2008), is that both the *means* and *process* of empowerment must change for the *ends* to be realised. In other words, the three are

interrelated and for empowerment to occur, all three must be acted upon. In reality, it is not likely that an intervention strategy will be designed to address empowerment from this perspective.

With the diverse definitions of empowerment and the strategies for achieving it, it seems that many times the term has been misused and some actions taken by developers can be better referred to as "inclusion" strategies than "empowerment" strategies. "Women" and "empowerment" have been used as labels in intervention strategies, when the processes are actually devoid of the critical elements of empowerment. All this points to the need for an approach focused less on categorization and box checking than on analysis of actual processes through which power is made. This emphasis on process – and specifically the role of technology as enabling tools in the process of making – is the main focus in this thesis.

Uganda has undertaken research into tools for gender empowerment and this thesis is concerned, specifically, with the impact of this research. It asks the question to what extent have these technologies improved the lives of poor women and empowered them to realize their efforts towards alleviating the poverty that lies at the historical root of their disempowerment. An aspect of empowerment that this thesis picks up for analysis is the need to look at women's productive activities in context – notably, within the context of households where other members may also belong to overlapping disempowered groups. The research will pay special attention to the way designers of technologies have picked up upon and reflected understanding of the context within which women's use of labour saving tools takes place. In short, the thesis intends to offer a critical examination of how designers have framed users, applying a gender relations and empowerment perspective.

1.3.3 Technology and development

Technology is often defined in terms of the design and development of tools, machines and technical processes. In this regard the word is sometimes shorthand for innovation (i.e. new devices or processes). The tradition of technology studies initiated by Marcel Mauss takes a different approach (Schlanger 2006). It equates technology with technique. The study of technique begins with the body and addresses embodied capacities and their acquisition (e.g. tree climbing or swimming). Mauss wrote a classic paper on techniques of the body in 1934 (Schlanger 2006). Embodied capacities can be extended by the use of tools, machines and biological or technical processes, but the process begins with the human capacity to make. If the body (and human agency more generally) is hidden or ignored then the essential human purposes served by the acquisition of technique, and the enhancement of technique through use of tools, machines etc., risk being obscured. It is but a short step to the fetishization of the machine and worship of the new.

Here I am concerned with the analysis of technique for the light it throws upon technology as a means to material self-improvement and improvement in living conditions and livelihoods. As already implied, the focus of this thesis is on techniques of cattle rearing deployed by Ugandan women in generating or contributing to household livelihoods. I will be especially interested in attempts to improve cattle rearing that especially fit women's embodied capacities. As noted, most technology development efforts have either targeted men's activities, roles or tasks, leaving women struggling with "traditional" labour intensive, time and energy consuming techniques (FAO 1997; Doss 2001; Carr and

Hartl 2010; FAO 2010). Furthermore, until recent attempts to empower women, agrarian technology development was largely thought of in terms of decisions about techniques and processes deemed to address the market needs of the private business sector. Little attention was given to the appropriateness of proposed improved techniques to the capacities of end users, and the capacities of rural women especially.

This line of thinking led to a genre of studies mainly focused not on technique as such but on the dissemination of presumed superior techniques. There was little or no attention to the question "what makes this technique superior?". It was often enough to answer "this is the techniques that farmers in developed countries use". It was too frequently assumed that an exotic process, once introduced to Uganda, would be positive and unproblematic (Bourque and Warren 1987). Yet agricultural development seemed to be accompanied with a worsening of the position of women because agricultural technologies were only made for, or made available to, men (Boserup 1970). To correct this, there has been a global recognition of the need to look at the appropriateness of technology to the users, both men and women, but with particular emphasis on women in African agriculture, since they form such a large proportion of the farm labour force in basic food crops and household products (FAO 2001). The main reasoning behind this shift has been a realization that improved techniques – in this case of cattle rearing - may be feasible, in terms of market demand, or political desire, but this does not mean that they are socially acceptable or beneficial to all categories of users. International development agencies then started to demand an emphasis on women's productive contributions by policy planners and technology development agencies. The aim was to alter development practices so that women producers gained their fair share of technology inputs (Razavi and Miller 1995).

Because of this, there has been an urgent call for technologies that address the gender needs of users. The focus on some of these gender-based initiatives has been on reducing labour bottlenecks. In countries such as Uganda, with predominantly peasant agriculture-based economies, emphasis has been on reducing household labour bottlenecks that often tend to limit productivity (NARO 2001; MAAIF 2005; Carr and Hartl 2010). Household labour-saving tools are mainly important during the peak production season when hired labour costs run high. According to Carr (2010), targeting women addresses the problem directly since women are central to overcoming rural poverty through their role in providing basic feeding and welfare for the household. One strategy for empowering women addressed by the government of Uganda has been to introduce mechanization that reduces women's drudgery in agriculture (MAAIF 2005). This strategy entails the promotion of labour saving tools with a focus on women's roles and activities. This approach to mechanization seeks to empower women by freeing up their labour in agricultural production and thus increase the women's available labour time to engage in other income generating activities. Thus it is of interest to find out how effective has strategy this been.

Doss' analysis (2001) of designing technologies for African women shows that simply taking women into account is not sufficient. Developing technologies that truly improve women's well-being poses a much more difficult challenge. This is largely so (as this study will show) because women do not operate exclusively as women, but belong to a wider socio-technical system with a range of other actors (many of whom are men!). As such their

use of technology is bound to be influenced by these other actors in the socio-technical system, and thus the issue of gender interactions is inescapable. Consideration of gender indeed adds a new dimension to development debates, with issues surrounding development and dissemination of technology widening to include the cultural and economic complexity of gender relations (Bourque and Warren 1987).

Technologies for women thus have to be engineered with a sharp eye upon likely responses by men. There is no gain to women's welfare if the productivity of women's labour is increased only for the benefits to be appropriated by other actors. Conventional wisdom in technology studies tends to focus on aspects such as access to information and availability of credit or know-how as constraints to technology uptake and use (Feder, Just et al. 1985). But this focus will only partially improve women's uptake of technology and use at best. One of the limitations is that too many development programmes have been gender-blind in the past - they saw "the people" as their target group, and did not try to understand the different realities of men and women's lives. Even in cases where women are specifically mentioned as the most important target group, proper gender-focused analysis is seldom done on the impact an intervention will have on the lives of women (AusAID 1998), including (crucially), how interventions will impact on gender relations at household level and in the community more widely.

The purpose of the present thesis is to try and assess – through an analysis of a labour-saving tool in use – the significance of these gender-based contextual factors, and then to read back the lessons for the design and re-design of tools intended to improve the lives of rural women. This means that the way a machine embeds with existing production strategies will become a crucial issue in understanding how to empower women via labour saving tools. In exploring issues of technology use, Richards (2003) argues that it is necessary to see beyond the technology itself and the problems technological applications are supposed to solve to understand what parties and interests are being mobilized in arriving at solutions. The methodological tool for investigating technique in contextual practice he terms technography. Using this technographic approach, this thesis seeks to contribute to the understanding of the social, material and institutional contexts of technology use and uptake for the empowerment of women.

The main research question this thesis is targeted to answer, therefore, is as follows: How can engineers rationalize the design process to mobilize the potential of labour-saving mechanization tools to empower women in rural Uganda?. This can then be broken down into the following sub-questions:

(i) How can women's participation in the socio-technical networks of the design process be organized to ensure the design process turns out workable machines?
(ii) How can women gain greater access to labour saving tools?
(iii) What factors influence women's use or non-use of new machines/tools?
(iv) What is needed to make technology uptake and use successful and conducive to broader goals of women's empowerment?

Using the case study of the introduction of the forage chopper among smallholder dairy farmers, the thesis attempts to answer these questions in four empirical chapters. These explore issues of the design process for NARO's labour saving tools, the targeting of NARO technologies, the role users play in the dissemination of technologies and how women's

use of labour saving tools can be enhanced. In assessing the gender empowerment potential of the forage chopper among smallholder dairy farmers in rural Uganda, I draw upon Bartlett's definition of empowerment (see above). This is because it focuses on empowerment as a process, assessing not only the end results but the transformation in the means and process for achieving it. This process focus to empowerment also fits well with the Maussian perspective on technology as technique (as an embodied process of making). The successful uptake and use of labour saving tools as a means of empowering women also has implications for household distribution and allocation of labour and economic resources. Tracing the tool's potential to empower women thus requires a detailed examination of the transformation of enabling factors (resources, opportunities) and the decision making process in the different households. It is at this level that gender as the study of both men and women becomes an important aspect.

1.4 Rational design

As stated, the eventual aim of this thesis is to introduce gender into the process of engineering design. Design is sometimes treated as an impulsive conceptual process, dependent on sudden inspiration (a eureka moment). In actual practice, engineers are much more systematic in the way they proceed. By and large they presume that design is a rational process, involving definite targets and protocols for aligning technical possibilities and innovative solutions with client needs. In commercial practice this involves working closely with the client over specifications and tracking progress towards delivery on agreed targets. Designing labour saving tools (and other products) for rural women in Uganda requires a somewhat modified approach to rational design.

Women cattle rearers are not organized as a client group, and lack trusted interlocutors. In the absence of an agreed specification engineering design tends to be somewhat speculative. But much can be done to introduce pathways for feedback and modification into an initially speculative design process, and thereby develop a rationalized approach focused upon potential targets. Here, I identify four possible strategies to the iterative rationalization of the design process to address women's empowerment needs. These comprise: organization of feedback, reconfiguring the users, following the domestication process, and improving processes of technology uptake and use. In the thesis I use these four potential strategies as guides both to the technography (i.e. the account of the actual technological transformation process) and as pointers to possible improvements intended to address any weaknesses found. I further explain these four approaches in the empirical chapters of this thesis but briefly introduce them here.

1.4.1 Organization of feedback

One possible way of rationalizing the design process lies in improving the way feedback is organized between the technology designers and the targeted users. Design is a collaborative effort in which many people (engineers, technicians, users) play a role (Poel 2001) in varying institutional or social environments but, the representation of users in the design process is still limited (Cañavate, Casasus et al. 2009). Very often the network of engineers does not recognize the other social entities in the socio-technical system. Usually a distinction exists between users and developers, framing the "protected space where technology is made" and the "protected space where technology is used". In this chapter I examine the importance of the interactions between the designers and the other

people, as well as the interactions between the designers and other technical networks and their importance to turning out workable technologies.

Current practice during the development process of NARO technologies is to involve users in constraints identification and the evaluation process of the technology (AEATRI 1997). However, these are institutionally configured spaces that offer users little room for maneuvering. The concept of user participation in the design process has been theorized in the user-centred approach (Stewart and William 2005) where design decisions are much more likely to reflect values and desires of users. This study conceptualizes that users engaging with a new tool can directly contribute to redefining it, its use and social significance to create the practical usefulness of the tool. The study explores the approach of observational feedback with what Richards (2007) has termed "appropriately configured" performative mechanisms that minimize challenges of users' involvement.

1.4.2 Reconfiguring the user

A second possible element of rationalizing the design process lies in improving the way designers configure users. Many development interventions have focused on women and very often used "woman" as a label without examing the meaning of the term within the social context. Designers always have expectations of how the machine will be used, by whom and in what context. By so doing, they construct a "virtual" user, extracted from her work environment. But in technology development, women (users) are part of a socio-technical system, with other social entities or elements that combine or intertwine with the tool to determine its use and impact. Technology users are not fixed entities in terms of composition and activities and their interaction with a tool is structured by other social relations as well which are equally dynamic. This points to the need to reconfigure the users of tools/machines to close the gap between the "virtual" users envisaged in the development process and the "actual" users of the tool.

Two approaches have been theorized for constructing a "virtual" user: sociological analysis (Oudshoorn, Rommes et al. 2004) and interactive design (Stewart and William 2005). The sociological analysis opens up the context of the actual user to understand how their activities are organized and how these combine with other social entities. In this chapter, I examine the context of the actual users of the forage chopper to gain an understanding of how this influenced the uptake and use of the machine targeted for the women's empowerment. The interactive design process on the other hands allows a hands-on process of remodeling the machine by users, the details of which are discussed in the first possible approach to rationalizing the design process.

1.4.3 Following the domestication process

A third possible dimension of rationalizing the design process lies in understanding use of the disseminated technology that is evident during the domestication process. Social practices of use of a machine cannot be fully anticipated in the design phase; they only emerge during the interpretation and integration process of the machine (Rohracher 2005). This makes it necessary to follow through with the users when a new machine is introduced to understand how people use it. The relevance of this lies in the fact that processes of interpretation and integration of technologies by users are influenced by the social structures, circumstances and cultural conceptions of households. Hence the way users are organized in terms of activities and composition, the community resources

available to the different users, their ability to mobilize these community resources, and eventually the way all these intertwine with the machine will determine its use.

The different ways people use the machine emerges through the domestication process (Rohracher 2005; Stewart and William 2005; Williams, Stewart et al. 2005; Bray 2007) in which users integrate a machine into their daily lives. This process is characterized by making and remaking of the tool. Using the case study of the forage chopper, this study examines the process of domestication, describing the different types of use, symbolic expressions, making and remaking of the technology. The relevance of this in rationalizing the design process is that it explores the issues that facilitate use and non-use necessary to achieve the tool's empowerment potential for women. Technology is not a fixed plug-and-play type of device but, a process of making and remaking and if labour saving tools are to carry meaning for rural women, rationalizing their design process points to the importance of understanding the different community resources and the way users can mobilize them to facilitate uptake and use of the tool.

1.4.4 Improving processes of technology uptake and use

The strategies of rationalizing the design process would be incomplete without examining how the three strategies link with the policy environment to enhance technology use. The use of agricultural interventions as entry points for empowerment of rural women in Uganda had wider policy implications. Mechanization of agriculture to increase production & productivity, and/or reduce labour time especially for those engaged in agriculture (majority of whom are women - in the case of Uganda they constitute 80% (FAO 2010)), was one of the agricultural sector initiatives to improve women's welfare and also increase their access to production technologies (GoU 2005). However, policy formulation and policy implementation are usually two different things, and policy documents never spell out the implementation strategies.

Indeed the policy commitments allow a focus on women, and may facilitate the development of labour saving tools to reduce women's labour. However, this does not necessarily imply that there will be an increased efficiency of use of women's labour time in agriculture. To gauge this, it is important to understand how activities and work routines are organized and how these will embed with the new tool to achieve the policy objectives. This very often requires careful analysis of the target group in its context (women in resource-poor settings in the case of women empowerment policies), it requires incorporation of a proper analysis of the material environment (including use of tools – usually known as technology) and is bound to spell out a new role for engineers to effectively rationalize the design process to achieve the women's empowerment with improved technologies.

1.5 Research Methodology

This is a technographic qualitative research which focuses on a socially active labour saving tool. The research explores how designers organize feedback, how they construct the users and how the farmers use the machine when it is introduced. Technography has been proposed (Richards 2003; Kien 2008; Jansen and Vellema 2011) as an interdisciplinary methodology for the study of technology in everyday social situations. Jansen and Vellema (2011) define technography as ethnography of technology. Kien (2008) defines technography as a perspective for describing "socially active technology" in qualitative

research. Richards (2003), defines technography as an attempt to map out the actors, processes and client groups.

The analyst should see beyond the technology itself and the problems technological applications are supposed to solve (Richards 2003). According to Richards (2003), it is importnat to note that no technology can be fully understood unless the social dimensions in which it is embodied are properly specified. Technography aims not to complete description, but to gather relevant information to understand in braod outline tha ways tools, machines and social systems are combined and interact in any socio-technical system or process. The approach reveals how technology dynamically works with human actors (Kien 2008; Kien 2009). As explained by Richards (2003), this is a realistic evaluation that aims at understanding how the elements combine, but with a focus not on society, polity of community, but on socio-technical systems. Realist evaluation recognizes that processes or systems are open and cannot be isolated or kept constant (Pawson and Tilley 1997).

The axiomatic base upon which all realistic explanation builds is "causal outcomes follow from mechanisms acting in context" (Pawson and Tilley 1997, p58). Realistic evaluation, hence, enables us to develop the context-mechanism-output pattern configuration (CMOC) by analyzing the mechanism, context and outcome of a system or process. In this thesis, I use the technographic approach to illuminate the CMOC. The expected outcome in the development of the forage chopper is improving the situation of rural women with labour saving tools. The candidate mechanism (the research question) is ways of rationalizing the design process of labour saving tools to hit women's empowerment. A set of contexts then needs to be examined: the realities of use and users (social context of women's work). The benefits of using the technographic approach lie in being able to map out the different elements of the socio-technical system (the actors, resources) that interact with the machine, follow up on the different local resources and examine how these are being mobilized by the actors in the making and remaking processes to determine machine use. Using the technographic approach in this thesis I set out to map out the different social entities and gather information on domestic groupings, individuals/task groups and activity profiles of smallholder dairy farmers to understand what and how resources are being mobilized to determine use of the forage chopper. The study employs an in-depth qualitative realistic evaluation to explore how the forage chopper interacts with its social milieu when it was introduced among smallholder dairy farmers of Masaka, in Uganda.

1.5.1 The study area

The study was conducted in Masaka district of Uganda, in the four sub-counties of Kkingo, Kabonera, Mukungwe and Bukulula (Fig. 1.1). Masaka district, one of the oldest districts of Uganda, originally consisted of Rakai, Kalangala and Sembabule. Currently Masaka has been reduced in size after Kooki, Ssesse islands and Sembabule were elevated to District status. Masaka district is situated between 0^0 – 25^0 South and 34^0 East, having an average altitude of 115 m above sea level. Masaka borders the Districts of Mbarara in the west, Rakai in the south, Mpigi to the north-west, Kalangala in the east and Lake Victoria is in the south-west. The district has a total land area of about 4560.4 sq. km, 30 percent of which is water and swamps. Administratively, the district is divided into three counties and one

municipality with 23 rural sub-counties which are further divided into 127 parishes and 1331 villages (Source: Planning office - Masaka district).

Figure 1.1: Map of Uganda showing the study district
Inset showing the study sub-counties

The district has an estimated total population of 770,622 (2002 Population and Housing Census), 3.2 percent of Uganda's total population, with 51.24 percent being female. Masaka district is predominantly rural (10.6 percent of its population live in urban areas). The district has considerable ethinic diversity. The majority are Baganda, a Bantu speaking ethnic group, followed by Banyankole, Banyarwanda and Banyoro. The main religion in Masaka is Roman Catholicism, followed by Islam and Protestantism. Uganda's colonial legacy is such that religion influences national and local politics, as well as social policy. Religious affiliation determines social, political and economic outcomes at diverse levels; inclusion in a range of opportunities is often based on religious classification or identity.

The rainfall pattern is bimodal, with dry spells between July and August and January and March. Agriculture is the main source of income in the district. A majority of farmers are smallholders, growing both perennial and annual crops. The annual crops are mostly grown for home consumption, with the surplus being sold in the local and urban markets. Banana and coffee are the main cash crops, with maize a secondary cash crop, and sweet potatoes a secondary food crop. Livestock was not originally integrated in this system, but dairy cattle have gained prominence. It is now common to combine crops and livestock; the two enterprises are complementary.

1.5.2 Sampling of sites and respondents

The study followed up smallholder dairy farmers in various farmers groups in four sub-counties (Bukulula, Mukungwe, Kkingo and Kabonera). These sub-counties have benefited from the activities of Send a Cow (SAC) and Heifer Project International (HPI). The four sub-

counties were selected for research as having the highest concentration of NGO/project zero grazing animals during a pre-study phase after stratification of the district by the agricultural production sector based on exploratory visits and meetings with the district production officers. The study population comprises the smallholder dairy farmers, owning 1-5 animals, grazed in the back yard of their homesteads. The respondents included farmers and key informants.

Two main groups of farmers were selected for the study: smallholder dairy farmers with forage choppers (study group) and smallholder dairy farmers without the improved forage chopping technology (control group). The study group was purposively sampled to provide information-rich cases that could be studied in depth for gender-technology relations. The control group was randomly selected to find out what is typical of smallholder dairy farmers as a whole. At a later stage 2 more groups of farmers were purposively selected to gain more understanding about relevant actors in zero grazing. These were farmers with local animals and farmers who grew forage for sale to smallholder dairy farmers. Key informants included officials of livestock NGOs, NGO extension staff and NARO staff. The key informants were also purposively selected due to their role on the projects or organization. The sampling units were villages in the four sub-counties and the unit of analysis was the household. Both villages and households were randomly selected.

1.5.3 Data collection

Primary data and other information were obtained using in-depth, semi-structured and informal interviews and observations for both individuals and focus groups (Frechtling, Sharp et al. 1997; Hoepfl 1997; Fountain 2004; Ellsberg and Heise 2005) whereas secondary data was obtained from study of literature and documents. The author's professional experiences were also used to provide information on design aspects. Farmers' data collection was done for both the rainy (March to May and September to November) and dry seasons (December to February and June to August) to compare how gender relations played out during the peak production period and the non-production period in different households. Before data collection, some conventions had to be observed to gain access to respondents, especially among farmers.

Districts have district administrators. It is from this level that clearance to start any work in the district began. With this clearance I then had to seek clearance from the local area councils of the respective study sites because these were the gatekeepers to all the respondents in the study area. All this protocol had to be observed to ensure there were no ethical risks associated with the research. NARO's formal clearance to carry out research in the district had already been granted through its collaborative work with district MAAIF staff. An introduction letter from the research institute was used at the District, detailing what the research entailed, the research plan and requesting consent to carry out the research in the district. With this consent, the production department staff introduced me to the local area leaders, detailing the research objectives and plans and seeking their collaboration in the research. The local area council chairmen were used to gain access to the farmers, farmers groups and the NGO leaders. An informed consent was then sought of all the respondents to be interviewed and a clear explanation was given on the uses of the data, how the analysis was to be reported and how it was to be disseminated.

Interviews

In order to gain an in-depth understanding people's situated accounts and experiences in technology development and use, semi-structured and informal interviews techniques were used. The interviews allowed focused yet conversational communication with respondents with some flexibility to probe more details. The conversational aspects of each interview was particularly important with farmers, given their varying levels of literacy. A total of 120 farmer and 12 key informant (3 from MAAIF, 3 from SACU, 3 from HPI-MADDO and 3 from NARO) interviews were conducted. Data recording for all the interviews was in form of detailed notes as well as digital recording. The recorded interviews were stored in the computer and replayed during data entry. All farmer interviews were conducted in the local language (*Luganda*) and later translated into English during data entry.

Focus group discussions employed a topic guide to explore issues on farmers' context, how gender relations had evolved over time with the livestock NGO interventions, the implications this had for the introduction of the forage chopper, and how human-technology interactions had shaped the design of the forage chopper, and its method of use. Also covered were the gender-related effects of the tool on development and dissemination processes. Four focus group discussions were conducted, one in each study sub-county. It was difficult to separate the men from the women because of poor turn-out. One of the groups had more men than women, while the other three had more women than men, but it was difficult to raise a minimum of 6 people in the separate groups. Data recording for FGDs was mainly by detailed notes, made by the farmers themselves, coupled with audio and video recordings of the process and events. Farmer' participation in the process allowed group members to cross-check their responses and brain-storm on them until a consensus was reached. The audio and video recording were stored in the computer and played back during data entry.

Observations

Observations of respondents offered a deeper understanding of the context in which events occurred, of which either the respondents were not aware of or unwilling to discuss during interviews. Participant (direct) observation of the farmers, farmers groups and researchers was carried out using a structured protocol. This enabled me to describe the setting where the observations took place and what the physical setting of the different households/ workplaces was like, and to identify the people who participated and describe the content of the intervention. Owing to earlier interactions with some of the respondents during the development, evaluation and dissemination of the forage chopper, indirect or passive observations were not possible, since I was already known. Data recording for observations was mainly by making detailed notes, filming events and taking photographs to accurately capture settings. This facilitated the capture of both verbal and non-verbal cues. Audio recording of any conversations held during the observations was also done. Photographs, audio and video recordings were stored in the computer and replayed during data entry.

1.5.4 Data analysis

Data analysis was based on document analysis and cross-checking of documents and field notes. The stored audio recordings were replayed to cross check the detailed notes as interview responses were entered into the computer. The video recording were edited and

reduced to a manageable size for inclusion in the thesis while photographs were edited, re-sized and then used in the write-up to illustrate observed events. Data reduction was made of the written-up field notes to select, focus, simplify, abstract and transform data for manageability in terms of issues being addressed in gender-technology analysis. After data cleaning and sorting, the number of farmer interviews was reduced to 111 (35 farmers with forage choppers, 30 farmers without forage choppers, 27 farmers with local cattle and 19 forage sellers). Computer Aided Qualitative Data Analysis Software (CAQDAS) – Atlas.ti 5.0 was used for qualitative analysis. This program allowed both text and multimedia data storage, retrieval, structuring and processing. The recorded interviews were transcribed and incorporated into Atlas.ti. Codes were developed for retrieval and interrogation of data. The interview data was grouped into families for comparison of data across subsets.

1.6 Thesis outline

This thesis consists of 6 chapters: chapter 1 offers an introduction to the relevant conceptual framework for the research. Four empirical chapters (chs 2-5) then follow. These frame approaches to rationalizing the design process of labour saving technologies for women. The concluding chapter (ch 6) provides an overview and conclusions. Gender and technology are two themes that are threaded throughout all chapters. The four empirical chapters deploy the four identified ways of rationalizing the design process explained above as entry points viz.: iterative design process, constructing users, the domestication process and improving the processes of technology uptake and use.

Rationalizing the design process for labour saving technologies requires an examination of the different social entities in the social-technical system, how they are organized and how they can be re-organized to achieve the women's empowerment potential. This is the focus of Chapter 2 which emphazes on building feedback. Critical to this are the designers of machines, how they are organized, how their structures influence what they do, how they organize the design process or frame the design spaces and users' participation spaces. An important aspect of understanding the role of user lies in examining how designers frame users, which is the focus of Chapter 3. Beyond the virtual user, a clear understanding of the context of the actual user forms the basis of technology's empowerment potential for the women.

Armed with the role of the user and ways of reconfiguring the user, it is still necessary to know how use is framed when the technology is released. Chapter 4 focuses on the domestication process of a labour saving tool and the implications of this for the wider socio-technical configurations. In the effort to understand the role of the users (as captured in the organization of feedback, reinforced by the configuring of users) and use (as captured in the interactive design process) in technology development, it should be remembered that technology is embedded in the wider socio-technical configurations. The focus of chapter 5 is on the strategies needed to improve processes of technology uptake and use, to effectively achieve a saving of women's labour through new technologies. It focuses particularly on the social, material and institutional contexts for effective implementation of the empowerment policy objectives.

Chapter 2 Contextualizing participation in sociotechnical networks of the design

2.1 Introduction

The design process is one important locus where technical issues of technologies touch upon broader social issues. Although engineers are in most cases fully aware of the technical issues during the design process, Cañavate et al (2009) have criticized them for their lack of attention to the social implications of their work. In conceptualizing the process of technology design, Poel and Verbeek (2006) have argued that social reflection during the design process would allow anticipation of technologies-in-design in their use context. But a mere reflection on the design process is not enough to ensure that the design process turns out workable tools/machines. Design is a collaborative effort in which many people (engineers, technicians, users) play a role (Poel 2001) in varying institutional or social environments. Although it is clear that the final recipient of the design products is society, Cañavate et al (2009) argue that the presentation of society during the design stage is quite poor. I argue along these lines that beyond simply involving users in the evaluation of tools, users' participation needs an extended feedback process where users are allowed more time to interact with the tool, in order to turn out workable tools/machines.

Technology is a way of doing things (Richards 2007) , a process of making and re-making with adaptation being a continuous process. In other words, users' feedback is not limited to the design stage but should be applied to the entire process of development and use. The user-centered vis-à-vis the design-centered mode of technology development has been an issue of debate in the field of Science and Technology Studies (hence STS) (Stewart and William 2005; Dong 2010). In the design-centered approach, the design of the artifact is more or less a simple reflection of the values and priorities of designers (Stewart and William 2005), with users seen only as passive recipients of the technology and its embedded values (Sørensen 1994). The need to review this approach to technology design arose from the recognition of frequent failures in technology development (Sørensen and William 2002). The unintended technical and social outcomes of technology initiatives and the complexity of social interactions around the development and use of technology also played a part. Consequently, the STS focus on design has proposed "design by society" as a conceptual approach for examining, among other things, how societal values are built into the world by design (Woodhouse and Patton 2004). Woodhouse et al affirm that "design by society" is intended to signify that social norms, values and assumptions are reproduced.

The user-centered approach places users at the center of the design process from the stages of planning and designing system requirements to implementation (Baek, Cagiltay et al. 2008). Steward et al (2005) argue that unlike the design-centered mode of technology development, where users' relations are presumed by the technology producers, the design decisions of the user-centred approach are much more likely to reflect values and desires of users. Dong (2010) also emphasizes that the user-centred approach prevents designers from seeing themselves as "solution providers", and allows them to appreciate user capabilities, needs and expectations. Stewart and William (2005) have extended the user-centered approach beyond the design process itself to the process of using the tool, and referred to it as the "social learning process". They argue that social

shaping offers an evolutionary model of how societal requirements and technological capabilities might be coupled together. This approach assumes that the tool is "unfinished" as it lands among users, and it is the interaction with users that leads to a stable design. In other words, the social learning process allows users not only to evaluate the tool during the design process but to work with it, re-constructing it within their social, economic and cultural contexts to turn out a stable design that works for users.

A critical aspect of users' involvement has been their level or form of participation in the design process that can yield effective feedback to turn out stable designs. Richards (2007) identifies two forms of participation: deliberative and performative. He explains deliberative participation as seeking agreement on strategies through discursive means that allow expression of preferences and negotiation of consensus or compromise, whereas performative participation bases itself upon involvement in a set of actions (Richards 2007). However, Rohracher (2005) cautions on the user involvement as a panacea for bringing about "better" tools and contends that participation may contribute to emancipation of groups while on the other hand participation may strengthen tendencies of individualization and alienation.

Using the case study of the development of the forage chopper for smallholder dairy farmers, this chapter examines the design procedure for agricultural engineering technologies in NARO, focusing on how the designers' and users' worlds emerge and interact (how participation is framed). Pertinent to this, the research analysed the training of designers, to locate how this subsequently shapes their approach to design and frames their socio-technical networks. Attention is also paid to the designers' workplace environment in order to understand the contexts that enable or constrain designers' practices.

I used a technographic approach to explore the protected spaces where machines are made and the interaction of its actors with other actors in the socio-technical network. I conducted this study at the Agricultural Engineering and Appropriate Technology Research Centre (AEATREC) of NARO, focusing largely on the engineering workshop as the designers' work place that defines their positions and responsibilities in the socio-technical networks of the design process. The study population was a section of AEATREC staff, with key informants purposively selected among the technicians and research scientists. The nature, use and impact of technology is influenced by the identities of the designers, the institutional positioning of the designers and the context of design. For the remaining part of this chapter, I examine these aspects and look at how the different links frame the spaces of participation for users to turn out more workable machines. Although individual interviews and observations were used for data collection, some of the data presented here were drawn from the author's experience of working with the research center (from 1997 to date) and having been one of the pioneering graduates of the agricultural engineering bachelor's degree programme (1990-1994).

2.2 AEATREC's Design Context

Under the National Agricultural Research Laboratories (NARL), AEATREC is mandated to carry out applied and adaptive research, dissemination and training in agricultural engineering technologies (AEATRI 1995). The centre is headed by an officer-in-charge (OC) under the NARL Director of Research. Under the OC are 4 engineering scientists, 4

technicians and 6 support staff in NARO mainstream employment; and 2 scientists, 5 technicians and 11 support staff on contract (GoU 2004; AEATRI 2006; AEATREC 2007). Although the OC represents the NARL Director in all issues related to management of the centre and is expected to give guidance to all staff under him, he also carries out some research work due to the limited number of scientists. The scientists conduct research and are expected to guide the research assistants and technicians in the research process. The technicians, working under the workshop superintendent, are charged with the technology fabrication work of the centre (GoU 2004).

2.2.1 The designers' training

As one of the pioneers of the course from 1990 -1994, the author here reviews the agricultural engineering undergraduate training program at Makerere University as she experienced it. Initially, admission to the course was through one avenue of direct entry for students who had completed the Advanced Level training with principal passes in Physics, Chemistry and Mathematics. The four year training involved a concentration of study in mechanical engineering along with courses in general engineering for three years and then some basic agriculture and agricultural engineering courses in the last two years. Generally, engineering courses covered aspects of electrical engineering, fluid mechanics, thermodynamics, mechanics, materials, mathematics, surveying, computing, soil and water, farm power and machinery and agricultural processing. The agricultural courses covered crop and soil science, animal and food science, and economics and extension. Every students was required to carry out a design project in the fourth year to put theory into practice. Students in their third year would specialize in one of the following options: farm power and machinery, agricultural processing and farm structures, soil and water engineering. The undergraduate training incorporated an annual three months internship programme in industries and workshops, which usually included various hands-on laboratory/workshop classes focusing on current issues in the application of engineering principles. This was intended to prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge.

Over the years, some aspects of the bachelors course have been revised but, the basics have remained the same. The undergraduate degree program still extends over a period of four years, each year consisting of two semesters of 17 weeks (instead of the initial 2 terms of 4 months each) and one recess term of 10 weeks. Current admission is through three avenues: Direct entry, Mature age scheme and Diploma entry scheme. The change from the term mode to semester mode increased the number of courses students have to take in a year from an initial seven to almost double that. Notable among the course changes is the recent curriculum development that included courses in cross-cutting issues of gender and development. Some of the non-cross-cutting courses added include land policy and law, environmental engineering, management economics for engineers, gender in agricultural development and agricultural engineering in development. Currently, students only specialize at Master's level and the fields have been revised to include agricultural processing and food engineering, soil and water engineering, farm power and machinery, structures and environment engineering. The internships have been extended to research centres as well (http://agric.mak.ac.ug).

During the internship period, students work under the supervision of engineers and senior technicians in various engineering sections and disciplines. Regular field supervision by

university lecturers ensures that students maintain good conduct with the training places and that all relevant issues are covered during internship. An internship report is produced each year that details the aspects covered for each period and it must be signed by the training institution. The 1st year internship training is done at the university engineering workshop and covers the general electrical and mechanical engineering practical basics. For the 2nd and 3rd year internship trainings, the students are sent out to industries, and/or research institutes for hands-on experience. In the 4th year the students work independently on a project to design and/or develop a technology or production method/module. Upon deployment, these engineers usually have some experience with the workshop procedures and routines and can ably take part in the planning, designing, implementing and evaluating different technologies in the different agricultural engineering disciplines.

At AEATREC, the scientists are supported by a team of technicians trained in welding, machining and blacksmith work headed by the workshop superintendent. The technicians are certificate holders, with practical training in the different engineering workshop activities. In an interview with one of the technicians, he explained:

> *We received a basic two-year training at Busitema Agricultural College* (an agricultural mechanical college) *in engineering drawing, metal process engineering, electrical engineering, welding technology and blacksmith technology theories combined with welding and blacksmith practicals*. (Key informants interview, 2009)

Although at the moment the technicians' training incorporates a three to four months internship program as well at research institutes or workshops, the situation was initially different:

> *We did all our training at the college for both theory and practicals, without any internship training. It is a recent development that technicians are being sent out here for internship.* (Key informants interview, 2009)

He added that:

> *During this training, the students receive hands-on experience in the different fabrication processes, workshop routines and procedures, working under the supervision of the workshop superintendent and technicians.* (Key informants interview, 2009)

The research scientists work in the context of their specializations, and this determines their design strategies (AEATRI 1997; AEATRI 2003). Drawing from the author's university training experience, it can be said that the program involved a concentration of study in engineering but lacked components not directly related to engineering that would broaden students' practices and understanding. Consequently, students graduated with a rather narrow, engineering-based concept of the design process that focused largely on technical issues, as opposed to the exploration of design concepts incorporating social issues alongside technical aspects. As a result, the students are adequately grounded in the engineering aspects of design, but are limited in their socialization around design problems to the networks of designers. The internships only provided a window for

socialization within technical networks. Although the current training has incorporated courses on cross-cutting issues, the training has not yet opened up to courses like anthropology and sociology that might help engineers to understand users' practices. This means that there is still no interaction or involvement with technology users. According to Newcomer (1997), it is the design experiences that engineering students have in school that shape their thought styles and affect their approach to design throughout their professional careers.

2.2.2 The designers' world

The interplay of the different elements of the sociotechnical system cannot be fully understood without analysing the workplace environment of designers that frames their behaviour as agents in socio-technical networks. The engineering workshop is the designer's main work place at AEATREC and the "heart" of all engineering technology development. In the workshop, the engineers interact with technicians, all playing different roles in this workplace, as shown in Table 2.1. Although the engineers play the same basic roles, they work within their areas of specialization, namely fields such as farm power, agricultural processing and farm structures, water engineering and renewable energy (AEATRI 1997). The technicians, on the other hand, play a role in the development of all the different machines.

Table 2.1: Roles and Responsibilities of AEATREC design team

Designation	Core roles/responsibilities
Engineers	• develop and adapt technologies to the Ugandan context; • develop necessary designs and plans (engineering drawings/blue prints); • determine and specify fabrication methods, materials and quality standards; • oversee the fabrication of the technology; • spear head the testing and evaluation of the proto-types.
Workshop superintendent	• reading and interpreting engineering drawings • selection of materials. • setting specifications of the different parts during fabrication; • coordinating all the technicians during the fabrication of the prototypes.
Welding technician	• reading and interpreting of fabrication working drawings; • fabrication of all machine parts that require welding; • participation in testing and evaluation of fabricated prototypes.
Machinist technician	• reading and interpreting of fabrication working drawings; • fabricating machine parts that require machining; • participation in testing and evaluation of fabricated prototypes.
Blacksmith technician	♦ reading and interpreting engineering working drawings; ♦ forging and fabrication of designed prototypes ♦ production of forging templates, jigs and fixtures; ♦ participation in testing and evaluation of fabricated prototypes.

Source: AEATREC staff profile documents

Basic in the fabrication of all machines is the development of blue prints or working drawings for the machines to be produced. This is a computer aided process that allows iterative refinement of both the conceptual and physical design of the required machine. Based on the blue print, templates and fabricating jigs are produced (Photo 2.1) for ensuring that the same measurements are maintained for all the prototypes produced for

a particular machine. As evident from the photos, on a single sheet or work plate, several jigs/templates are set out for different projects to economize materials.

Photo 2.1: An array of jigs used in the manufacture of devices

Although the production line is not systematically set out, five work areas can be identified in the workshop: the raw material holding section (store), the machining section, the welding section, the spraying area and the technology storage/display area. Given the nature of the research work and the flow of funds, purchase of materials is usually done on the basis of the device to be fabricated. However, when funds are readily available, bulk purchases of common fabrication material is done and placed in storage (Photo 2.2).

Photo 2.2: Raw material holding section

Evident from the picture is the lack of storage racks for holding materials. All materials are simply placed on the floor, which definitely poses work hazards to the people accessing the store for materials. With the jigs and templates, the raw materials are marked, cut out and/or chiseled. Drilling of the required parts also occurs at this point. All this occurs in the welding section of the workshop (Photo 2.3).

Photo 2.3: The welding section

The welding section is the "heart" of production for all machines. The rough walls and floor evidenced in the pictures explain the nature of work that takes place in this section. Metals are cut and fitted together in this section either by welding or using nuts and bolts. It is semi-open to allow for faster ventilation considering the sparks and fumes given off during the welding process. There are some cut parts that are first taken to the machining section (Photo 2.4) before coming to the welding section or from the welding section to the machining section and then back to the welding section.

Photo 2.4: Machining section
(a) Student working on lathes; (b) Students punching a concave screen

The making of key ways, bolts and nuts and the punching of machine component to make screens occurs in the machining section and the finished parts in this section are then moved back to the welding shop for assembling the device. As shown in the picture, the precision required for the parts fabricated from the machine shop in most cases requires more than one person to operate the machine and position the job, or at least the use of holding vices to hold the part in position. Marking, positioning, guiding materials through vices characterize the nature of this work. The enclosed nature of the work place reflects the importance attached to the housed machines (delicate and expensive). Once a device has been fully assembled, it is then taken for spraying (Photo 2.5) before on-station testing commences.

Photo 2.5: Spraying section

(a) technician being assisted by a student assembling maize sheller prototype for spraying; (b) technician spraying a cassava grater/chipper.

Assembling of components is done in the open space in front of the welding section to allow for last minute welding of some components. It usually requires more than one person to put all the different parts in their respective places (Photo 2.5 (a)). By the nature of the fabricated devices/machines (bulky and rough), there are no work benches for assembling the machine components. Squatting and bending characterize this part of the fabrication process. Similarly, spraying of the machines is done standing in the open, unfortunately without face masks to protect the person from the paints (Photo 2.5 (b)).

Finished devices are moved to the display/storage section (Fig. 2.6), ready for demonstration and dissemination. Sometimes though, this very section holds the devices awaiting on-farm evaluation. With engines already mounted or other sensitive components, this section is properly enclosed to keep the devices safe (Photo 2.6 (a)). The bulky orders of some finished devices are sometimes stored outside due to space limitation (Photo 2.6 (b)). There are four different colours used to identify the devices by projects/programs: blue for processing, green for farm power, silver for water and lead oxide (maroon) for renewable energy devices.

Photo 2.6: Storage section of finished devices

What then is the implication of this kind of set up on the behaviour patterns of designers, and how does it impact on the design process of engineering tools? The workshop is the place where the physical design takes place, the place where the design takes shape, an environment where engineers and technicians interact with the technical objects. It creates the framework that helps designers to define their responsibility in socio-technical networks But it also excludes some other actors from the design process. Although designers frequently interact with other technicians/artisans undergoing training and

technology users on study tours, these actors do not actively take part in design work within the workshop. This presents two challenges to users' participation: the public normally lacks knowledge of decisions made in the design process, and there is limited opportunity for user voices to be heard when design decisions are made.

2.2.3 AEATREC's design process

How is the design process of labour saving technologies organized at AEATREC? Basically, AEATREC's design procedure employs a participatory technology development approach that involves participation of farmers in the needs assessment, prioritization and evaluation of technologies, participation of other stakeholders in sourcing for interventions, and participation of engineers within a multidisciplinary team (AEATRI 1995; AEATRI 1997; AEATREC 2000). However, drawing from the training of the current crop of engineers, this is not something designers became familiar with in their training, but something acquired as part of on-the-job training. Overall, the development of AEATREC's interventions begins with a series of surveys, to collect data on agricultural engineering constraints from farmers.

The surveys are conducted using one-on-one questionnaires and/or interview guides, administered by the researchers. Needs assessment surveys allow users (farmers) to identify their own needs and later to prioritize them for interventions, with the facilitation of the researchers. This plays back into the dissemination of developed interventions with the transfer of a technology originating in suggestions from those who require it (the farmers). Participatory methods are useful in revealing opinions and views of farmers. However, they do not necessarily reveal what the farmers *do*, because very often the researcher's presence conditions the farmer's participation. The author's experience in these surveys has been that either the farmers will colour a picture that seeks a lot of sympathy for their situation or they take the line of not wanting to wash their dirty linen in public. Unfortunately, data used in the needs assessment process is based purely on one method of data collection - questionnaires or interview guides, administered over a limited period of time, without any other method like follow-up observations that would allow the researchers to cross-check the survey data. All that notwithstanding, based on the findings of the needs assessment survey(s), research planning meetings are held with the different stakeholders and collaborators to prioritize the identified constraints that later guide the design process

The stakeholders normally include farmers, farmer group leaders, district extension agents, district NGOs in related agricultural fields, local fabricators, other technology developers. This is necessary to enable the Centre to access knowledge/ideas and new technologies and to establish uptake pathways for developed technologies. Due to the diverse mix of participants, these meetings usually take on the group mode of discussion, with the researchers facilitating the meetings. These meetings are intended to counteract the shortfall resulting from the participatory needs assessment, as well as to promote users' involvement in the design process. However, the scope of these meetings depends on the researchers' facilitation skills and group dynamics. Drawing from the proceedings of these meetings, the research team develops a range of interventions to respond to prioritized constraints. Although surveys form the core of AEATREC's technology development assessment methodology, areas of intervention for the entire organization are periodically reviewed during NARO's strategic review planning process (NARO 2000; NARO 2007).

The development of the forage chopper originated from the interaction of researchers with zero grazing farmers around the Centre during a biogas project (AEATRI 1995; AEATRI 1997; AEATREC 2000). Its introduction in Masaka district, however, followed a diagnostic survey by the Livestock Systems Research Program (LSRP) project in 1998/1999 (LSRP 1999) under NARO. During the diagnostic survey the smallholder dairy farmers in Masaka identified feed shortage for dairy cattle and drudgery presented by high farm labour demands as the major constraints. Lack of sufficient land for forage production coupled with forage scarcity for dry season feeding and labour shortages necessitated efficient use of available forage by minimizing its wastage. After prioritizing the constraints, different intervention options were screened on how to improve the feed resources. Establishing fodder banks and leguminous forage were the two interventions targeted to increase feed availability, whereas forage processing and conservation were targeted for the efficient forage utilization option. Part of the drudgery identified in the LSRP survey was associated with forage processing. Also one of the roles of the first project was to promote efficient utilization of fodder, which entailed forage chopping for conservation of forage for dry season feeding as well as to reduce fresh forage wastage.

After addressing the first constraint of feed shortage, a second NARO project addressed the issues of promoting forage conservation and reducing the drudgery associated with forage chopping, hence the introduction of the forage chopper among the smallholder dairy farmers by NARO. Based on identified constraints, very often AEATREC links up with both regional and international research institutes to source technologies that could be adapted for Ugandan conditions (AEATRI 1995). NARO also builds regional cooperation and collective action among the National Agricultural Research Institutes (NARIS) to facilitate collaboration and sharing of gains from research at sub-regional level (http://www.naro.go.ug). The research team at AEATREC has greatly tapped into this collaboration for its adaptive research component, developing a range of technologies for the local conditions.

The initial working design of the manual forage chopper was one such benefit of AEATREC's collaboration with Sokoine University of Tanzania. It was obtained by the former institute director from Tanzanian farmers during a biogas technology training workshop. The first option of a motorized forage chopper was obtained from the collaboration with the International Rice Research Institute (IRRI) in the Philippines, but this was not suited for smallholder dairy farmers in Uganda, hence the selection of the manual forage chopper for these farmers. Whereas farmers were involved in the needs assessment and prioritization process, they were not represented in this planning of interventions. In other words, there is no participation of the users in the planning of intervention. The effect of this emerged during the domestication process of the machine when it was released to the users (Chapter 4).

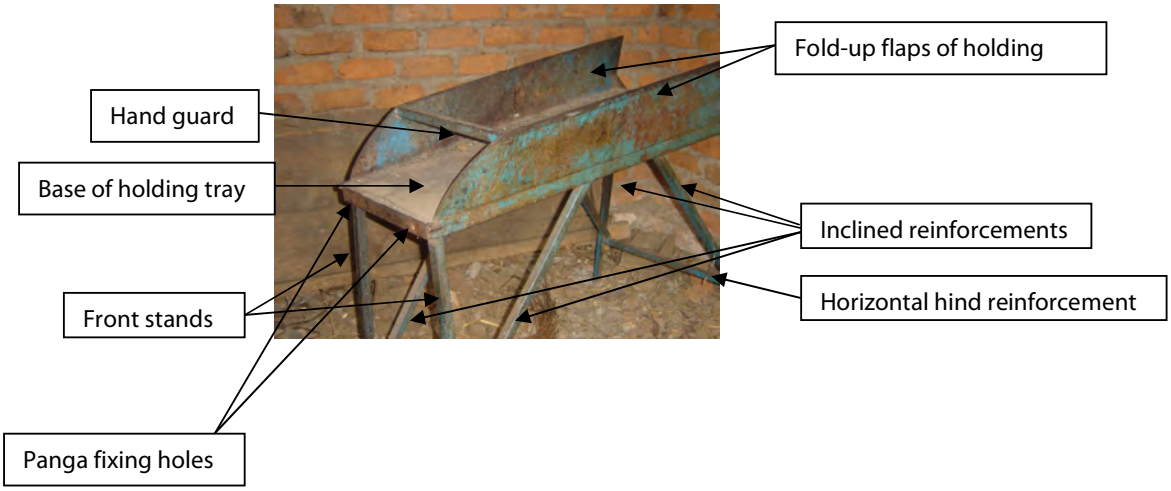
Prototype Development

Between 1997-2000, I took part in the development of the forage chopper, and here I describe the basic development procedure of engineering technologies at AEATREC as I experienced it. The design process entails development of prototypes, evaluation and modification of prototypes. As earlier discussed, AEATREC is mandated to carry out both applied and adaptive research. The design and development of the manual forage

chopper was purely adaptive research. The initial design of the manual forage chopper (Photo 2.7) was an all-metal frame, with an open frame base and a lever operated panga attached to one end. The researchers assessed the performance of this design using computer models. Some of the Tanzanian farmers that the former director visited had also shared their lessons with him and these were drawn upon during the assessment.

Photo 2.7: Design used in adaptive research

Farmers chop a variety of materials with varying lengths, ranging from forage to crop residues. With the open frame base, some of the unchopped material could either easily pass through or fall off from the sides, requiring collecting now and again, which would prolong the time required for the chopping activity. The open end at the panga slot also meant that users could easily push the hands too close to the panga, representing dangers of accidentally cutting one's fingers, as in the case of traditional hand chopping. This original design also had no means of controlling the length of cut that researchers deemed necessary to minimize forage wastage. In the needs assessment that led to the development of the forage chopper, forage processing was identified as predominantly a task for women, very often assisted by children. The designers' targeted user of the forage chopper was an adult woman, with an average waist height of 1m from the ground. On this basis, the research team re-designed the chopper to include several features to improve the efficiency of the machine as well as its ergonomic aspects (Photo 2.8).



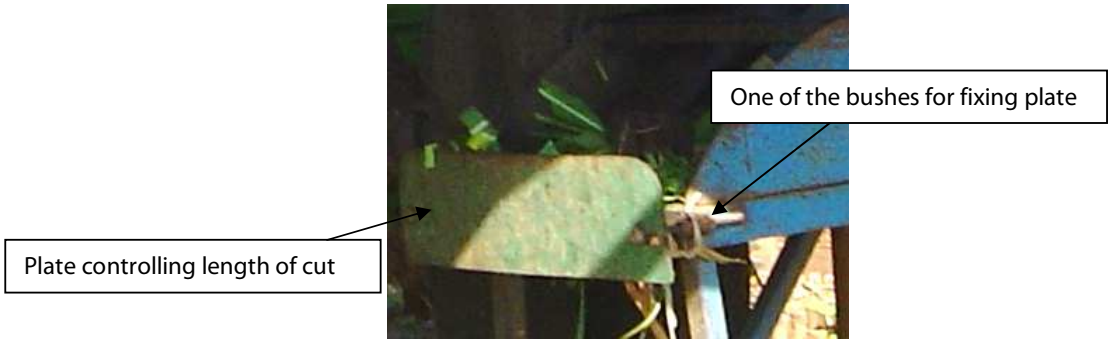


Photo 2.8: First NARO prototype

The standard NARO design comprises of the following modifications: metal holding tray to minimize the falling of unchopped forage, safety hand guard to prevent the operator's hand from reaching the panga, plate controlling length of cut for pre-setting the length of chop, and adjustable panga position to accommodate both right- and left-handed operators. The lever operated mechanism of the panga was retained. Given the weight of the holding tray, the stand was redesigned to offer better support for the holding tray as well as to increase stability of the machine during operation. In the modification of the original design to NARO's prototype, the engineers worked independently of the users. The different changed components were based on the engineers' assessment of the original design not on the users' assessment. When the first prototype was completed, it was subjected to both on-station evaluation and on-farm evaluation. The aspect of on-farm evaluation brought back the users' involvement in the design process. This further points to the gap in users' participation in some aspects of the design process, the first being their absence in the planning of interventions and the second one being in the fabrication process of the machines.

Evaluation of prototypes

A general evaluation procedure applies to all developed machines. A completed machine undergoes two types of evaluation: on-station evaluation and on-farm evaluation (AEATRI 1997). The on-station evaluation of prototypes allows designers to evaluate the design's overall effectiveness and make any modifications before subjecting it to field conditions. It targets mainly the engineering performance of the machine, focusing on the efficient operation of the various components, checking for areas of weakness and the output of the machine (AEATRI 1997). The people used in the on-station evaluation are usually drawn from the Centre's support staff and, in the rare instances where a particular category is needed and not available among the staff, from the surrounding community. On-farm evaluation, on the other hand, allows assessment of the machine by the users, focusing on operation procedures, maintenance, safety issues as well as rate at which the machine eases a particular production activity (AEATRI 1997). This enriches the iteration process of technology development with the targeted users' input/modifications, which can enhance the uptake and use of the finished machines.

During the on-station evaluation of the forage chopper, a range of operators (men, women, youth – boys and girls) was necessary to reproduce the actual field conditions of intended users in assessing the output capacity of the machine. Although the forage processing role was identified as predominantly a matter for women and children, the survey also showed some households where men chopped forage. Time taken by each

operator to chop a given weight of forage was noted to assess their output per unit time (AEATREC 2000). The design team evaluated the engineering performance of the different parts in regard to the efficiency of performance during the operation of the machine. Operator concerns were noted in regard to ease of operation and safety of the machine. No comparison was done for the ease of the chopping operation between the traditional hand chopping and machine chopping during the on-station evaluation. For on-farm evaluation of the forage chopper, a sample of households from the initial farmers who had taken part in the needs assessment survey was purposively selected to have access to some women, men and the youth users.

The selected farmers were first trained for about 1-2 hours on the operation and maintenance of the machine, showing them how to fix/change the panga, adjust length of cut, and demonstrating the actual operation. One week was then allowed for each set of users to operate the machine and offer feedback. Issues of focus during on-farm evaluation of the forage chopper included: overall design of the machine in regard to ease of operating the machine, mode of operation (operating position, source of power), portability of the machine, safety aspects in handling the panga during operation, and ease with which the activity is carried out compared to how it is without the machine (AEATREC 2000). Comparing the two forms of evaluation of the forage chopper, on-farm evaluation presented more challenges to getting effective feedback from the users than on-station evaluation. The first challenge the on-farm evaluation presented was that the designers offered only one design for evaluation, to be compared to traditional hand chopping, which limited users' participation in the evaluation process. As the domestication process later showed (Chapter 4) this approach also limited the options users could make in selection of the technology.

The second challenge presented by on-farm evaluation of the chopper was with the duration during which users were expected to give feedback on the machine. On-farm evaluation was limited to one week for each of the selected category of farmers. The users were located in different households, meaning either the group had to converge on one household to do the assessment or the machine had to be rotated among that category of users for a week, implying a limited number of days in a particular household. Some of the issues that were being assessed, like ease of operation, required a prolonged period of interaction with the machine for the user to be able to offer useful feedback, as data from the domestication process later revealed (Chapter 4). Besides, issues of repair and maintenance could not be assessed in the one week the users' interacted with the machine. Furthermore, as data in chapter 4 will again reveal, the constraints repairs presented were user/household specific, and emerged over a prolonged time of use. The coping strategies deployed were far from what users learned in the short training. It was one thing telling the farmers where to source spares and quite another actually to afford to source for those spares from envisaged sources.

Another aspect that was limiting in the on-farm evaluation was with the training of users. At the time of the survey, chopping was predominantly a women's activity. Later as the data on reconfiguring the users reveals (Chapter 3) households were not fixed entities in terms of composition and activities. This meant that the trained person was not necessarily the only person performing that role in a particular household. This, as the domestication process showed, not only points to a knowledge/skills gap in the management and

maintenance of the machine, but also points to a gap in the feedback process, affecting the iteration process of developing a workable technology. However, even with these challenges to on-farm evaluation, farmers still observed certain things that were used in some subsequent modifications, as discussed in the next section.

Modifications of prototypes

The need for modification of prototypes normally arises from the users' views on the prototypes that emerge during on-farm evaluation. For the on-farm evaluation of the forage chopper, farmers raised two major design concerns: the cutting edge of the panga and the height of the machine when children were expected to do the chopping (AEATREC 2000). With the straight type of panga, only the middle section of the panga actually did the chopping, implying wear to just a limited area. Consequently, farmers proposed using a sickle shaped cutting edge to increase the effectiveness of the panga. The farmers argued that with the sickle shaped edge a larger area would be available for chopping than was the case with the straight panga. In as far as the height of the machine was concerned, households with child operators suggested using adjustable stands that could allow users to vary the height of the machine to accommodate the varying heights of the operators.

Also some aspects of the design of the forage chopper did not reflect a gender dimension of the targeted users, as emerged later on in the on-farm evaluation of the machine. The development of the forage chopper targeted a women's role in livestock production. However, the selection of the materials of fabrication was dictated by the designers' need to turn out a durable product more than the weight the users could readily carry. Although the design process had assumed outdoor storage, it later emerged that the value farmers attached to the technology did not permit them to leave the technology outside, which made the weight of the chopper a critical aspect of the design process. With regard to the bulkiness of the machine, farmers proposed detachable parts of the forage chopper that they could assemble when they needed to use the machine, rather than having a rigid bulky machine. In responding to the farmers' proposal of changing the shape of the panga, the research team designed and fabricated a panga with a sickle shaped cutting edge (Photo 2.9).

Photo 2.9: Panga with a sickle shaped cutting edge

Indeed the cutting edge was increased with this sickle shaped panga but two problems then arose. In an effort to make a durable panga, the weight of the fabricated panga (about 2kg) was more than that of the readily available pangas in hardware shops. This implied some additional strain on the operator's hand. With the heavy panga, the research

team had hoped that the weight would reduce on the strength required by the operator during chopping, by providing part of the weight required for the cutting force (AEATREC 2000). Secondly, there was also limited capacity for the local artisans to fabricate this type of panga because most of these artisans lacked forging work places required to make this shape. Unfortunately, AEATREC could not take on the production of these pangas because being a research centre technologies are only produced on a research basis, and line production cannot be sustained. This highlights another crucial dimension of the design process: receiving feedback and organizing interaction with local manufacturers, an issue that also emerged during the domestication process of the forage chopper as being crucial to facilitating technology uptake and use.

Responding to the height concern, the forage chopper stands were also redesigned to reduce on the material used for some parts as well as to accommodate height adjustments (photo 2.10). However, evaluation of this prototype presented two challenges: the stability of the machine was affected, and with the weight of the upper part of the machine resting on the bolts, the drilled holes widened with time. The firmness of the machine on the ground was affected by the hitching points on the stands, with a wobbly effect during the operation for two of the adjustment positions. Stability was only guaranteed when the machine was dropped to the lowest level where the base flashed with the upper section of the bigger square hollow section of the legs. The unsteady motion coupled with the weight of the upper section of the machine exerted uneven loading on the bolts at the hitching points that led to wearing out of the edges of the holes through which the bolts passed, which then weakened the hitching points (AEATREC 2000).

Photo 2.10: Prototype with adjustable stand

The adjustable prototype was only tried on-station and was never promoted among farmers due to these technical setbacks and design implications for material selection of the machine which would have translated into high cost if more durable materials were to be used. With the limitations imposed on the capacity of the local artisans to fabricate parts of the forage chopper, coupled with the need to considerably lower the cost of the machine, a compromise had to be made on several aspects that were tried in the design and modification processes. AEATREC settled for the use of the straight panga readily available in all local hardware shops instead of the one with a sickle shaped cutting edge, but the current prototype of the forage chopper has been redesigned to respond to the farmers' persistent need in easing its portability (Photo 2.11) by having detachable components. With the expense attached to the forage chopper and the security risks the detachable panga presented most households were uncomfortable leaving the machine outside at night. However, most of these farmers had limited available family labour to

assist them to move the forage chopper whenever they wanted to use it, and even where family labour existed, there was limited space for storage of such a bulky item. With regard to having some components of the machine detachable, the feasible component to detach was the holding tray.

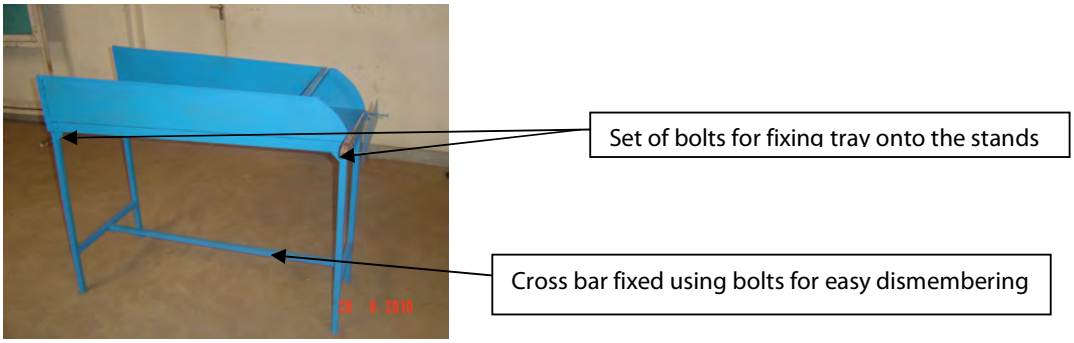


Photo 2.11: Current forage chopper prototype

Although the purpose of on-farm evaluation is to collect users' input to the developed prototype i.e. to increase representation of society in the design process, the extent to which this input was incorporated into the final designs of the forage chopper was quite limited, which then defeated the intention of the whole process. The modifications discussed above indeed show a level of users' participation in the design process that might have led to a more workable device, but failure to recognize key points for these inputs suggests a need for designers to rethink participation of other actors in the design process. Clearly the designers are knowledgeable about the aspects of inclusive design, but they are still failing effectively to put them into practice. What emerged as the first disseminated prototype of the forage chopper represented few of the farmers' concerns that had emerged during on-farm evaluations, and the current design has only emerged as it is from persistently reiterated farmer demands for easy mobility and storage. Women were targeted in the design and development of the forage chopper, but little consideration has been given to their ability to move the bulky device around. Even the detachable tray of the current prototype is still too bulky for women to easily handle it without calling for assistance from other family members.

Secondly, children form an important component of the family labour force for forage processing activities and researchers' failure to cater for their inclusion as users of the technology in regard to the design height has had implications on the adoption and use of the forage chopper in households where the forage processing role is ascribed to children. Although the current design is a result of a series of iterative evaluations of the first prototype that has undergone a range of modifications, when it was released to the smallholder farmers the machine still underwent a process of interpretation and integration, influenced by social structures, operational circumstances and cultural conceptions of households as discussed in Chapter 4. Following up on the forage chopper, the feedback process allowed for during the on-farm evaluation of the technology was not sufficient to give effective input. When users eventually interacted with the machine over an extended period, re-constructions of the machine emerged, with varying materials of fabrication, size and design, responding to farmers' financial capacity. Some aspects of the design, like the plate controlling the length, that designers had considered essential for effective operation were removed for what users termed "improved ease" of operation.

Varying sizes of machines emerged to accommodate varying heights of users, especially children, and materials of fabrication changed in type, quality and quantity to fit within users' budgets.

What emerges from all this is that in spite of the participatory approach to technology development, the design process of AEATREC is still inclined more to a design-centred mode of technology development than to the user-led innovation approach. An assumption of exclusive expertise by researchers still appears to dominate the technology design processes. With the farmers' modifications that emerged during the on-farm evaluations and the continued use of the forage chopper, it became apparent that technology innovation was not restricted to the technical specialists or engineering workshops, calling for strategies to tap the innovativeness of users through some monitored extended feedback process. The implication of this is that an extended feedback process allows users more time with the machine, and this in turn can reveal more information than designers can pick up from short on-farm evaluations.

2.2.4 Linking research to practice: disseminating AEATREC's technologies

Proxies in form of linkages between the governing body (the state, international donors and farmers' associations), the knowledge generating body (NARIS, both public and private) and the constituency (users/farmers, companies) are usually used to launch the center's new technologies. Such linkages are established during agricultural shows, farmer field days, trainings and scientific fora. These linkages offer the necessary platform to launch new technologies, disseminate ready-made technologies and generate/share knowledge (Odogola 2000). In linking with practice, AEATREC has involved the private sector (especially the small-scale manufacturers), farmers and farmers organizations, government ministries, research partners, NGOs and local artisans. The objective of all these linkages is to avail the technologies to different uptake pathways, either for dissemination or mass production (Odogola 2000).

In another effort to have the production of some of the technology parts within the communities and boost the uptake of technologies, AEATREC organized a series of trainings. The trainings targeted community workshop technicians, rural blacksmith/artisans and district extension officers. The central objectives of these trainings are to offer refresher training to the participants, equip them with new knowledge required for fabrication of some of the spares required for the various machines and to boost the uptake of machines (AEATREC 2001-2007). Since the local artisans, community technicians and extension officers are constantly in touch with the farmers, they provide an uptake pathway for new machines. Farmer training on the other hand is to equip users with skills for appropriately operating the machines. AEATREC also takes part in a number of outreach programmes which provide a platform for displaying innovations, launching new machines, sourcing of existing machines and getting feedback from the different technology users (AEATREC 2000-2007).

Whereas the private sector can ensure readily available machines, this linkage presents two potential constraints: the patenting rights of the machines, and marketing of mass produced machines. With the adaptive nature of research that the centre is partly engaged in, it is difficult to work out modalities of patent rights on some of the machines, hence there is a risk of having some items reproduced by the manufacturers without giving

AEATREC credit for its efforts. Secondly, the private sector is driven by market demands. With the subsistence nature of agriculture in Uganda it is difficult to guarantee manufacturers a ready market for all machines. As such, despite all the Centre's efforts to link its technologies to the local manufactures, this link is still non-operational and AEATREC continues to handle farmers' technology demands as they come in. Another constraint in the dissemination process pertains to the local manufacture of machine components. The need to train local artisans arose from the importance of having the service nearer to technology users for repairs, maintenance and fabrication of spare parts for some machines.

AEATREC's focus in drawing artisans for training is usually on those formally engaged in the production of agricultural implements/tools. However, in some localities there are limited numbers of traditional blacksmiths and sometimes none at all. There was no established working relationship between the local welders and the technology designers. This had implications for the way designers had defined the spaces to be occupied by participation in the design process. Broadening these spaces of participation to include the local welders would benefit both the farmers and the designers. It would improve the quality of local manufacture and repair and thus improve women's access to technology.

2.3 Conclusion

This chapter explored how interactions are contextualized in the socio-technical networks of the design process. I started the chapter hypothesizing that for technology development to turn out workable innovations, there is need to rethink design procedures. Users and designers should interact effectively to incorporate societal issues alongside technological ones, so as to broaden researchers' practice. Using the case study of the forage chopper development, this chapter examined the distinction between the "protected space where technology is made" and the "protected space where technology is used" and the influence one has on another. In order to understand how users behave around a technology, the designers need to broaden the spaces for participation by opening up both the technology design space and technology use space. This can be done by allowing for observational feedback as users interact with technology to enhance its practical usefulness.

The designers' ability to facilitate effective feedback in the design process starts with their training background. This chapter has shown that engineers in Uganda lack training in relevant components of social analysis. Even with recent curriculum developments introducing courses for cross-cutting issues, additional courses in anthropology and STS are lacking. These are necessary to understand users' practices. As noted earlier the design experiences that engineering students have in university are major factors shaping their thought styles, and are thought to affect their approach to design throughout their professional careers. So one possibility of improving the interaction of designers and users to build effective feedback would be to require engineering students to encounter a broad spectrum of issues concerning participation in their training. This responsibility largely lies with the engineering schools.

The technology development design process of the forage chopper was an iterative process and the current design has undergone a series of modifications following both a set of evaluations of the first prototype and emerging farmers' design demands on the first

disseminated prototype. This level of participation however is still not enough because as the chapter has shown, there was little reflection on the users' input in the final prototype. Designers engaged the users in the evaluation process, but their input was not fully incorporated. The first possibility that designers could use to improve interaction with the users lies in increasing the number of designs taken to the users for evaluation to give them a wider variety to choose from instead of turning out a single design. With more than one design, it would be possible to get different users' groups to evaluate the designs on a comparative basis, thus increasing the utility of the feed-back information. Varying a basic design in both material and size would also be a useful step in eliciting heterogeneous user needs.

Another possibility to improve user feedback to the design process lies in increasing the duration users interact with the technology beyond the initial evaluation period. The one week that was used in the evaluation of the forage chopper was too short a time to assess the device effectively. When users would be allowed a prolonged period with the machine, there would be much more innovativeness in user responses. This would be useful in turning out stable designs. However, for this process to carry meaning for the design process, it needs monitoring. For the extended feedback process, a machine can be released to the users, but considered "unfinished" by the designers, with users being openly encouraged to experiment with ways of using the device in everyday life. On one hand, this would allow users better scope to engage in hands-on remodeling of the machine to create a stable design, and on the other hand it allows designers to know what resources users need to mobilize in order to improve technology uptake and use. "Appropriately configured" devices (perhaps issued with a range of user inter-changeable parts) would permit effective exploration of design options in everyday usage, and thus serve as a means for engineers to monitor an extended feedback process.

Lastly, the possibility of extending the participatory approach from only being used for needs assessment and prioritization to involving users in the planning of interventions might yield valuable dividends. In the development of the manual forage chopper, farmers took part in the needs assessment and were next involved in the process of evaluating an already developed machine. They played no role in the process of planning the intervention. However, if the design process could open up at this stage as well to allow users the opportunity to be heard in design decisions, this would have a dual function. It would give user representatives a better sense of the range of design possibilities, and it would also improve their ability to give informed feedback at a later stage. If women users took part in the actual design process itself it would be both exciting and enlightening to see what use they would make of this ownership opportunity.

Chapter 3 Exploring household organization of activities for potential gender empowerment through labour saving technologies

3.1 Introduction

In agriculture-based countries, development efforts to reduce rural poverty have prioritized household labour saving tools (NARO 2001; MAAIF 2005; Carr and Hartl 2010). These technologies are often most important during the peak production season when demand for hand and hired labour costs run high. According to Carr (2010), women have been specifically targeted in the development and dissemination of these tools because they are central to overcoming rural poverty. The objective has been that of helping reduce time spent on farming and domestic activities to make it available for other productive income generating activities. However, in order to understand the potential for gender empowerment of introduced technology there is need first to relate the technology to the complex setting in which users are situated. In this chapter I argue that targeting women with technology development is in itself not enough to guarantee that they will benefit - let alone that these benefits will lead to empowerment - because the use and impacts of a machine are partly determined by the household organization of activities. Although most development interventions focus on improving the welfare of women, it must be realized that women's welfare is based on complex interactions within households which are not fixed entities in terms of composition and activities.

The household organization of activities is significant in understanding the potential for gender empowerment through labour saving tools because domestic activities are re-shaped by the introduction of a new technology. It is necessary to understand how technology intertwines with the often complex household division of labour. Although gender-development and gender-technology debates have emphasized the importance of gender targeted interventions for sustainable development, as well as the equity implications of access to and use and benefit from economic resources, (United Nations 1995; UNFPA 2008; FAO 2010) fine ambitions are often undermined by the gender dynamics triggered off by the interventions themselves. As noted by Doss (2001) gender relations are dynamic and respond to economic incentives and opportunities, making it difficult to understand how they will react to the introduction of a new machine. In short, it is difficult to predict, *a priori*, what the dynamics of technology use will be within households and communities.

Doss (2001) argues that it is usually assumed that women will benefit if project design simply takes into account women's roles and responsibilities. In consequence, many development interventions have focused on the women alone, and very often use the term "woman" as a label, without consideration of the social construction of gender that would show how men and women are assigned certain traits and attributes that may or may not be limiting to their development. Developing technologies to improve women's wellbeing poses more difficult challenges because women are part of a socio-technical system, cooperating with other social agents. Understanding the way different agents and elements combine or intertwine in the practice of a technology is an important step in determining the use and impact of the technology.

Hence, a detailed understanding of the interaction of technology with social agents is important in understanding the gender empowerment potential of a technology. Technology users are not fixed entities in terms of composition and although women are frequently singled out in empowerment strategies, they are not stand-alone individuals. They belong within domestic groupings experiencing a developmental cycle. Nor are the activities that determine the use of the machine fixed either. So understanding the way the machine intertwines with the composition and activities as households develop and mature is crucial in assessing the potential gender empowerment of technology. What is needed first of all is a descriptive methodology to capture these dynamic relations within households and communities. Here we term such an approach "technography".

With the case study of the introduction of the forage chopper among smallholder dairy farmers in Masaka, this research explores how the technology interacted with different but inter-related social agents and how these inter-relations determined its use. The introduction of the forage chopper was one of the interventions developed by the National Agricultural Research Organization (NARO) to address forage processing constraints in the zero grazing livestock production system (see ch 2 above). Forage materials for zero grazing animals require to be chopped for ease of consumption by the animal and increased palatability of the forage. Hand chopping is the common practice by most farmers. But it is low in output and lacks uniformity in length of cut. Also, the method is tedious, time consuming and quite dangerous for the operator. In an effort to address some of these constraints NARO developed a manual forage chopper intended for farmers owning not more than five animals.

The technographic approach was used to map out the different social agents involved and to gather information on household members and activities/task and task groups, and activity profiles of smallholder dairy farmers, to understand what and how resources were mobilized to determine the use of the forage chopper. The study employed an in-depth qualitative realistic evaluation (Pawson and Tilley 1997) to explore how the forage chopper interacted with different social agents when it was introduced among smallholder dairy farmers of Masaka. The qualitative approach allowed for description, understanding and explanation of the complex and changing phenomenon of gender relations and how these relations impacted on the introduction of the forage chopper. The gender analysis included activity profiles for smallholder dairy farmers (what men, women and children do); resource access and control profiles (who has access to and control of what type of resources and decision making trajectories), and analysis of the socio-economic context within which Ugandan smallholders carry out farming. The study relied mainly on interview data and technographic observation for empirical purposes.

The study population were smallholder dairy farmers, owning 1-5 animals, grazed in the back yard of their homesteads. Two groups of farmers were selected: smallholder dairy farmers with forage choppers (study group) and smallholder dairy farmers without the improved forage chopping technology (control group). The forage chopper was introduced as part of a zero grazing livestock production system intended to allow women to benefit from zero grazing animals. In the remaining sections of this chapter the way NGOs and NARO framed the "virtual" users of technologies that were targeted for women's empowerment will be examined. How women were situated will also be analysed – as

actual users, focusing on organization of household activities and documenting how the introduced technology eventually interacted with these activities.

3.2 Construction of a "virtual" user

Masaka district used to be Uganda's food basket, but it is one of the districts which suffered from earlier civil war, poor governance, epidemics and total collapse of the service delivery system. This bad situation resulted in the decline of Masaka both socially and economically between 1971 and 1985 (MDLG 2007). Most former local administrative structures were destroyed in the chaos and the few which survived were highly dilapidated. In an effort to escape poverty, men and youth pursued the urban migration pathway towards off-farm employment and education which severely reduced the agricultural labour force, slowing recovery and adding burdens on women. In the post-conflict reconstruction process several NGOs came up with agricultural programmes to help revive the district. Two noteworthy agricultural non-governmental organizations for the livestock activities were Send a Cow (SAC) and Heifer Project International (HPI).

Send a Cow Uganda (SACU) was introduced in Masaka district in 1999 by the proprietors of the St. Jude Family Training Centre with the intention of improving women's welfare in the household, hence contributing to improving family livelihoods. Heifer Project International (HPI) was introduced to Masaka in 1993 by the Masaka Diocesan Development Organization (MADDO), a Catholic church-based organization. In the effort to resettle farmers in a socially and economically drained district, the NGO interventions targeted rural women for a range of reasons, as some official explained:

> *The project targets the disadvantaged groups in the community. These groups include widowed, orphaned or needy households. Since the men can seek employment off farm, the project targets the women in these households to enable them generate an income on-farm so as to uplift their position in the community.* (SACU key informant, 2008)

> *The project targets the vulnerable people in the community, with emphasis on the women.... because in most societies, the women are always lagging behind in all the developmental issues. The project targets to give the women some enterprise where they can generate an income on-farm.* (MADDO key informant, 2008)

In order to enable women to attend to both their reproductive and productive roles in the confines of their homes, the NGOs introduced exotic zero grazing cattle to enable women to generate an income on-farm. On why the exotic cow, one SACU informant explained:

> *As much as it says Send a Cow, the initial intention was to actually send an animal. Emphasis was put on the cow for its multiple benefits. The farmer gets milk which she can sell to earn some daily income as well as use some for the family to improve nutrition. The cow also provides manure which the farmers can use to feed the soil.* (SACU key informant, 2008)

Both NGOs used the farmer group approach, re-organizing farmers into formal working groups for training purposes and targeting of interventions with an emphasis on women farmers, as project coordinators explained during key informants interviews:

> *We work with households, targeting the whole family but, our emphasis on the women in the family is only to provide a sustainable entry point to the family. Our previous experience of targeting the youth in Mukono during the inception period of SACU forced us to review our approach to settle for an "easy" entry point to the family. The youth sold off the animals, the revolving fund was never paid back to the group and they frustrated our efforts when they did not measure up to the organization's expectations, consequently failing our interventions. We have found the women to be more consistent and once trained they are more committed to the implementation and repayment schedules of the group.* (SACU respondent, 2010)

> *… Although our support goes to an individual family, we channel it through farmers groups. So an individual must belong to a farmers group. Our emphasis is on women because it has proved more sustainable to work with women than men or youth farmers groups. It is easier to mobilize women than the men or youth. Besides, given the nature of our enterprises, it is the women who are usually at home. The biggest challenge we have had with the youth is the rural-urban migration rate of the youth which impacts on the sustainability of the project.* (MADDO respondent, 2010)

Two aspects were common to both projects: ownership of the animal was always tagged to the woman and it was the woman who signed a contract with the NGO, although it was labelled a "family project"; and the "pass-on" notion was used to ensure multiplication of the project efforts. A first time beneficiary received a heifer and had to pass on the first heifer to another farmer. According to one HPI official, passing on the gift was not only in terms of the animals but also in passing the skills and knowledge acquired during the life cycle of the project:

> *Passing on the gift is our promise that ensures a never-ending cycle of giving and an end to hunger and poverty. Not only does it apply to animals but to the skills, all the knowledge and other resources like seeds or planting materials. Like the other principles in our 12 cornerstones, the passing on the gift principle applies to all our project recipients, staff and everyone committed to HPI's work.* (key informants interview, 2010)

With growing attention on women in development it seemed logical for the NGOs to give their intervention this focus. However, they abstracted the users from their work environment, treating them as a loose collective of female individuals. This defeats the notion of labelling the NGO intervention a "family project". Neither women nor households in which they were situated were static, either in activity or composition. As implied by the SACU respondent, the agencies sought a sustainable or "easy" entry point into the family sphere, and calling the cow "a women's" animal and tagging ownership solely to the women, played a part in getting women's commitment to the project. Of course another advantage the NGOs had with this approach is that most rural women are housewives and so they could supposdly actively participate in a home based enterprise. But there is nothing in what informants said to suggest that they had much sense of how a woman

constructs her role within a household, and how these constructions might vary from household to household.

The zero grazing livestock production system is associated with high feed requirements due to the higher milk producing capacity of stall-fed cattle (Kabirizi and Nanyeenya 1998). Reducing drudgery presented by high farm labour demands and increasing farm productivity, particularly in the intensive zero feeding dairy production system, were identified as priority needs of smallholder dairy farmers of Masaka during a diagnostic survey by the Livestock Systems Research Program (LSRP) project of NARO in 1998/1999 (LSRP 1999). Lack of sufficient land for forage production coupled with the forage scarcity for dry season feeding and labour shortages for forage preparation necessitated the efficient use of the available forage by minimizing its wastage. The role of the first NARO project was to increase feed resource availability as the project leader explained:

> *The two interventions targeted to increase feed availability were establishing fodder banks and leguminous forage, focusing on the grass used whereas forage processing and conservation were envisaged for the efficient forage utilization role.* (key informant interview, 2008)

She went on to explain how the project targeted technologies:

> *The project targeted smallholder dairy farmers on zero or semi-zero grazing system of livestock production. .....Participating farmers had to have the animals of course, the land, and at least 0.5 acres of forage.* (key informant interview, 2008)

The second NARO project (the forage chopper), followed immediately after the first phase of establishing fodder banks. Among the constraints identified by the smallholder dairy farmers during the LSRP survey was the drudgery associated with forage processing. Secondly, one of the roles of the first project was to promote efficient utilization of fodder which entailed forage chopping for conservation of forage, especially for dry season feeding, as well as to reduce forage wastage in the rains. After addressing the first constraint (feed shortage) the forage chopper then became immediately relevant to the smallholder dairy farmers as the team leader explained:

> *For one of the project technologies where farmers had to conserve the forage, we later introduced the forage chopping technology. We required these farmers to chop the forage to very small pieces and we realized this was going to be very strenuous on the farmers when using the traditional hand chopping method.* (key informant interview, 2008)

Although NARO's development routines point to a pre-selected user framed by the earlier intervention, land area grown with forage was another criteria for framing the NARO user, as was number of animals. Furthermore, NARO envisaged the user as an overburdened woman within the zero grazing system who had to be assisted to improve her welfare. This focus on women as individuals extracts them from their work place context. No data seem to have been collected on what that context was. In particular, information is needed on the way people and processes interact within the larger socio-technical system to determine how the introduced technology is absorbed.

3.3 The context of the actual user

In contextualizing the introduction of labour saving technologies, I found it useful to look at the setting of the user. By this I mean gender relations in production, with a focus on the livestock production activities, and gender relations in household economic resources that defined the choices available for the different household members in determining their responses to the introduction of the forage chopper. The introduction of labour saving technologies has implication for labour allocation patterns for all members of the household, and to an extent in between households as well. The data presented in the following sections is based on 65 farmer interviews conducted among a random sample of smallholder dairy farmers (35 farmers with and 30 farmers without forage chopper), coupled with my direct field observations.

3.3.1 The setting of the users

The African rural household tends to be both a unit of production and consumption, with a complex division of labour, especially where multiple wives and/or three generations are present, and labourers are resident with the family for the whole or part of the year. In the study area, I encountered different configurations of households, which I decided could be best grouped into three categories as follows: male headed households, female managed households, and female headed households. The characteristics of the different domestic groupings are summarized in Table 3.1 below. For the different domestic groupings, the average household included children in day schools, household heads not physically present but playing a key role in decision making and economic function of the family, and hired workers. But, it excluded the school going children in boarding schools and the youth who had migrated to urban centers.

Table 3.1: Characteristics of domestic groupings

Characteristics		**Domestic groupings**			
		Male headed		**Female headed**	**Female managed**
Description		With both husband & wife	Divorced/ widowed	Unmarried, separated, widowed	With male head migrated to urban center
With chopper	No.	24	2	7	2
	Ave. size	5	7	5	5
Without chopper	No.	24	-	4	2
	Ave. size	6	-	4	7

Source: Research interview data, 2008 from 65 farmers

It was observed that workers hired for livestock production activities often shared residence with the family, on which one farmer explained:

> *The people we employ for livestock production activities in most cases come from afar, either from other counties or neighbouring districts. With these animals, we are up early and there is always work to do the entire day till late in the evening. So, it is better you provide accommodation for them.* (farmer interview, 2008)

Another female farmer added:

> *With crop production, we just hire in casual labourers from within the community, but with the zero grazing activities we usually get people coming from other parts*

of the district and it is cheaper and convenient to provide accommodation for them than expecting them to commute every day. (farmer interviews 2008)

The gender roles and responsibilities of household members varied across the domestic groups. To gain an overview of the gender division of roles and responsibilities in the study area, I coupled household interviews with focus group discussions (FGDs). I conducted four FGDs, one in each study sub-county. It was difficult to separate the men from the women due to the attendance numbers. The responsibilities of men, women and children are summarized in Table 3.2.

Table 3.2: Gender roles and responsibilities

Domestic grouping	Gender roles and responsibilities			
	Men	Women	Boys	Girls
Male headed	♦ Securing family land (buying) ♦ Constructing house ♦ Paying school fees ♦ Family health care	♦ Caring & domestic work ♦ Securing production (leasing) ♦ Buy school items (books, uniforms) ♦ Children's & own clothing	♦ Fetching water & fire wood ♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Looking after animals	♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Caring for siblings ♦ Fetching water and fire wood
Female headed		♦ Securing land both for production & home construction (buying & leasing) ♦ Children's education ♦ Family health care	♦ Fetching water & fire wood ♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Looking after animals	♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Caring for siblings ♦ Fetching water and fire wood
Female managed	♦ Securing land (buying) ♦ Constructing home ♦ Paying school fees ♦ Family health care	♦ Caring & domestic work ♦ Children's & own clothes	♦ Fetching water & fire wood ♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Looking after animals	♦ Cooking ♦ Housework (cleaning house/compound, washing clothes/dishes) ♦ Caring for siblings ♦ Fetching water and fire wood

Source: Focus group discussion data

The focus group discussions pointed to the general division of roles and responsibilities. Further interactions with farmers, and household observations revealed that some of the established household roles had been largely redefined over time in many households in the face of a changing economic situation, the impact of the HIV/AIDS epidemic and rural-urban migration, as one of the farmers explained:

> *I am the 'husband' and 'wife' in this household; I have fended for my household all along without a cent from the father of these children. I am all there is to the survival of this household.* (farmer interview, 2008)

It was observed in a number of households that alongside traditional roles, women had also taken up additional income earning activities. The situation was not unique to the female headed households, but occurred even in some male headed households. In short, women's roles and responsibilities had increased. One woman in a male headed household linked this to the expense of education:

> *We managed to change the roof of our house when I sold one of the heifers. With the university fees, we are forced to sell off some of the calves to be able to see our children through university.* (farmer interview, 2008)

Although women in female managed households freely talked about their changing roles in coping with socio-economic change, it was not the case with their counterparts in male headed households. Of 48 male headed households (with husband and wife present) I encountered, I only got 18 women to talk openly about their changing gender roles as a result of the increased household economic pressure. I also observed that the socio-economic change in Masaka not only affected women but seemed also to have eroded men's commitment to their established patriarchal roles. In one FGD, some men commented:

> *Things have changed over the years and since our wives have also started earning some money, they take on some financial responsibilities. Jobs are scarce of late, with a lot of competition. If I manage to pay the fees, she buys the books.* (FGDs, 2008)

> *Sometimes we earn so little from the work we do and we cannot sustain all the family demands. We try to do our best but sometimes it is difficult to take care of all the family responsibilities.* (FGDs, 2008)

Contrary to the old way of thinking that women and children are solely dependent on the male household head, these data point to changes in activities routinely expected of women. For women to play a role in the economic functioning of the households (e.g. to provide school materials, and buy clothes) implies that they have added new activities to traditional tasks. Thus it can be argued that while the traditional gender ideology provides a general normative framework of reference for judging the behaviour and responsibilities of males, females and children, the norms no longer describe what is the case in actual instances. This is why it is necessary to have an accurate picture of actual household circumstances before designing a "labour saving" intervention

3.3.2 The labour patterns among smallholder dairy farmers

Labour allocation patterns have implications for the introduction of labour saving tools. This is because the gender division of labour and access to family or hired labour in a household are some of the aspects that influence machine uptake and use. This study focused on livestock production activities of the zero grazing enterprise. Combining

interviews and FGDs, the gender division of labour across the different domestic groupings for zero grazing activities emerged as summarized in Table 3.3.

Table 3.3: Gender division of labour for zero grazing cattle

Hhold category	Activity	Men	Women	Both	Children	Hired labour
Male headed	Securing land	√				
	Securing animal	√				
	Shed construction	√				√
	Shed maintenance	√			√	
	Planting forage		√		√	
	Weeding forage		√			
	Fertilizer application		√			
	Shed cleaning		√		√	√
	Feeding		√			√
	Vet services	√				
	AI services[3]	√				
	Delivery of calves			√		
	Fetching water	√			√	√
	Forage harvesting	√			√	√
	Forage	√			√	√
	transportation			√	√	√
	Forage processing	√				√
	Milking			√		
	Selling milk			√		
	Selling animals					
Female headed	Securing land		√			
	Securing animal		√			
	Shed construction					√
	Shed maintenance			√		√
	Planting forage		√			
	Weeding forage		√			
	Fertilizer application		√			
	Shed cleaning		√			
	Feeding		√			
	Vet services		√			√
	AI services[1]		√			
	Delivery of calves[4]		√			
	Fetching water				√	√
	Forage harvesting				√	√
	Forage				√	√
	transportation		√		√	√
	Forage processing		√			√
	Milking		√		√	
	Selling milk		√			
	Selling animals					
Female managed	Securing land	√				
	Securing animal			√		
	Shed construction					√
	Shed maintenance					√
	Planting forage		√			√
	Weeding forage		√			
	Fertilizer application		√			
	Shed cleaning		√		√	√

[3] Veterinary doctor
[4] Woman assisted by a veterinary doctor

	Feeding		√			√
	Vet services		√			
	AI services[1]					√
	Delivery of calves[2]		√			√
	Fetching water				√	√
	Forage harvesting				√	√
	Forage transportation		√		√	√
	Forage processing		√		√	
	Milking		√			
	Selling milk			√		
	Selling animals					

Source: Research data, 2008 from 65 household interviews and 4 FGDs

The gender division of livestock production roles was largely governed by the gender ideology discussed in section 3.3.1. Although some activities were solely prescribed to men or women or children, further field observations revealed that in many cases these activities were shared. Over and above family labour, there were also activities for which hired labour was contracted. The sharing of roles points to a general feature of many households – that allocation of duties is flexible in terms of activities and gender composition. Around animals, the job has to be done, so the activity may be taken up by whichever household member is available. With the enrolment of hired labour, household composition in relation to task allocation was even more variable. From the farmer interviews, diverse explanations were proffered for the actual division of labour reported or observed. Important was that the household division of labour also had to take account of school. With Universal Primary Education (UPE) and Universal Secondary Education (USE), the time available for the children to assist their parents was limited to working in the early hours of the morning on week days and over the weekend. In some households, farmers indicated that:

> *The boys have to do some of the livestock production activities in the morning before leaving for school or late in the evening when they return. Over the weekend they join me for the crop production activities.* (farmer interview in a male headed household, 2008)

> *The children can only help out before and after school hours. The children do most of the chopping and fetching water for both the animals and domestic use.* (farmer interview in a female headed household, 2008)

This was the case in 35 of the 65 interviewed households. In another 20 of the 65 interviewed households it was observed that school going children hardly took part in production roles as one farmer explained:

> *I cannot count on the school-going children's labour. Their schools are located a long distance away from here which requires them to set off very early in the morning and in most cases returning quite late. So to be able to manage the different activities, we hire someone to assist us with the animals and my wife and I focus on the crop activities* (farmer interviews, 2008)

The school going children hardly contribute to the family labour force because they leave very early in the morning and by the time they return it is too late for any production activities. In the absence of the children, it is just me and my wife readily available for production activities. It is difficult to manage all these activities, especially during the rainy season when we have to attend to the crops as well. It was cheaper to get someone for the animal because we can use some of the money from the milk sales to pay his labour. (farmer interview, 2008)

With the strong hold of the Catholic church in the district, it was also observed that children were frequently sent for church lessons on Saturdays, reducing on their available time to engage in productive activities. One farmer lamented:

The school going children are always engaged in their studies that even over the weekend some of them still have to report to school or go for religious studies. (farmer interview in a female managed household, 2008)

Unlike the crop farming activities where labour demands go down during the dry season, livestock labour demands are almost a constant throughout the year, as the farmers seasonal calendar for livestock activities and constraints (Fig 3.1) shows.

Jan – Mar	Apr – Jun	Jul – Sept	Oct – Dec
1st Dry spell	**1st wet season**	**2nd dry spell**	**2nd wet season**
Plant fodder/ rely on crop residues	Farm/communal feeds available	Plant fodder/rely on crop residues	Farm/communal feed available
Use non-conventional/ wild feeds	Make hay/silage	Use non-conventional/ wild feeds	Make hay/silage
Low milk yields	Tick borne diseases	Low milk yields	Flies common
Feed scarcity	Flies are common	Feed scarcity	Tick born disease

Figure 3.1: **Seasonal variations of livestock activities and constraints patterns**
Source: Adapted from (NARO 2001)

Whereas forage was readily available in the wet season, there were other activities (like making hay/silage) that required farmers to prepare for the next dry season as well as strict animal health practices, since this season meant high occurrence of animal diseases. In the dry season, farmers were hit with feed scarcity. With the stall-fed animals, the search for forage was at its peak in the dry season, yet milk yields were too low to provide income for purchase of non-conventional feeds. This implied a constant labour demand for zero grazing animals and the organization of these different activities required more than just family labour to make zero grazing work. Irrespective of household category, there was a shortage of family labour and this necessitated the enrolment of hired labour. Looking at the picture for livestock production labour for all 65 farmers across the different domestic groups, labour was drawn from the family, from hired sources or from a combination of both (Fig. 3.2). Family labour was overall more important than hired labour, but it is worth noting that the proportion of hired labour was significant for women headed households. There is a general problem with hired labour. Farmers found it usually unreliable, expensive and scarce, especially during the peak production period when labour demands peaked. One farmer explained:

It is difficult to access hired labour during the busy [peak] production period because of the high demand. When they (hired workers) *want to make quick money, they take on many jobs but never finish them on time. They keep on jumping from one job to another, taking so long to complete yet they charge us highly.* (Farmer interview 2008/09)

Figure 3.2: Household division of livestock production labour
Source: Research data, 2008 from 65 farmer interviews

Although farmers enrolled hired labour for production activities, several households worked closely with their hired labourers. Farmers attributed this situation to the constraints associated with using this labour source and the high labour demands of the zero grazing system, which caused a lot of labour turn-over in many households. Hired labour was not confined to particular household types, and the data confirm that neither a focus on households nor gender relations is enough to understand labour allocation and management issues.

Decision making responsibility was variable across households (Fig 3.3). Decision making largely involved men, women and the older children. It was observed that hired workers were not key decision makers over allocation of household labour/activities. All the farmers interviewed pointed to household head, spouse or children as the people involved in decision making. In the male headed households, there was a high involvement of men in most decisions. Joint labour allocation decisions were mainly observed under two circumstances. Where men relied on farming as the main source of income, and used family labour more than hired labour, then the involvement of wives in labour allocation decisions was necessary to adequately access family labour. Second, where men had formal employment joint labour allocation decisions were made because the man's financial support was often required to enrol hired labour while the women's support was required for effective management of family activity.

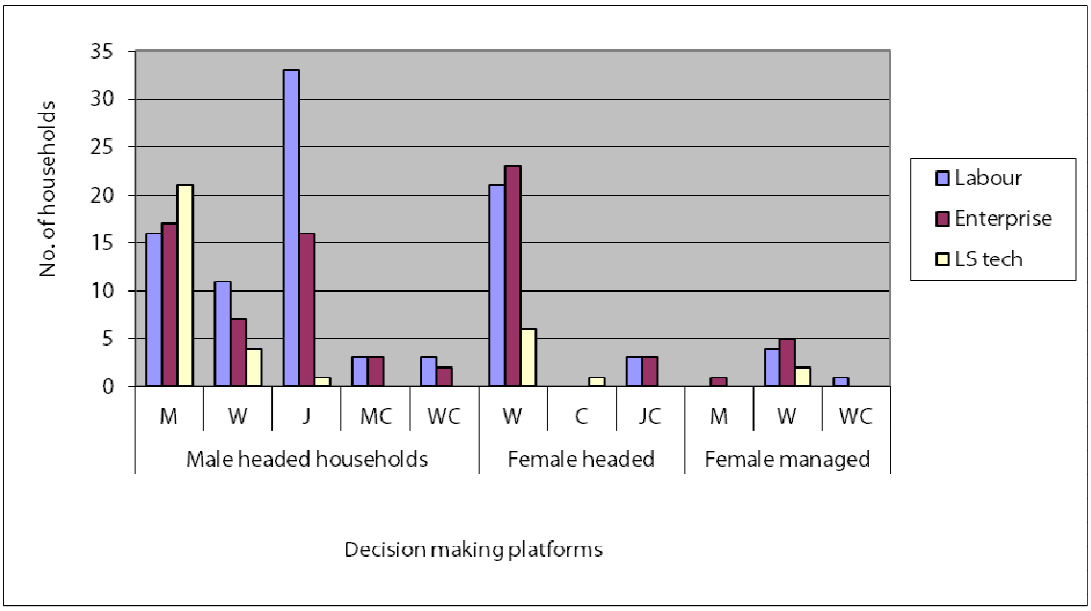


Figure 3.3: Decision making in households

M: men's decision; **W:** women's decision; **J:** joint decision; **MC:** man taking lead but consulting wife; **WC:** woman taking lead but consulting man; **C:** older children's decision; **JC:** joint decision with older children.
Source: Research data, 2008 from 65 farmer interviews

Among the 11 female headed households, there were only 2 households where women consulted older children because the children played an important role. In all the female managed households the case was:

> *With my husband working away from home, I make all the necessary decisions on production enterprises & household division of labour for production, but with some limited consultation from him since I rely on his financial support to pay for hired labour.* (farmer interview, 2008)

With the different people involved in production and decision making in different households, coupled with varying availability of school going children and hired labour, the data show that division of tasks is a complicated process, and differs over domestic groupings and can change over different periods. What becomes clear is that the way different activities are organized in different domestic groupings, for different task groups around the four seasons, and the way these arrangements intertwine, constitutes the process through which zero-grazing works. There is no model household nor single type or way of working, and accordingly there is no single type of gendered work. Grasping this situation is the challenge for designers interested in helping women work better.

3.3.3 Gender relations of economic activities

Agro-pastoral activity was the main economic activity in the study area. This means growing both annual and perennial crops and keeping both local and exotic livestock. Annual crops served both for home consumption and as cash crops. Income generating enterprises/activities varied across the different household types as shown in Table 3.4.

Table 3.4: Distribution of income generating activities

Hhold category	Income generation		
	Men	**Women**	**Shared**
Male headed	♦ Coffee ♦ Cattle – esp. sale of animals (local, exotic) ♦ Bananas (cooking type) ♦ Forest reserves (sale of timber, firewood & poles) ♦ Poultry (Esp. Eggs) ♦ Back cloth making ♦ Brewing ♦ Brick making ♦ Masonry work ♦ Carpentry ♦ Trading (agricultural commodities) ♦ Transport services (motor cycles, taxis) ♦ Real estate ♦ Formal employment (salaries or retirement benefits) ♦ Fishing	♦ Cattle – esp. sale of milk (zero grazing) ♦ Bananas (cooking & eating type) ♦ Vegetables ♦ Pigs ♦ Goats ♦ Handcraft (mats, baskets) ♦ Local poultry	♦ Cattle ♦ Bananas (eating type) ♦ Milk ♦ Maize ♦ Cassava ♦ Beans ♦ Fruits ♦ Poultry ♦ Hiring labour for crop production
Female headed		♦ Zero grazing cattle – sale of milk and animals ♦ Local cattle (few cases) ♦ Bananas (cooking & eating type) ♦ Pigs ♦ Goats ♦ Poultry ♦ Vegetables ♦ Fruits ♦ Coffee ♦ Local poultry ♦ Brewing ♦ Selling forage ♦ Handcraft (mats, baskets) ♦ Hair saloons ♦ Road side markets ♦ Village phones ♦ Hiring out labour ♦ Formal employment (salaries or retirement benefits)	

Female managed	♦ Coffee ♦ Forest reserves ♦ Brick making ♦ Masonry work ♦ Carpentry ♦ Transport services (motor cycles, taxis) ♦ Real estate ♦ Formal employment ♦ Fishing	♦ Cattle (zero grazing) – sale of milk & animals ♦ Bananas (cooking & eating type) ♦ Poultry ♦ Pigs ♦ Goats ♦ Vegetables ♦ Fruits ♦ Handcraft (mats, baskets) ♦ Local poultry	

Source: FGDs research data, 2008 from 4 FGDs

Men generated income from large livestock, traditional and non-traditional cash crops whereas women generated income from small livestock animals and food crop enterprises. Women's crops were similar across different types of households, a difference being apparent only in the scale of production. Whereas women in male headed and female managed households mainly generated their income from the sale of surplus food crops, there was less sale of food crops in female headed households. Irrespective of the household type, zero grazing animals formed an important economic resource for women, and it was rated as their number one economic asset (and an asset that individuals could use as collateral) (Fig 3.4).

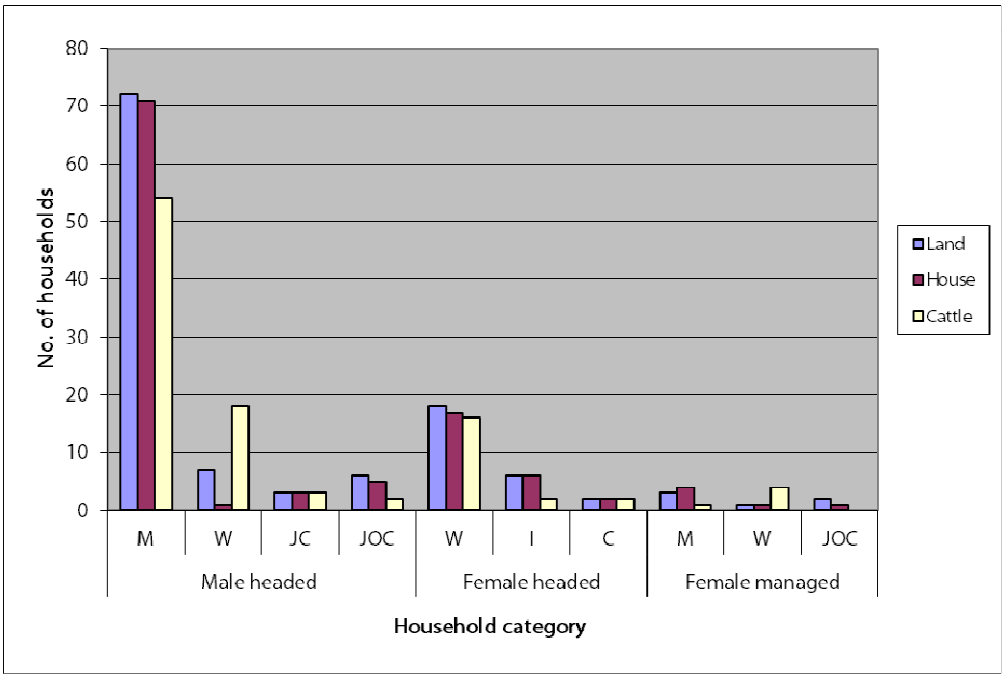


Figure 3.4: Distribution of main economic assets

M: owned by men; **W:** owned by women; **JC:** owned by men but jointly controlled; **JOC:** jointly owned and controlled; **I**: Inherited from spouse or parents; **C**: Children

Source: Research data, 2008 from 65 farmer interviews.

These data further point to the fact that households are not fixed in terms of activities. People engage in different activities, some shared and others not, and the way the different activities are organized and interact with other aspects of the socio-technical

system is important to determine the use of labour saving tools. Drawing from these data, the next section will explore how the introduction of the forage chopper affected users in these variously organized and changing households.

3.4 Impact of the forage chopper on household organization of labour

Of the 35 households selected with the forage chopper, only 24 were still actively using the technology when this study was conducted. Data presented here is based on interviews with households still using the device. The forage chopper was developed with the assumption that it will save labour for rural women and hence give them more control over their own labour, and thus free them for other income generating activities. In the users' rating of the forage chopper they concurred that the machine eased the chopping operation, saving them time and labour, which (in principle)they could utilize to perform other production activities (Fig 3.5). But whose labour did it save? Having targeted women in the development of the forage chopper, it was necessary to examine the outcomes of this technological change for the women concerned.

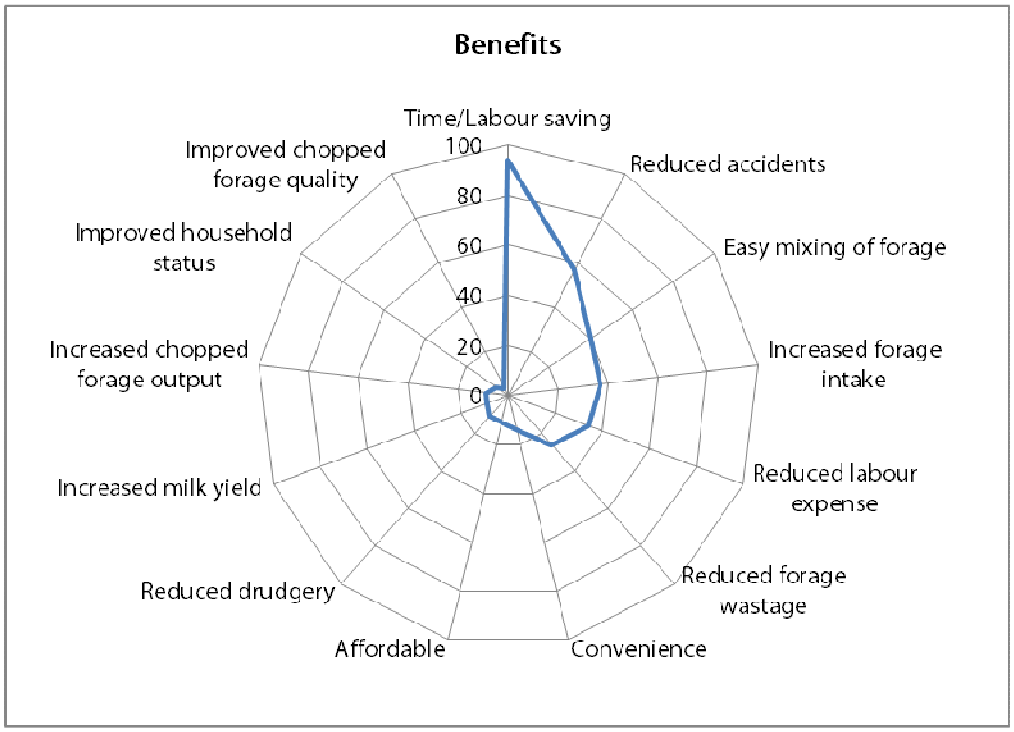


Figure 3.5: Farmers' rating of the forage chopper
Source: Research data, 2008 from 24 using households

The analysis of activities of smallholder dairy farmers showed that the households and farmers were not fixed in terms of activities. This implied that the introduction of the forage chopper saved different people's labour, not necessarily only women's labour, since forage chopping was not only restricted to women. Beyond freeing labour, other things had to be in place for women to benefit from the labour saving tools. The introduction of one labour-saving technology did not imply that women necessarily had control over their saved labour, because differences in household decision making power influenced their ability to benefit from labour-saving technologies. Whereas this control was less of a challenge in female headed and female managed households, Fig 3.3 reveals men's heavy

involvement in the decision making process over labour in male headed households. The way male headed households are organized and how this interacts with livestock production activities matters if women are to benefit from labour saving tools.

Comparing allocation of livestock production labour for user and non-user households (Fig 3.6), it seems there was more use of a combination of family and hired labour in the male headed households, whereas the non-users relied more on family and hired labour.

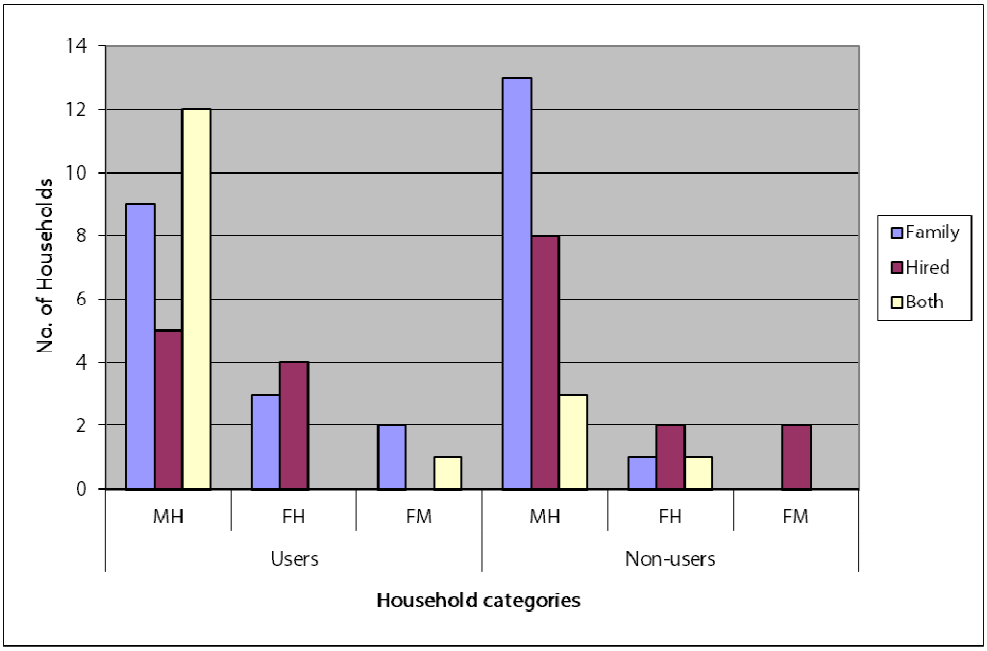


Figure 3.6: Household allocation of livestock production labour

FC: Forage chopper users; **WFC:** without forage chopper. **MH:** male headed; **FH:** female headed; **FM:** female managed

Source: Research data, 2008 from 24 using households and 30 non-using households

Since no base line data existed for the "before" situation on labour patterns in user households, two possible interpretations can be made of Fig 3.6: either the use of the forage chopper allowed a redefinition of roles, altering the balance between family and hired labour, or the decision to adopt the forage chopper depended on the relative availability of family labour for livestock production activities as shown in Fig 3.2. Either way, it is clear that users and households are not fixed entities in terms of activities and composition. So, the forage chopper has variable implications in terms of potential gender empowerment through technology. It can also be noted that, given the variable nature of users and households in terms of activities, the forage chopper did not ease the labour constraints for women alone, but for entire households. What carried the greatest significance for women themselves was the ability to reallocate saved labour to own benefit, whereas the data above suggest that in male-headed households the greatest benefit was the capacity to cut down on hired labour. We have to wonder, therefore, whether the adoption of "labour saving technology" for women in male-headed households actually increased their labour burdens.

3.5 Impact of technology on household economic resources

The introduction of new technologies always has implications for household economic resources. The introduction of the forage chopper had two implications: a possible indirect income increase from effective utilization of the machine, and the expense associated with purchase and maintenance. The contribution to increase in household income was twofold: saving on labour costs and greater income from milk production. Altering the balance between family and hired labour implied a reduced dependence on hired labour, hence an important cost saving. Furthermore, with properly chopped forage reduced wastage for forage was reported which implied reduced labour in processing forage. From farmers' ratings (Fig. 3.5), there was a notable increase in animal forage intake attributed to well chopped forage, which implies increased milk production from healthy, well-cared for animals, thus an income boost from milk sales

A down side was the expense of acquiring the device. The initial cost of the NARO forage chopper was high (USh. 110,000=) which prompted farmers to seek alternative sources, as the account of the domestication process in Chapter 4 will make clear. Even with other sources, some farmers still found costs prohibitive. The persistent use of hand chopping method after the introduction of the forage chopper is to be attributed mainly to the issue of cost. There were farmers who wanted the device but argued:

> *Our resources are so constrained that we cannot afford to raise such amounts of money [for the purchase of the forage chopper].* (farmer interview, 2008)

As it will emerge from further analysis of non-users in Chapter 4, cost factors were the major limitation on those farmers who never managed to use the forage chopper. Only a limited number of farmers received machines as incentives for participation in the NARO forage conservation project or in NGO projects. The financial situation of some farmers was worsened by low livestock productivity, resulting from poor quality animals. This implied that the cattle enterprise could not cover all livestock related expenses. Not only was cost involved in the purchase of the machine, but a further constraint cited by farmers was the subsequent maintenance and repair costs (Fig. 3.7).

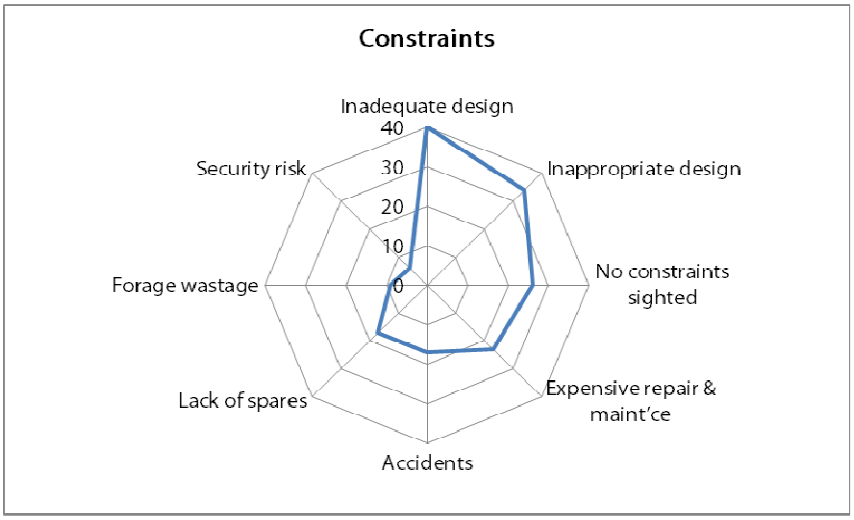


Figure 3.7: Farmers' rating of the forage chopper
Source: Research data 2008 from 24 using households

Most repair works centred on damaged forage chopper stands, broken or damaged bolts and worn out or damaged pangas and panga holes. When simple repairs were not done in time, damage accumulated, adding to eventual costs, or alternatively the machine became unusable. The biggest bottleneck was to do with any repairs that involved welding. This racked up repair and transport costs. Given the remoteness of many farmers from trading centres where welding services could be found, many users abandoned their machines and reverted to traditional hand chopping methods.

3.6 Conclusion

This chapter has analysed the importance of understanding the organization of household activities, and the ways in which women-targeted technologies interact with these organizational factors. It has been argued that targeting women with a device is in itself not enough to guarantee that women will benefit - let alone lead to empowerment - because the use and impacts of a technology are partly determined by household organization. I conclude that although it is important to put emphasis on women individually in technology development in the bid to increase their access to technology, a detailed understanding of the gender-based division of labour within households is essential. Increasing women's access to technology is in itself not empowering, and may even increase women's workload where decision making power remains solely with men. Data presented in this chapter support this point of view.

When technology developers extract women from their work environment, they risk targeting virtual users instead of actual users. Understanding the context of actual use is important when targeting individuals with technology interventions. This study has shown that gender ideology provides a general normative frame of reference for regulating the behaviour of men and women but does not determine what men and women actually do. This is very much a function of specific situations. This is why an anthropological style of research can help close the gap between the virtual and actual user in technology development.

Over and above reconfiguring the user, the process of making a machine work entails understanding what resources or parties have to be mobilized by the users to arrive at workable solutions. Beyond the machine, there are other elements or social entities in the socio-technical system. This chapter has shown that the way different activities are organized in the households, and the composition of users labour (family labour, hired labour or both) are both not fixed aspects of the socio-technical system, thus implying that a range of interests can be mobilized to arrive at solutions. Developing technologies to improve women's wellbeing thus requires understanding of the way the different household elements combine or intertwine with technology to determine use and impact. Because gender relations are dynamic, it is difficult to predict patterns of technology use before the event, and technographic insight is a potentially useful input to the design process.

Chapter 4 Domestication of Technology: The case of the forage chopper for smallholder dairy farmers

4.1 Introduction

New technologies are often threatening and challenging, so that to be incorporated in our lives, they must be successfully "domesticated" (Bray 2007). Although designers make some predictions about the social practices involved in use of technology during the design phase, there is still scope for people to use technology in other ways than those envisaged in the design process. It therefore becomes important to follow the process of integration of technology within the user's world because in that process technology may be transformed along with users themselves. It is this combined effect of user and technical change that presents a major challenges in predicting technology uptake and use within households.

The term "domesticated" is used here to apply to the process through which a new device is "tamed" or appropriated within the domestic space (Stewart and William 2005; Williams, Stewart et al. 2005; Bray 2007; Oudshoorn and Pinch 2008). It serves to highlight the internal negotiations, challenges to power and control accompanying adoption of the device (Stewart and William 2005; Williams, Stewart et al. 2005). New machines have to be transformed from being unfamiliar and possibly threatening into familiar objects embedded in the practices and routines of everyday life (Lie and Sørensen 1996). The processes of integration and interpretation of a machine are therefore usually influenced by the social structures, circumstances and cultural conceptions of households. Interplay of the machine with these relations shapes the process and outcome of technological change. Technology innovation is not restricted to the technical specialist; users engaging with a new device directly contribute to redefining technologies, their use and social significance (Sørensen and William 2002). Therefore, the social practices associated with use of a device cannot be fully anticipated in the design phase; they emerge during the interpretation and integration processes (Rohracher 2005), and this is why technography is needed as an element of iterative design.

In the domestication process various forms of usage are possible, entailing elements of adjustment and copying. These forms of usage are influenced by the distribution outlets for the machine and after sale services and also by the ability of people to mobilize community resources to facilitate the process of (re)making. Here, as mentioned before, I use technography as an approach to examining the organization or interplay of the different elements of the socio-technical system facilitating the process of (re)making (Richards 2003; Kien 2008). To gain an understanding of the interplay of the social and technology, this research followed up the process of integration of the forage chopper among smallholder dairy farmers in Uganda. The research focused on access to the machine and the social practices of usage that emerged in the domestication process.

In the process of domesticating the device three groups can be recognized: users, former users and non-users. This chapter focuses on these three groups, in order to understand usage issues, how farmers mobilized community resources to facilitate the process of making with the device, and why in some situations farmers opted not to engage with the technology. Two groups of farmers were selected: 35 smallholder purposively chosen dairy

farmers with forage choppers studied in depth for social and technology interaction aspects; and 30 smallholder dairy farmers without the improved forage chopper randomly selected to find out why in some situations farmers opted not to engage with the technology. The data presented in the remaining sections were observations of these smallholder dairy farmers combined with interviews conducted prior to and after the observations. Informal conversations during the observation phase were also necessary to gain deeper understanding of the different situations.

4.2 The users

Usage comprised two aspects - making and remaking. The process of making entailed mobilization of community resources (technical services, materials of fabrication and after sale services). This mainly comprised sourcing for technical support and technologies through other uptake pathways in addition to NARO. The process of remaking entailed adjustments and modifications to the introduced machine to make it workable for users. Materials of fabrication changed with time from an all-metal technology to one combining metal and wooden parts and then to an almost all-wooden machine. Variations in the size of the machine emerged. A range of coping mechanisms was devised, either to accommodate specific needs/requirements of heterogeneous users or to address issues of after sale services. Among the 35 households initially owning the forage chopper, only 24 households were still active in using the machine during the study. The remainder had abandoned it (Table 4.1).

Table 4.1: Distribution of use and former use

Model/Type	No. of hholds	Users	Former-users
NARO model	8	3	5
NARO reproduced model	2	1	1
Various all-metal models	12	9	3
Metal/ wooden models	8	7	1
Wooden models	5	4	1

Source: Research Data, 2008 from 35 households

The NARO model

The use of the NARO forage chopper involved diverse aspects of the remaking process. The farmers reconfigured the machine to suit their own socio-economic context, adjusting it to their needs and availability of resources. At the time of this research, only 3 households (2 male headed & 1 female headed) out of the 8 initial beneficiary households still continued to use the machine. The design had incorporated an adjustable plate (Photo 4.1) for presetting the recommended length of chop (1 – 1.5 inches). This was intended to promote efficient utilization of forage by uniform chopping. As discussed in chapter 2, one of the constraints the forage chopper was designed to address was the non-uniform length of traditional hand chopping that affected the consumption and mixing of forage with other feed materials.

Photo 4.1: NARO forage chopper design

Several adjustments and copying strategies were devised in these three households to use the machine more effectively. These ranged from removing some parts to gaining performance speed, adding components for efficient operation, to improvising for spare parts. All users concurred that:

> *Feeding the animals was indeed simplified by the acquisition of the chopper because it made chopping of forage a lot easier, less laborious and less time consuming.* (farmer interview, 2008)

However, for the hired workers operating the machines, time could only be saved in a particular context:

> *When you have so much work to do in limited time, you need to work fast. Sticking to the required length of 1 inch is time consuming. So to save some time for other livestock production activities, I remove the plate and chop free style. As long as the grass is cut to pieces, the animals will eat it irrespective of the length of cut.* (farmer interview, 2008)

In the 3 households still using the original NARO forage chopper, the forage processing role was assigned to hired labourers who had made various alterations to simplify their work. The first adjustment encountered was the removal of the plate controlling the length of cut (Photo 4.2).

Photo 4.2: Plate controlling length of cut removed

In two of the three households the hired workers failed to chop with the plate fitted and in one household the bolts were lost and the plate damaged from frequent removal to accommodate the needs of the varying operators. Attempts were made to replace the plate in this household during the initial period of study, but subsequent follow-ups revealed that it was not consistently used. Further observations and interactions with hired workers confirmed their claim that with the plate in position a lot of time was spent in chopping small pieces. In the interest of time saving, so as to attend to other production activities, labourers only aimed at chopping forage into reasonable sized pieces (Photo 4.2b) so that the animals could consume the feed, without every piece being a regulation 1-1.5 inches in length.

> *Even without the plate, I can maintain a reasonably uniform length of cut, with minimum wastage by the animals. You see, the plate was limiting how fast I chopped and when I removed it one day, I realized that I worked faster. So I decided to remove it for good.* (users interview, 2008)

Although some disadvantage was noted with chopped lengths in excess of 3 inches, it was observed that anything between 1-3 inches was sufficient to minimize losses of chopped forage and the absence of the plate certainly did not stop users from approximating correct lengths. Asked about the time spent in collecting more forage to compensate for the incurred wastage, once it was noted by the researcher that some animals were observed to search for finely chopped pieces, one worker argued:

> *With or without any forage wasted, I still do the same amount of work when it comes to processing of forage. There is always some unconsumed forage irrespective of the length of cut pieces. Sometimes the animals are just wasteful.* (farmer interview, 2008)

Whereas length of cut defined the designers' notion of effective chopping, users were simply concerned with reducing forage to sizeable pieces without necessarily paying strict attention to the exact length of chop. Clearly, precision was to the designers as swiftness was to the users. What was important to users was saved time, and the details of length of cut were immaterial. Understandably, there was no incentive for hired workers to comply with the recommended length of cut. Increased milk production from quality feeding only benefited the owner and the hired work was still faced with the same amount of work (or

more). What transpired is that a simple adjustment of removing the plate shifted the emphasis of the operation from uniform length to speed. This means that in the design of technologies, developers need to be well informed about user preferences. The actual person who eventually gets to operate the machine matters more than targeting on a nominal beneficiary. A "virtual" woman may look good in NGO reports but if the real operator is an underpaid male labourer then the machine will be modified or abandoned.

Another factor that emerged during the observation phase to explain the removal of the plate was the frequent blockage of the panga slot (Photo 4.2a), especially when high moisture content legumes were mixed with Napier grass. This necessitated frequent unblocking of the slot. Furthermore, the presence of the plate restricted passage of some feed material like banana stems. The frequent need to clear or unblock this slot, coupled with the inconvenience of the plate during chopping of some material, induced many operators to remove the plate so as to gain quick access to the slot. One hired worker explained:

> *The plate makes it difficult to quickly clear the panga slot. Without it I work faster. Besides, when one has worked with the machine for a while, you can easily estimate the length of cut without the need to pre-set it with the plate.* (farmer observations, 2008)

All the three NARO-user households experienced the problem of accumulated forage in the panga slot and the restricted passage of some chopped material. Although the users' quick way of solving this problem was to remove the plate, from the author's knowledge of the design aspects of the machine, the slot was big enough to permit cleaning using a knife or any blade without removing the plate. However, this had to be done on a daily basis, to avoid build-up of material in the slot that would make cleaning difficult. Furthermore, the clearance left for chopped material to fall through was ideal as long as users held small bundles of forage (enough for one hand) or split up the banana stems before chopping. However, what the users' adjustment means is that beyond simplifying the process, the total time spent on the process (including cleaning and unblocking) is important, and simply removing the plate did the trick. This implies that in the design of labour saving tools designers need to have a clear understanding of the users' notion of efficient utilization of the machine. It is in fact ironic that labourers modified (simplified) the machine to save labour in the use of labour-saving equipment. This seems to suggest that designers might think more about how to save set-up times, and ensure that where possible key parts can more easily be adjusted or removed.

Beyond removing the plate to gain work speed, other adjustments and coping mechanisms were devised to facilitate continued use of the forage chopper. In all three households where the NARO forage chopper was maintained, even the lack of some spares did not deter continued use of the machine. The second adjustment I encountered was in regard to the bolts holding the panga. The forage chopper was designed for outdoor storage but not all farmers left the machine outside. As one of them explained:

> *We never leave production tools outside, we always store them away. With such a technology, we have to store it away nicely or at least move it near the house instead of leaving it at the cattle shed. But then you have to remove the panga*

because it is dangerous leaving it out there for it can be used by the wrong people. (farmer interview, 2008)

In another household:

Even if I store away the machine, the panga is a threat to family security when left on the machines. Besides, the same panga is sometimes used for other production activities. (farmer interview, 2008)

With this frequent removal of the panga, all the bolts holding the panga eventually got lost. In two households the farmers replaced these bolts with ordinary nails (Photo 4.3). In Photo 4.3a it will be noted that the farmer had left the nail protruding outwards to allow for the removal of the panga, thus presenting potential risks to the operator. In Photo 4.3b the farmer had nicely rounded off the nail but then this meant that the panga could no longer be detached, as was the initial practice.

Photo 4.3: Coping with spares

Evidently the hope that standard parts would be easily sourced in case of damage did not apply. Few farmers had access to these spares, which forced them to adjust to available resources. Bolts are specialized parts, with specific sizes for a particular task. Designers need to understand that their own interpretation of standard use of specific parts is not always compatible with users' conditions and access. Even the simple ordinary nails, however makeshift, were enough to get the farmers going. This means that in the absence of technical support or after sale services, technology developers need to be well informed about the kinds of services or likely repairs available to farmers, and try and design with these means in mind.

The third adjustment encountered during technography was addition of parts or components to improve the efficient operation of the machine. In one household, the operator had added a wooden piece (Photo 4.4a) to prevent chopped forage from falling underneath the machine, which increased the collection time of chopped forage. In the absence of a collecting unit, farmers conventionally used gunny bags laid out just beneath the chopping end. As chopping progressed, the chopped forage would accumulate and eventually pour beneath the machine onto the ground. It was observed that the wooden piece blocked the gap between the stands. It also provided a slope for the piled chopped forage to fall away from the machine.

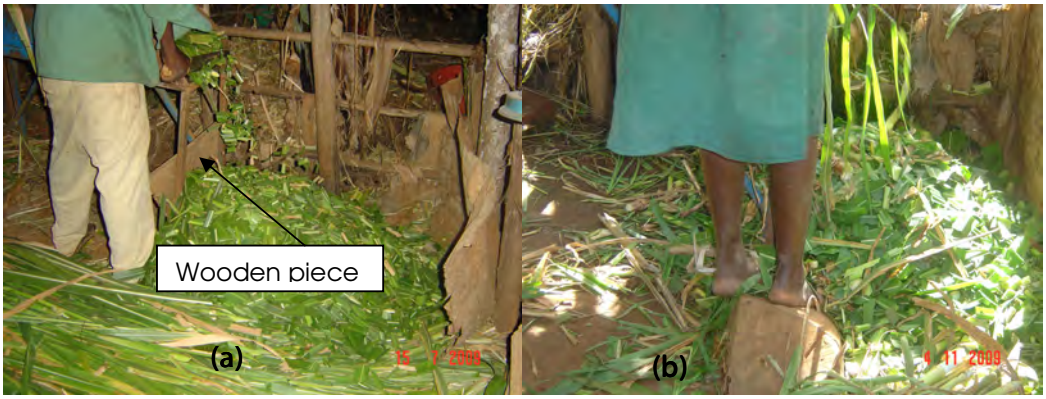


Photo 4.4: Users' coping mechanisms

Another aspect that farmers struggled with was to make the forage chopper usable for children. As discussed in Chapter 2 and 3, in the NARO survey exploring the constraints that smallholder dairy farmers experienced, the forage chopping role was largely described as belonging to women and children. However, the height of the final prototype was too high for children, an aspect farmers had attempted to point out during the on-farm evaluation of the machine (Chapter 3). But this was never sorted out. NARO's failure to accommodate child users in the design of the forage chopper did not necessarily deter users from ascribing the forage chopping role to children. Facilitating children's use was the fourth area of adjustment encountered in the technographic exercise.

In one particular household a shortage of hired labour saw the forage processing role temporarily shift to children. Faced with the task, children improvised to compensate for their heights (Photo 4.4b). The girl in the picture used a wooden block as a stand to gain some height, enabling her to exert the necessary weight on the panga for efficient operation of the machine. With the lever mode of operation, operator height mattered. There was need to exert considerable force on the panga during its downward movement to achieve the chopping effect. It got more strenuous when chopping the tougher stem ends of the forage rather than the leaves. It was much easier for tall than short operators to attain the necessary force.

These encountered adjustments point to a number of aspects of domestication. There is no ready-to-use technology. Out-of-the-box and African farming do not go well together. Design and use are not related in any simple way. And the users' input to the design process is crucial to turn out a workable design. Simple additions can facilitate easy usage of a machine. This then means that in the introduction of a machine, developers should be well informed about resources available to users and how these are likely to be mobilized to facilitate use of machines. Technographic observation is an important part of the feedback process.

The NARO reproduced model

More smallholder dairy farmers required the forage chopper than the NARO project could cater for, implying that potential users had to incur the cost of the machine. Although NARO had the capacity to produce more machines for farmers, NARO choppers cost USh.110,000 per unit to build, and few farmers could afford this. Emphasis on technical efficiency of the NARO forage chopper had resulted in the use of high cost materials which

translated into the cost of the finished machine. As a result, farmers resorted to other means of acquiring the forage chopper. Farmers engaged local welders and carpenters to reproduce designs they had acquired from researchers and/or fellow farmers during farmer-to-farmer visits. "Fabrication" was a socially-varied process. Some buyers paid for a finished product. Others participated in the fabrication process, either by making the device or by providing materials and paying only for the fabricator's labour.

One of the attempts at making the device encountered in this research were two farmers who reproduced the NARO design using the services of local welders, maintaining the overall design features but varying material specifications (Photo 4.5). Both farmers belonged to the same farmer group where four members had received NARO forage choppers. Given close association, it was easy to get the details of the design.

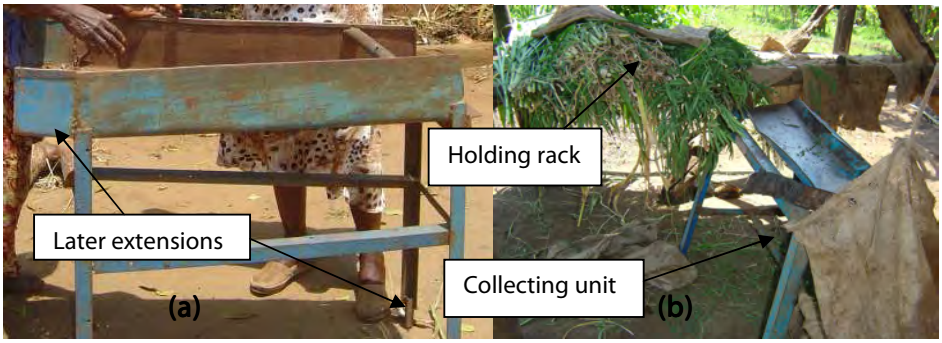


Photo 4.5: Reproduced NARO design

As observed from Photo 4.5a, the holding tray was initially made a little too short, so that an extension was later added conveniently to accommodate the length of the forage. Secondly, the height of the machine was also previously slightly shorter than the farmer desired, so that some pieces of hollow sections were later added to the stands to increase the height of the machine. Inquiry into the production procedure revealed that the farmer's remote location from the trading center where the machine was fabricated had made it difficult for the continued modifications deemed necessary with continued use of the machine to be undertaken. Besides, the welder had only made a single visit to take the measurements of the original machine and never cross-checked his fabrication against it. Later this farmers abandoned the use of the machine, on the basis that it was a poorly reproduced design.

In the second household, the size and shape of the holding tray were totally changed and the height of the machine reduced (Photo 4.5b). The reduced height proved favourable to children, since they very often assisted their father with forage processing. Further inquiry revealed that children had not been deliberately targeted in the development of the machine as the farmer explained:

> *I carried a photograph of the NARO machine to a welder and asked him to reproduce it. It was not intentional to make it short to accommodate the children although it eventually worked in my favour. The welder did it to economize on the materials used.* (farmer interview, 2008)

To compensate for the reduced area for holding unchopped forage, the farmer had improvised with a wooden rack to hold forage (see Photo 4.5 (b)), constructed within the chopping shed near the machine. As the farmer later explained, this was done to avoid constant bending to pick up forage which he claimed was prolonging the activity time. Another modification this farmer added was a gunny bag for collecting chopped forage instead of placing plastic sheets beneath the machine. Although initially the design incorporated the plate controlling the length of cut, it was hardly used. In regard to this the farmer explained:

> *… the forage chopper has a "step"* (i.e. the plate) *for measuring the length of chop but sometimes I remove it to gain more speed when I am constrained by time and just use my eyes to gauge the length of chop.* (farmer interview, 2008)

As occurred with users of the NARO model, simply removing the plate allowed the farmer to gain more speed. Analysis of the users of reproduced devices points to a very important community resource in the use of the forage chopper – welding. In the absence of NARO's technical services, the farmers tapped into available services to make the machine. Although poor workmanship was at times evident, the role of the welder in fabricating the forage chopper points to a crucial group of resource persons that technology developers can utilize to increase farmers' access to the machine and offer after sale services. Training of welders on the design should be incorporated into the design process.

The all-metal models

Beyond reproducing the NARO model, the making process took on other design formats, varying in material selected (metal sections, scrap material and wood), design and dimensions to accommodate user needs and requirements. A range of all-metal machines with different stand designs and varying forage holding tray sizes was encountered (Photo 4.6). Of the 12 households with the all-metal machine, only 9 were still actively using the machine - two female-headed and seven male-headed households. With the exception of one household where the farmer doubled as a welder, the making process for all-metal machines involved either paying for a finished product or providing raw materials and paying for the labour of fabrication.

Table 4.2: Farmers' technology development roles

Users' role	Household type		
	Male headed		Female headed
	Men	Women	
Paid for finished machine	1	3	2
Provided material & paid for labour		1	
Project incentive	1		
Fabricated machine	1		

Source: Research Data 2008

Photo 4.6: Reduced material designs

Common to all machines was the evident reduction of cost of materials used for fabrication. Where the metal base holding tray was maintained, the overall size of the machine was reduced (Photo 4.6a, b & c) or where the overall size of the machine was maintained to accommodate the length of forage, the base was an open bar frame (Photo 4.6 d). There were also adjustments made by some farmers to all-metal machines. In one-male headed household, the farmer added a sheet to the chopping end of the machine for delivery of chopped forage directly to the feeding trough (Photo 4.7a).

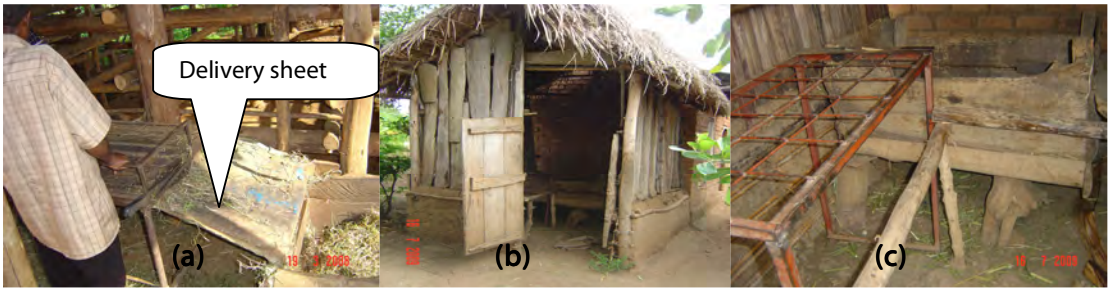


Photo 4.7: Farmers' adjustments

To minimize the work of collecting chopped forage, this farmer positioned the machine within the cattle shed area, attached a metal sheet inclined to the feeding trough to provide a slope for chopped forage to fall directly into the trough. In another-male headed household, the farmer constructed a lockable wooden unit for storage of the machine (Photo 4.7b). He then added a box at the front of the machine, slightly raised from the

ground, for collecting chopped forage (Photo 4.7c). Like the NARO model users, all these farmers detached the pangas from the machine for similar reasons. Even with the storage provision, the farmer always removed the panga as one of them explained:

> *It is not safe to leave a panga outside because it poses potential danger to us since outsiders can use it for the wrong purpose. Anyone can easily break into this house* (referring to the lockable unit). *Sometimes we even need the panga for other activities because it is the only sharp panga we have.* (farmer interview, 2008)

Characteristic of all households where these machines were found was either their association with a welder or the proximity to trading centres where welding was possible. As with the NARO reproduced model, welders played a critical role in the making process. Fabricating agricultural tools was not their main line of work; they mainly made frames for windows and doors, metal gates, metal windows and metal doors. Although the quality of some of the machines was not comparable to that of the NARO device, welders were an important source for the machine for some farmers. Unfortunately, as earlier discussed in Chapter 3, NARO did not have any formal working relationship with community welders. NARO's trainings largely focused on local artisan or workshop technicians formally engaged in the development of agricultural tools and implements. Given the information from this thesis on the welders' role in the making of forage choppers, it is evident that any welder can handle fabrication of the machine. It then becomes important for technology developers to think about incorporating this element in the existing community-based socio-technical system.

Also evident from these observations is the farmers' ability to mobilize community resources to address their constraints. The high cost of the NARO model forced farmers to find alternative sources for the forage chopper and even to rework aspects of the machine better to suit their needs. Not only did size reduction lower the cost of the machine, it also made it more portable and child friendly. Quality alone is not enough to justify to farmers the cost of the machine; affordability counts. Over and above the cost, the ease of moving the machine was also important to users. Like the users of the NARO design, safe storage was equally important for these farmers. Also, children formed an important part of the family livestock production labour force and their ability properly to operate the machine was important in many households. In fact, in the one male-headed household where the farmer fabricated the machine, he purposely made a very small model, specifically targeting his children.

The metal/wooden models

Any change in material specification or reduction in the amount of metal used implied a reduction in the cost of the device, and also increased portability. In addition to all-metal models, various models with a metal base but wooden stands were discovered (Photo 4.8). Of the eight households where this model was found, seven were still actively using the machine. Incorporation of wood in the design lowered both cost and weight. Besides lowering the price of the machine, the use of wood meant more farmers could be directly involved in the fabrication process. Irrespective of the household category, the users' role in the technology development process moved from simply paying for a finished product (with scarce cash) to taking part in the fabrication process. This is because all farmers fabricated the stands from home, while also keeping the metal base. With the exception of

one woman in a male-headed household who provided raw materials for the base and only paid for fabrication labour, all other farmers paid for a finished metal base.

Photo 4.8: Incorporation of wood in the design

The version in Photo 4.8c was more popular among farmers, though with varying designs for the wooden base. As observed from the photos, the forage holding tray of this model was tremendously reduced compared to the length of forage. Essentially the device has become a table-top guillotine. Portability of the machine was important in households where farmers could afford indoor storage. In four of seven user households farmers used indoor storage but, in the other three households indoor storage was not possible. Farmers had to find other means of securing the machine. Fixing the stands in the ground as in Photo 4.8b was another way to safe guard the machine from theft, but also of increasing its stability during operation. Farmers used gunny bags or polyethene sheets placed beneath the machine for collecting chopped forage. So it was important for the machine to maintain the same position to avoid spillage to the ground. One farmer explained:

> *Because of the limited space in the house, we had to fix the poles in the ground, least it is stolen. So we only remove the panga after using the machine and leave the rest outside. Another benefit I got out of this is that the machine is more stable now when we are chopping. With this small size, it was difficult to maintain it in one position when chopping. To avoid spillage on the ground you had to keep moving the machine back to where you positioned the gunny bags which was increasing the time we were spending on the forage processing activities.* (farmer interviews, 2008)

Another adjustment encountered with some farmers using this type of model was the construction of either a forage holding rack (Photo 4.8c, behind the machine) or a wooden extension on the stand to hold forage (Photo 4.9a) as a means to compensate for the reduced size. Even so, even with the home made stands, cases arose of users who could not operate the machine properly due to its height. Like in the case of the NARO chopper modified for child operators, the farmer in one male-headed household added a wooden stand (Photo 4.9b) to accommodate the varying heights of users, since a range of different people were involved in the processing activity.

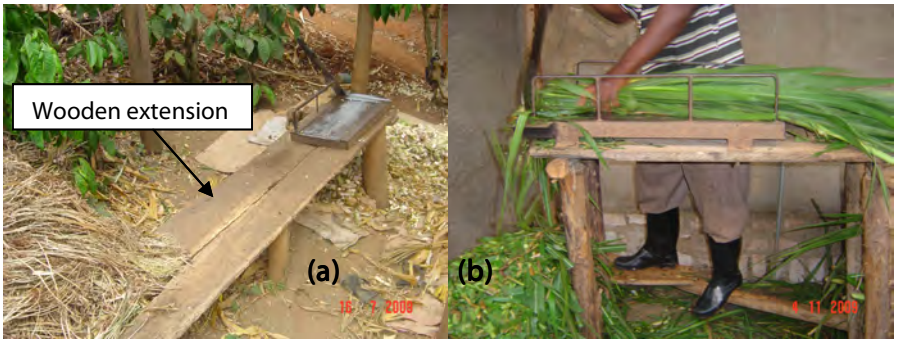


Photo 4.9: Farmers' modifications

Characteristic of all these households was their remote location from welding services and their ease of access to timber. All these farmers either grew eucalyptus or had access to it, which made it easier for them to produce the stands. The metal base was fabricated from materials bought in trading centres and farmers made the wooded stand onto which they mounted the metal part using ordinary nails. This is a further demonstration of the users' ability to mobilize local resource to address their needs. It emphasizes the importance of technology designers being well informed about user contexts, because this context defines what they can or cannot afford.

The wooden model

Technography uncovered more models during the research period as farmers continued to adjust to availability of resources. The range ran from all-metal choppers to a combination of metal and wood and eventually to all-wooden machines (Photo 4.10). Out of five households in which I found this last type of device, four were still actively using the machine. With the wooden model, farmers' involvement in the fabrication of the machine increased to the point where the machine was almost entirely fabricated on-farm. Excepting one female-headed household, where the farmer sourced timber and paid a carpenter to fabricate the machine, the men in the other three male-headed households fabricated their own machines, even though only one was a qualified carpenter. Ready access to wood was common in all these households.

Photo 4.10: Wooden machines

In the female-headed household (Photo 4.10a), the farmer acquired eucalyptus poles and engaged a carpenter to make the machine, at a cost of 15,000/=, using ideas and knowledge the farmer had acquired from fellow farmers. The only metal part on the machine was the panga slot, fitted to the frame using nails. In one of the three male-headed households (Photo 4.10b), the farmer decided to put his carpentry skills to use and

fabricated his own wooden machine. Similar to the first one described, the only metal part was the panga slot. Although in the other male-headed households none of the men had formal carpentry skills, they all managed to turn out functional machines. Adjustments were also observed with wooden machines targeted on increased efficiency. The farmer in Photo 4.10b eventually added a wooden block at the chopping end of the machine to minimize spillage of chopped forage (Photo 4.11a), especially during the dry season when relatively dry feed material was chopped.

Photo 4.11: Farmers' modifications

With variations in the type of wood used, one farmer was presented with difficulty in moving forage towards the chopping panga due to the rough surface of the forage holding base. To overcome this, the farmer cut a plastic piece and placed it on top of the wooden tray nearest the panga slot. This provided a smooth surface for moving forage towards the panga (Photo 4.11b). He further made provision to ensure that chopped forage landed in the collection bin placed in front of the machine. With a banana fiber rope tied across the front legs, he hung a gunny bag to act as a delivery chute to the collecting trough of chopped forage. This minimized the time spent collecting chopped forage.

Evident from the observations of all users, the processes of making and remaking of the forage chopper were independent of the household categories identified in chapter 2. Indeed the household categories provided useful information on the incentives both men and women had for investing in the forage chopper. The women in the female- headed and female-managed households were more willing to invest money in the machine than the women in the male-headed households because their saved labour contributed to raising incomes they directly controlled. Men's incentive to invest in the machine also lay in the ability to redirect saved labour/time to raising incomes they directly controlled. However, even though the different household categories influenced willingness to invest in labour saving technologies, they had little influence on how different farmers (re)configured the forage chopper. Rather, the processes of making and remaking were dependent on farmers' access or proximity to welding and/or carpentry services as well as access to materials (metal, wood or both).

Similarly, the different farmers' technology development roles were more influenced by the type or model of machine they used than the household category to which they belonged. The type of fabrication material largely framed these different roles. The all metal design machines were either paid for or received as an incentive. The metal/wooden machines were either paid for or involved a combination of a welder & farmer working together (welders made the metal part, and farmers the fabricated stands). The wooden

machines largely involved farmers fabricating the machine themselves, with one exception where the materials were provided to a carpenter. The implication of these observations for technology developers is that usage of a machine is a reflection more of access to materials and ability to mobilize community resources and services than a reflection of household category. Irrespective of household type, users will engage in similar activities to make the machine work for them. This then calls for in-depth exploration of what local resources are available to users and how these can be mobilized to increase farmers' access to the machine.

4.3 The former users

The result of a failed remaking process was the emergence of former users. As earlier shown in Table 4.1, of the 35 households initially having the forage chopper, 11 households had abandoned its use. Abandonment of the NARO model (five out of eight households) was highest, followed by the various all-metal models (three out of 12 households). There was then one former user of each of the other three machine types. Two categories of former users were encountered: those who stopped using the technology involuntarily (the expelled (Wyatt 2003; Wyatt, Thomas et al. 2003)) and those who discontinued use voluntarily (rejecters (Wyatt 2003; Wyatt, Thomas et al. 2003)), distributed across the various models for varying reasons of discontinued use as shown in Table 4.3.

Table 4.3: Distribution of former users

Model	Expelled			Rejecters		Total
	Spares	Dead animal	Changed enterprise	Inefficient	Inappropriate	
NARO model	3	1	1			**5**
NARO reproduced				1		**1**
All-metal models	1		1		1	**3**
Metal and wood		1				**1**
Wooden models				1		**1**
Total	**4**	**2**	**2**	**2**	**1**	**11**

Source: Research data, 2008 from 11 households

The Expelled

The expelled had stopped using the technology involuntarily, because of cost or lack of spares, death of the animal, or changed enterprise. Lack of spare parts accounted for the largest number of expulsions, but was confined to households that had acquired the metal model. Repairs requiring technical assistance presented a big challenge to farmers due to their remoteness from trading centres with workshop services. Although no occurrences of damaged machines were encountered among these former users, there was discontinued use due to loss of panga bolts and damaged pangas (Photo 4.12). With continued use of the machine, the hole drilled through the panga enlarged, and eventually one side gave way, rendering the panga unusable.

Photo 4.12: Damaged pangas

Punching this hole required access to a workshop with drilling services as well as machining services to round off the pointed tip. In the two male-headed households where this problem was encountered, farmers made no attempt to replace the panga. Seemingly the farmers could afford the cost of the panga, but one of them claimed:

> *... I didn't know where I could take the panga to make that hole. Even the end was too pointed, unlike the damaged panga and I had no idea of where to get one with a flat end.* (farmer interview, 2008)

In the other two households (one male-headed and another female-headed), it was the loss of panga bolts that made the farmers abandon the chopper. Although these were parts NARO designers had hoped could easily be sourced from local hardware shops, farmers made no attempt to find bolts. In all these households the machines were abandoned outside and farmers reverted to the traditional hand chopping method. This suggests an information gap between technology developers and users. The situation was worsened by NARO's lack of after sale services and technical assistance to users. Over and above this though, there seemed to be a reluctance on the side of farmers to make efforts to fix the machine, perhaps because it had no obvious monetary value. All these farmers had received the machines as part of a project: three of them were on the NARO project and the other one was given the machine due to his outstanding performance on the MADDO project.

In two male-headed households where women controlled the livestock production enterprise, discontinued use arose from the death of the farmers' animal. Both these farmers were members of SACU farmer groups and the selection criteria did not permit them to qualify for another animal right away. One of them explained:

> *My animal died before delivering a replacement. I had not yet even made a pass-on. According to the group regulations, I had to join the queue again and wait for a pass-on because I cannot qualify for another original.* (farmer interview, 2008)

I also encountered two male-headed households where discontinued use arose from a change of enterprise. One sold off the animal and took off-farm employment, while the second one changed from zero grazing of exotic animals to free range grazing of local animals, due to the unsustainably high labour demands of the first of these livestock production system. As he explained:

My family labour force is quite limited with most of the children in boarding schools. Hired labour was scarce and unreliable most of the time. So I decided to sell off the exotic animals because I was finding it difficult to cope with the labour demands. However, I still wanted some animals, so I opted for the local ones because they were less demanding. (farmer interview, 2008)

This farmer eventually abandoned the machine outside in a very sorry state. Irrespective of household category, farmers do not need the chopper if they fail to sustain the zero-grazing livestock enterprise. This is a reminder that different elements of a technological system combine to facilitate use in an integrated manner.

The Rejecters

The rejecters of the forage chopper were users who had discontinued voluntarily, either due to poorly designed (inefficient) machines or wrongly selected (inappropriate) technology. In the female-headed household where the NARO model was reproduced, discontinued use arose from poor copying of the design, that made its use quite strenuous, forcing the farmer to settle for other alternatives. To this farmer, it was a matter of poor selection of material combined with poor workmanship:

The artisan used very poor quality materials [so that] in the first place that some parts wore out very fast. The first feeding tray he made was a little short and I made him put an extension, which gave the machine a poor finish. Then the slot he made for the panga was misaligned on the left hand side so that the panga could not easily be lowered. The children tried to use it, but the legs were a bit wobbly, making the machine very unstable. (farmer interview, 2008)

Although the driving factor behind poor selection of fabricating material was a desire to keep down costs poor fabricating skills further aggravated the problem. Many fabricators relied on photographs or sketches farmers made of the different machines they had come across, without necessarily seeing the machine physically. Besides, fabricating agricultural tools was not their mainstream work. For someone producing the machine for the first time, the challenge to come up with a correctly dimensioned machine was obviously too much. One fabricator confessed:

I specialize in making window and door frames and the materials we use the most for this kind of work are angle lines and solid square or twisted bars. I only made the forage chopper on request by my neighbour and I could not incur the cost of other materials that were used for the machine we were copying from for a once-off order. (interview with a welder in Nyendo, 2008)

Eventually it emerged that poorly reproduced designs were hard to operate. Sometimes farmers ended up using more time with the machine than they did in traditional hand-chopping. In one female-headed household a poorly produced home-fabricated stand rendered the machine unusable. In addition to poorly reproduced designs, there was a male-headed household where the forage chopper was rejected on the basis of its low output for the number of animals he had. He had resorted to a semi-zero grazing system, sometimes chopping forage for the animals for late evening or night feeding of calves. This farmer claimed:

The technology was good but only ideal for farmers with few animals. With the increasing number of animals, it becomes a little inconveniencing using the manual forage chopper. The chopper cuts small sized bits which requires a lot of time to chop enough quantities for each animal. (farmer interview, 2008)

Indeed, the manual forage chopper was designed for farmers with not more than five animals, three being the ideal. However, there were cases of farmers with more than five animals who had acquired the machines without this kind of information, only to realize that using the machine did not save them any time. Whereas some then opted for the semi-zero grazing system to cope with the forage demands, others reverted to the traditional hand chopping method. This is another situation where using the forage chopper makes no sense. Failure to sustain use was less dependent on household category, however. Former usage was largely framed by access to information regarding relevance of the machine and technical after sale services, availability of spares and sustainability of the zero grazing animals enterprise. Studying former usage reveals the constraints in user-producer interaction, highlighting poor technology information flow and the weak link of community based repair and local manufacturing services. This is another example that points to a need clearly to understand how different elements of the same technological system combine or influence each other and how farmers mobilize them to provide solutions.

4.4 The non-users

In spite of the encountered usage, there were farmers who did not take up the forage chopper. Of 30 households sampled without the forage chopper, there were farmers who had never used the forage chopper because they never wanted to (resisters (Wyatt 2003; Wyatt, Thomas et al. 2003)) as well as those who had never used the forage chopper because they could not get access to the technology (excluded (Wyatt 2003; Wyatt, Thomas et al. 2003)). Of these 30 households, six had resisted use of the forage chopper, whereas 24 households felt excluded from the use of the machine (Table 4.4).

Table 4.4: Distribution of non-users

Household type	Resisters		Excluded			Total
	Inefficient	Alternative	High cost	Limited info	Scarcity	
Male headed	1	4	13	4	1	**23**
Female headed			5	1		**6**
Female managed		1				**1**
Total	**1**	**5**	**18**	**5**	**1**	**30**

Source: Research data, 2008

The Resisters

The use of the forage chopper was resisted for two reasons: cheaper alternatives and ineffective technology. Five out of six resisters had the cheaper alternative of a readily available production labour force, low cost of hired labour compared to the investment in the machine or ability to combine zero grazing with free range grazing (use of the semi-zero grazing system). One farmer confessed that:

> *There is no doubt the forage chopper simplifies the task a great deal….* (farmer interview, 2008)

But further argued that:

> *… with my readily available hired labour for the livestock production activities, investing in a machine has never been a priority.* (farmer interview, 2008)

Another stated that:

> *… when the children were still around, there was readily available hand labour that it never ever occurred to me to find an alternative. Even when they left, I found it [more] convenient to enrol hired labour for forage chopping than investing in the forage chopper.* (farmer interview, 2008)

This clearly indicates that ability to mobilize community services cuts both ways. It assisted some to obtain the forage chopper. But in other cases (of non-use) the reason lay in the ability of farmers to mobilize community resources, such as hired labour and grazing land, as an alternative. This capacity, however, was observed mainly in the male-headed households, and is related to the dominance of men over household decisions, as described in Chapter 2. Leaving aside cheaper alternatives, one farmer argued that the forage chopper was ineffective and did not seem to save users time, as was previously anticipated:

> *I have seen people operating the forage choppers but the output of these machines is still very low and requires one to have ample time to raise the amount of forage required for the day's consumption. When I compare the time required for the chopping activity when using the forage chopper against the time I have for all the production activities, using the forage chopper is not appealing to me at all. I just do not have the time to waste on the details of forage chopping using the machine.* (farmer interview, 2008)

The issue of the forage chopper not saving sufficient time was indeed raised by users in section 4.2. This is an indication of varying user assessments of the machine and developers, and raises a question about the specification of the exact context in which a technology indeed saves labour. In fact several of the user adjustments, such as removing the plate, adding forage delivery units, constructing forage holding racks and fixing machines in the ground, were efforts to reduce on forage processing operation time as a whole. There seems as yet no settled agreement on the efficacy of the machine, suggesting the work of designers is not yet over.

The Excluded

The second category of non-users were the excluded farmers, who had never used the forage chopper because they could not get access. This was mainly for three reasons: prohibitive cost, limited information reaching farmers regarding the machine (especially its source), and lack of readily available machines in some farmers' localities. In 18 of the 24 excluded households farmers found it difficult to raise money to purchase the machine. Some confessed:

> *We are still doing very badly in the livestock sector yet we still strive to see that we engage in better/improved practices. The labour saving technologies indeed make a difference but our income is still very poor and as such we cannot afford some of these technologies.* (farmer interview, 2008)

To many it was the case that:

> *The forage choppers are expensive and we simply cannot afford one.* (farmer interview, 2008)

The high numbers of non-users citing high cost in male-headed households has two implications. Either where men controlled income allocation, labour saving technologies were not a priority when allocating household resources, or where the women controlled livestock generated income, it was too low to cover all livestock generated expenses. In light of limited resource to allocate, farmers are bound to be more discriminating in what technology they invest in and will endeavour to adjust to need, but within the constraints of available resources. The cheaper alternative of readily available family labour was an option men could utilize more than women, since the men largely controlled household allocation of labour, as revealed in chapter 2. This points to the issues raised in chapter 2, that in targeting technology it is important to explore how households function.

On the other hand, five households were excluded due to lack of awareness on use or source of forage choppers. It was observed that farmers who were not beneficiaries of donor projects were persistently left out of livestock development related trainings. One of the four excluded farmers claimed:

> *We have not been well exposed to those farmers utilizing the technology for us to appreciate the benefits of such machines. We have heard about it on some radio programmes but since we have not had a chance to see it, we have never given it much thought.* (farmer interview, 2008)

Another stated:

> *I have never seen or even heard about the forage chopper. I am just learning from you today that such a machine exists. Even in the group farmer-to-farmer study tours, I have never come across it. But even when the machines become readily available, my financial situation cannot permit me to acquire one.* (farmer interview, 2008)

Exclusion was further aggravated by the uncoordinated efforts of different actors to address smallholder dairy farmer constraints, coupled with limited focus on agricultural engineering technologies by most intervention agencies. In one household the farmer was aware of the forage chopper's existence but did not know where to source it locally. Except for the wooden model, the other models required farmers to travel to Masaka town to order for one, something they considered tiresome, given that ready-to-buy forage choppers are not on the market. Household category had an effect on non-use of the

machine. Household resource allocation (both income and labour) patterns as observed in chapter 2 influenced non-use.

4.5 Conclusions

This chapter has described what happens when a labour saving technology hits the ground, examining what happened when different people started to use the forage chopper, a process (of usage) that involved making and remaking of the machine. It showed how farmers mobilized community resources to facilitate the process of (re)making, and why in some situations farmers opted not to engage with the technology. It has been argued that when a new machine suggests a new way of performing a known task, it is important to study how people actually use the introduced machine. This is because there is always great scope for interpreting and integrating the machine in everyday life. This study has shown that social practices of use of a machine cannot be fully anticipated in the design process; they only emerge during domestication, i.e. a process dominated by interpretation and integration activity. Effects never arise from the machine itself but from the interplay between the machine and the complicated social, cultural and economic patterns that form its context of use.

All the various adjustments and modifications that took place when the forage chopper was introduced also point to the fact that there is no "ready to use" machine. Users deal with introduced machines differently. In other words, not only is the machine shaped at the point of design; it is shaped also at the point of use or implementation. This implies that adaptation is a continuous process, making it rather difficult to talk about the consequences of a technology that arise after it is implemented. Users engaging with the forage chopper (re)configured it in different ways to make it work for them. The analysis revealed that the processes of making and remaking were less dependent on household type than access to materials and users' ability to mobilize community resources and services. In fact users' constrained ability to adequately mobilize community resources to their own advantage led to discontinuation (former use) and rejection (non-use) of the chopper.

This study therefore suggests that a clear understanding of what services and community resources are available, and how they are being organized in arriving at solutions, is important for sustainable use of technology. Use, forms of non-use, and resistance to use, constitute a spectrum of relationships with technology relevant for its further development. Welders formed an important part of the (re)making process, thus pointing to the need to get fabricators into the design and release process early enough to help with the emergence of more useable and cost-effective machines. However, as shown in chapter 2, there are no formal arrangement between NARO engineers and local welders that could effectively utilize this potential. The low quality of the prototypes produced by local welders calls for specific strategies to improve the potential contribution of local fabricators in the prototyping process.

Chapter 5 Making technology conducive to empowerment

5.1. Introduction

Mechanizing agriculture to reduce labour time – through use of labour saving tools – is one of Ugandan government's strategies for the empowerment of women. This thesis accepts that reduction in women's drudgery in agriculture could be one step towards empowerment but argues that this mechanization policy requires that other factors be addressed for empowerment effects to be realized. Policies are statements of intent to guide or direct actual developments. Whether or not these intents will be realized depends on the context and dynamics of implementation. This chapter argues that a new technology has to be carefully embedded within existing production strategies and that good coordination among the different actors involved is needed for the intended saving of women's labour time to happen.

Understanding the processes of technology uptake and use requires us to move beyond the design process of the machine and pay attention to the wider material and institutional environment in which it operates to improve utilization. So, beyond good policy intentions we need to address how materiality and the institutional environment are organized and interrelate with technology users to be conducive to the broader goals of empowerment. Policy ambitions therefore need to be checked against their implementation to reveal the extent to which (in this particular case) labour saving tools increase efficiency of use of women's labour time in agriculture, and the coordination of partners and stakeholders in the socio-technical system.

To see what is still missing to make the chopper work for women, it is worthwhile to take stock of chapters 2-4. Chapter 2 argued that organizing effective feedback in the design process would allow designers understand how users interact with a device to generate practical usefulness, an aspect that can then be fed into the iterative design process. A second strategy to adapt technical devices to user contexts, was discussed in chapter 3: reconfiguring the user was shown to be critical in placing devices in wider user social structures to ensure effectiveness. Chapter 4 revealed (through technography and analysis) the social practices of use of a machine through which a device becomes integrated within everyday life in a farming community. Chapters 2-4, in other words illustrated that technology is not fixed. The out-of-the-box character of modern computers, for example, are desirable features only in so far as they empower users to become networked in an electronic society. This means that being ready to use is not an end in itself; processes of making and re-making are important to ensure fitness to purpose. A source of complexity, in this regard, is that the underlying social norms of users may not change at the same pace as policy and institutional frameworks, which is why it becomes important to place technology use in the wider social context, and to develop additional and complementary strategies to attain gender empowerment policy objectives in specific social settings.

Lifting the gaze to these wider issues causes us to ask (in the Ugandan case) how government defines gender equality and empowerment. What approach is in place to achieve this aim? What implementation strategies have been used? More specifically, what implementation strategies can be used for the mechanization strategy described above if

it is to carry specific meaning for rural women? What are the institutional transformations required for this, and how do technology developers need to change? These are the questions to be addressed in this chapter to arrive at a better understanding of what is needed to make the use of labour saving technologies successful and conducive to the broader goals of women's empowerment. The remainder of the chapter focuses on how the Government of Uganda has handled gender equality and empowerment issues. The chapter then uses the results of the forage chopper development study to suggest ways in which current implementation strategies can be improved. In particular, it is asked what needs to change from the technology developers' side to rationalize the design process.

5.2. Policy commitment: gender and agricultural development

The important role of women in agriculture in many parts of the world has called for attention to gender-specific constraints in agricultural production. Gender equality has become a core development issue (World Bank 2001), because of the realization that the gender balance of power affects, and in turn can be affected by, the forces of development and technological change (Earth 2003). Gender and development efforts, especially in the developing countries, have therefore focused on addressing gender disparities existing between men and women (Ahikire 1998), which tend to disadvantage the female gender and limit its capacity to participate and benefit from development (Phalane 2005).

In Uganda, gender and agricultural development strategies have been derived from the Poverty Eradication Action Plan (PEAP), which has been Uganda's national development planning framework and overarching plan for poverty eradication, aimed at transforming the nation into a middle-income country (MFPED 2004). The PEAP consisted of a decentralized, sector-wide strategy which provided a framework within which sectors (like health, education, water and agriculture) developed detailed policies and plans in order to operationalize actions to achieve the objective of PEAP (Muhakanizi 2000; UNCT-Uganda 2003; MFPED 2004). In April 2010 the PEAP was replaced by the National Development Plan (NDP) whose development approach intertwines economic growth and poverty eradication. In other words, while PEAP emphasized poverty eradication and prioritized social services, the NDP adds an emphasis on economic transformation and wealth creation to the vision of poverty eradication.

The 2004 revised PEAP was framed around five pillars: economic management; production, competitiveness and incomes; security, conflict resolution and disaster management; good governance; and human development. Although each Government sector is grouped as much as possible under one of the five pillars, many sectors contributed to the objectives of other pillars as well. The agriculture policy strategies respond to the second pillar of the PEAP. The PEAP strategy for poverty eradication has focused on modernization and employment, emphasizing the modernization of agriculture in particular, through the promotion of modern production techniques for smallholder agriculture (MFPED 2004). The focus on agriculture was because it employs the largest number of Ugandans in rural areas as compared to other economic sectors and because agriculture is particularly dependent on public goods, including research, extension and marketing support (MFPED 2004; Potts and Nagujja 2007). The Plan for the Modernization of Agriculture (PMA) was therefore developed as part of the sector-wide policies for the agriculture ministry to respond to the objectives of PEAP by increasing the productivity of the factors of production in agriculture (Bahiigwa, Rigby et al. 2005; GoU 2005).

The main objectives of the PMA are to increase incomes and improve the quality of life of poor subsistence farmers; improve household food security; provide gainful employment; and promote sustainable use and management of natural resources (Bahiigwa, Rigby et al. 2005; GoU 2005). Seven intervention areas were identified to achieve the PMA objectives: Research and Technology Development; National Agricultural Advisory Services; Agricultural Education; Improving Access to Rural Finance; Agro-processing and Marketing; Sustainable Natural Resource Utilization and Management; and Physical Infrastructure. Agricultural technology development and dissemination, which is the focus of this study, directly falls under the first and second pillars of the PMA. The research and technology development component of the PMA aims at creating "a farmer responsive research system that generates and disseminates problem-solving, profitable and environmentally sound technologies on a sustainable basis" (GoU 2005). The National Agricultural Advisory Services aim at providing extension services that are decentralized, farmer owned and private sector serviced (MAAIF 2000).

Within the framework of the PMA other policies have been developed for adequate implementation of its pillars. Among the approved sectorial policies is the agricultural research policy. The National Agricultural Research Policy (NARP) was formulated to adequately coordinate research in both public and private sector institutions, guiding generation and dissemination of improved technologies and defining horizontal linkages of national and local research bodies with other stakeholders (MAAIF 2003). The policy was derived from, and based upon, the basic principles of PMA aimed at poverty eradication by mainly targeting subsistence farmers and also by creating an enabling environment for commercial producers. The key principles of the policy include: responding to market opportunities; empowerment of the stakeholders; scientific integrity and professional excellence; decentralization of research services; promoting participation of private sector, civil society and farmers; the separation of public funding from the delivery of research services; mainstreaming gender issues and concerns; mainstreaming social, human and environmental concerns and quality assurance of agricultural services (MAAIF 2003). For the implementation of the NARP, the National Agricultural Research Act (2005) provided for the establishment of NARO as the apex body for guidance and coordination of all agricultural research activities in the NARS in Uganda.

As the apex body overseeing the implementation of the NARP, NARO formulates strategic plans for agricultural research to ensure that research responds to the needs of farmers and generates problem-solving, profitable, gender sensitive, and environmentally sound technologies. The key PMA strategies in agricultural research and technology development include decentralized research, pluralistic research, and greater farmer and private sector participation in planning, implementation and funding of research. The decentralization of research and technology development and dissemination to agro-ecological zones is in line with the Government's policy of devolution of powers and responsibilities to local authorities, a major feature of both PEAP and PMA. In this regard, NARO services are decentralized to 19 public agricultural research institutes: 6 National Agricultural Research Institutes (NARIs) for strategic and national level research and 13 Zonal Agricultural Research & Development Institutes (ZARDIs) for applied or adaptive research in specific agro-ecological zones (NARO 2007). The National Agricultural Research Laboratories (NARL) is one of the 6 NARIs and as pointed out in Chapter 2, under NARL,

AEATREC is mandated to carry out applied and adaptive research, dissemination as well as training in agricultural engineering technologies (AEATRI 1995).

Whereas a National Agricultural Research Policy exists to drive the research and technology development component of the PMA, currently there is no comprehensive and coherent National Agricultural Advisory Policy. The National Agricultural Advisory Services (NAADS), a key component of the PMA – Pillar 2, was created by an Act of Parliament through the NAADS Act in 2005 to replace the Government agricultural extension services which collapsed during the political turmoil in the 1970s and early 1980s (MAAIF 2000; GoU 2005; NAADS 2005; Potts and Nagujja 2007). NAADS advocates for an agricultural advisory service that is: owned by stakeholders; effective; sustainable to deliver and market targeted; and that contributes to the realization of agricultural sector development programs. The creation of NAADS also emanated from the policy of devolution of powers to take extension services closer to the people (GoU 2005). The operationalization of the PMA spells out four areas of NAADS/NARO linkages: in the service delivery through service providers, NAADS is supposed to act as a direct pathway for NARO technologies; NAADS is supposed to participate in NARO's technology development at farmer group level; NAADS is supposed to provide a feedback mechanism on NARO's technologies; and adaptive research costs at the zonal centers are supposed to be shared between NAADS and NARO (GoU 2005). Part of NAADS intentions is to build the capacity of farmers to enable them to drive the process of technology generation and development based on their expressed needs (MAAIF 2000; Bukenya 2010).

Of specific concern to this research is the PEAP's views on the empowerment of women. Addressing gender inequalities is highlighted as key to achieving the country's poverty eradication goal of PEAP. As such, gender was one of the issues that received special attention in the revised PEAP, with emphasis being placed on addressing intra-household relations for agricultural productivity. Consequently, the 2004 revised PEAP provided a strategic entry point for ensuring that gender inequalities were addressed in sectoral policies and practices. The PMA's strategies of achieving gender equality can be traced in the implementation efforts of its different pillars. In the agricultural research policy, mainstreaming gender issues and concerns is one of the key priority areas (MAAIF 2003). Through this priority area, the NARP ensures that research priorities and programmes pay special attention to the rights and responsibilities of women.

NARO's efforts of seeking ways in which gender concerns can become integral components in development and transfer of technology can be traced back to the NARO Strategy 2000 – 2010 (NARO 2000). The main driving force behind NARO's attention to gender is the desire to increase relevance, efficiency and effectiveness in addressing needs and objectives of all stakeholders in a demand-driven research system, which is also in line with the PMA (NARO 2000; Opio 2003). On the extension side, NAADS mission on poverty and gender is to make a significant contribution to creating conditions within which the rural poor, especially women and youth, can address their livelihood needs (MAAIF 2000). Implementation of this strategy is through gender mainstreaming at all levels of operation and in all program activities, avoiding reinforcing existing forms of inequity and focusing on increasing the asset base of the rural poor thereby decreasing their vulnerability and increasing their opportunity for economic growth.

The government further established a gender policy to coordinate gender mainstreaming in all development interventions. The National Gender Policy (NGP) established in 1997 and revised in 2007 is part of Government policy of mainstreaming gender concerns in the national development process. The ultimate objective of this policy is to evolve a society that is both informed and conscious of gender and development issues and concerns. Although sustainable development calls for maximum and equal participation of both men and women in development, the NGP identifies the problems of women in Uganda quite clearly: "Uganda is a patriarchal society where men are the dominant players in decision making, although women shoulder most of the reproductive, productive and community management responsibilities many of which are not remunerated or reflected in national strategies" (GoU 1997).

The NGP objectives are to: reduce gender inequalities for all for improved sustainable livelihoods; increase human rights knowledge and understanding for all; strengthen women's presence and capacities in decision making for meaningful participation; and address gender inequalities and ensure inclusion of gender analysis in macro-economic policy formulation, implementation, monitoring and evaluation. Implementation of the policy is guided by the following principles: gender equality by elimination of gender inequalities and empowerment of women in the development process; addressing gender inequalities across all sectors and levels; affirmative action to bridge gender gaps in the various development areas; addressing household and family relations especially regarding appropriation, ownership and control of livelihood assets; and promotion of GAD and WID approaches. Gender mainstreaming is no longer optional but an obligation in Uganda's development efforts. The policy makes gender responsiveness mandatory for development practitioners.

All these are laudable policy intentions by the government to address gender and agricultural development issues. However, policies usually circulate at high speculative levels and do not engage with the lower practical level. To date, the PEAP's participatory approach to empower the poor/vulnerable has not been fully developed (GoU 2009). The combination of constitutional change, economic progress, and shifting political priorities, over time, weakened the political salience of the PEAP, turning it into a mere technical document, developed by the MFPED (GoU 2009). The biggest setback of the PEAP in terms of its capacity to achieve change has been that as a framework rather than a plan, the PEAP had no detailed implementation strategy, and was not costed nor budgeted.

Progress on the implementation of the PMA can be traced through the sectorial policies and strategies that have been formed in line with the seven pillars. One joint review of the PMA indicated that the PMA is not intended for the agricultural sector as a whole, but an operational framework for eradicating poverty through multi-sectorial interventions . Although the PMA's multi-sectorial nature gave it the breadth that agriculture needs to move forward, its spread across 13 ministries and agencies has affected its implementation (GoU 2005). As such, in regard to meeting its objectives, the PMA has not properly exploited the potential synergies from the different pillars. While progress has been made in the implementation of some pillars, others are yet to make a mark (GoU 2005). In regard to technology development, the PMA advocates for research to put emphasis on farm power and tillage, post-harvest handling and agro-processing technologies to reduce

drudgery particularly of women, increase productivity, reduce losses, add value and improve quality (MAAIF 2005).

One policy that the government formulated to allow citizens to take charge of the development agenda is the decentralization policy (Bitarabeho 2008), directly linked to the good governance pillar of the PEAP. The decentralization policy provides the institutional framework for the implementation of all poverty reduction policies by devolution of power to district and sub-county local governments, and decentralization of power and resources directly to farmer groups (Kisembo 2006). The objective of most of government's programs is to empower local communities and community based organizations to make more effective demands on public and private service providers and to participate in creation and direction of such services. However, policy formulation documents only spell out governments intentions for development but, fall short of such implementation strategies. The implementation of the decentralization policy has given rise to other needs and new challenges. With the central government setting national priorities and determining sectoral guidelines (which have to be adhered to by local government), coupled with the maintained influence by line ministries on the district local governments as implementers rather than facilitators, competition for power and resources emerges which compromises development efforts (Kasumba and Land 2003; Okidi and Guloba 2006; Steiner 2006; Steiner 2007).

Furthermore, the empowerment of citizens envisaged through popular participation is limited due to the restricted level of human and financial resources in most districts (Okidi and Guloba 2006). Okidi et al further argue that whereas giving fiscal autonomy to local authorities was a step in the right direction, the major setback has been the limited potential to generate revenue. District resources come from locally generated revenues and central funding but, the local revenue base in most districts is weak and central transfers usually come with a string of conditions that tend to undermine genuine local decision making. This also explains why increasing participation of women has been confined to a few women (Muhumuza 2008).

Women's participation and benefit from labour saving tools has encountered similar constraints. The development of labour saving tools is emphasized in the technology development aspects of the PMA, with a strong focus on reducing the disproportionate workload of women. Although this has indeed promoted the development of labour saving tools, this has not been enough in itself to guarantee that women benefit. Furthermore, a number of these technologies remain on the "shelf" (MAAIF 2005), because some have not been commercially developed, packaged and marketed for the benefit of the majority of subsistence farmers (largely women). Inadequate multiplication of the technologies has also affected their dissemination. These shortfalls point to two aspects of the implementation strategies: the policy's focus on gender gets translated to a simple label of "women"; and what technology is, is not well understood in the implementation processes.

As for the first, simply putting emphasis on individuals and promoting the development of labour saving tools without understanding how the sociotechnical system is organized is not enough to achieve the policy objectives of women's empowerment with labour saving tools. As shown in Chapter 3, implementation of the policy objective of empowering

women has frequently been done by isolating them from their environment, resulting in policy implementation that does little to alter the structures that subordinate women. A further review of research contribution to the poverty eradication objective revealed that in spite of the enabling legal framework (the NARS Act (2005)) and NARO's comparative advantages (a good reputation in producing quality outputs, highly qualified human resources and existing infrastructure and strategic partnership and collaborative linkages), agricultural research has not yet fully contributed to more growth and poverty alleviation because research – extension – market linkages remain weak. As discussed in chapter 2, although NARO has had substantial achievements in developing technologies, the dissemination process is not working well. Indeed drawing from the professional practice at AEATREC (discussed in Chapter 2) of linking research to practice, the Centre has not actively involved NAADS. AEATREC has directly linked its technologies to the end users, working directly with farmers or the private sector. This further points to the gap between policy principles and practice, revealing difficulties in the implementation of policy. Using the case study of the introduction of the forage chopper among smallholder dairy farmers in Masaka, I reviewed some of the implementation processes in the next section.

5.3 Characterization of dissemination strategies

Women's empowerment strategies reviewed in chapter 1 emphasize increasing women's skills, capacities, rights and opportunities. Strategies undertaken to achieve Uganda's ambitious policy objectives for women's empowerment have included a range of actors: government institutions, NGOs and other development partners, with varying ranges of interventions to fight rural poverty. The introduction of zero grazing livestock technologies discussed in the earlier chapters was in line with the government efforts of women's empowerment and included both NGO and research efforts. There are several factors that influence or improve the rate of use of new technologies. In this section, I critically look at two dissemination strategies (information flow and availability of materiality) after which I examine the structural transformation needed to improve the processes of technology use.

5.3.1 Information flow

Appropriate translation of policy into practice requires information regarding interventions designed to achieve the policy effect. Yet, the NAADS Master document argues that it is difficult to achieve delivery of services for individual farmers, which is why strategies emphasize the importance of creating institutions through which they can act collectively. Direct government efforts to improve information flow between farmers and technology developers has been through the NAADS program that tried to empower farmers through farmers' fora and farmers' groups to demand, pay and control extension services

A similar principal of targeting information to groups of farmers was being promoted under the NAADS program for collective action. Indeed, the fact that women were already organized in social groups made it easier for SACU and MADDO to target their interventions to women. Not only did the groups facilitate the NGO's smooth entry into the community, farmers equally found the groups highly rewarding. Initially, women were organized in informal social support groups, mainly coming together to offer each other financial support to rebuild their homes as well as social support during functions. As the groups got formally organized, the scope of the areas for interaction widened. Interview analysis of the 65 zero grazing farmers in the four sampled dairying sub-counties of

Bukulula, Kkingo, Kabonera and Mukungwe revealed that 61 of these farmers were still actively participating in group activities. An analysis of their collective action showed meetings, training workshops, community support and farmer-to-farmers visits (Fig 5.1) as the four most important collective actions farmers were engaged in.

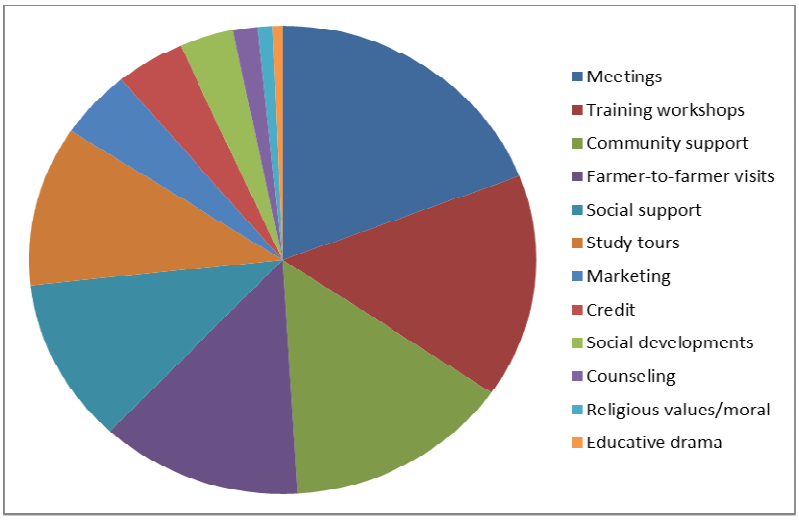


Figure 5.1: Farmers groups collective action
Source: Research Data 2008

Analysis of the benefits derived from the groups (Fig 5.2) revealed that groups were a key means of acquiring and sharing knowledge and skills; socializing in the community and; building attitudes and social values. In the rural setting, social networks are still important for survival, and farmer groups were found to be very important because access to information was largely dependent on membership of groups.

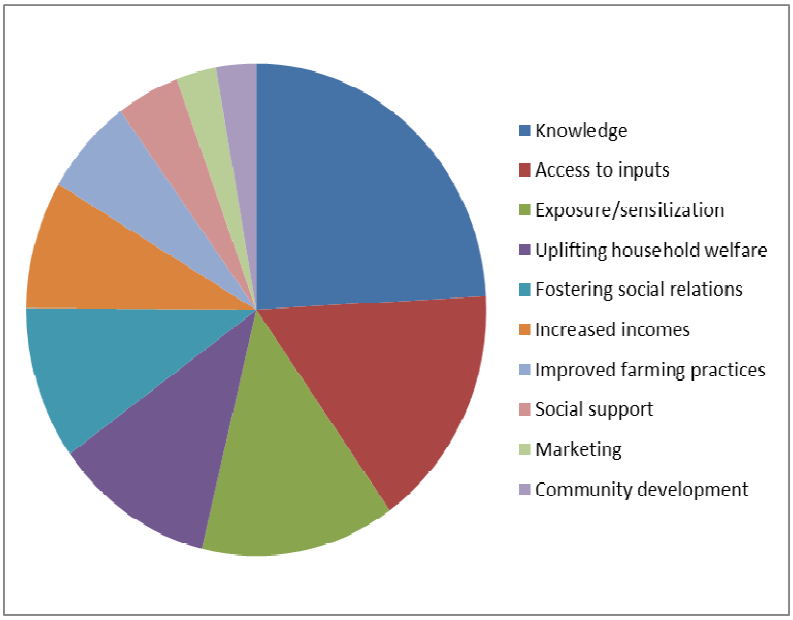


Figure 5.2: Farmers' assessment of farmers groups attributes
Source: Research Data 200

However, as Benin et al (2007) pointed out for the NAADS case, groups only facilitate access of both technical and social information to group members. Non-members are disadvantaged as they cannot easily access information. Furthermore, NAADS has tended to focus upon the economically active poor and it has not improved access to services for poorer farmers or those with limited resources, the majority of whom are women (Benin, Nkonya et al. 2007). Illiteracy has also been a fundamental barrier to participation in knowledge societies.

Although the groups served a purpose, acquiring information alone does not do the job. Information access which was enhanced through sharing knowledge and exposure/sensitization was indeed essential for creating awareness among farmers of the different interventions they could utilize to avert their situation. But, sharing information is not the same as effectively using a new tool or changing work routines and activities at the farm/household level. Understanding the way the different activities or work routines are organized and how they interact with the technology is important for implementing technology interventions. A good flow of information between farmers and technology developers/disseminators therefore, not only benefits farmers but, more importantly benefits technology developers in improving their understanding of how the technology is embedded in existing production strategies.

5.3.2 Materiality

A technographic perspective of promoting technology uptake and use stresses the importance of materiality (raw materials, tools, equipment, machines). Any implementation process therefore needs to pay close attention to these factors. Sustainable uptake and use of technologies is influenced by the distribution patterns and/or means of multiplying the technology built into the development process. As earlier discussed in chapter 3, the introduction of the NARO forage chopper among the smallholder dairy farmers was based on the treatment selection/allocation criteria of the farmers that were involved in forage conservation. Only 8 households selected for the conservation of forage received the forage chopper as an incentive to facilitate the conservation technology. All other farmers on the project and in the area had to find means of acquiring the forage chopper. Since AEATREC has no field distribution outlets, this implied that farmers requiring the AEATREC machine had to source for it from the Centre which entailed incurring transportation costs on top of the machine cost.

In as much as NARO has zonal centers that are used for demonstration of interventions, they are not distribution outlets for engineering technologies. Farmers requiring these technologies have to make arrangement of picking them up themselves from the research centre. Furthermore, AEATREC has no field service centres that farmers can quickly turn to when in need of technical assistance. After sale services are usually provided on a demand basis. This constrains the availability of the machines, consequently affecting their uptake and use. Inadequate multiplication of NARO's technologies as earlier discussed has also impacted on their dissemination. AEATREC had made attempts to link up with the private sector for mass production of stabilized machines but, the operationalization of this never came to bear as discussed in chapter 3. Drawing from the factors that affected the uptake and use of the forage chopper examined in chapter 4, the lack of this after sale services (availing spares and maintenance services) contributed to 43% of the users stopping the

use of the tool, while scarcity of technology (caused by limited distribution outlets and inadequate multiplication of the machine) accounted for 8% of the excluded non-users

The constraints in availability of the machine reveal that technology is not a simple plug-and-play type of gadget but, a process of getting things done effectively. As discussed in earlier chapters, farmers turned to local welders to source for the machine and after sale service in their effort to avert the constrains of technology availability. However, as earlier discussed in chapter 3, NARO had no formal arrangement with these local welders. Farmers' engagement with local welders points to one direction in which NARO can go: the local manufacture of machines which can increase farmers' access. The presence of the local welder in the socio-technical system also requires incorporating them in the design process since they are important both in the development of machines and in the provision of after sale services. This mobilization of local resources is therefore key to improving the uptake and use of labour saving tools. Beyond the dissemination strategies for increasing the uptake and use of the technology, what institutional organizations are needed if farmers are to successfully use the technology? This question is answered in the following section.

5.4 Strategies for successful use of labour saving technologies

Successful use of labour saving tools calls for implementation structures that facilitate coordination among different actors involved in the socio-technical system. It also requires institutional transformations that will allow farmers to make simultaneous decisions to benefit from interrelated technologies. Using the case of the zero grazing livestock technologies, in the next section I present the situation as it exists among the smallholder dairy farmers and how this can be improved.

5.4.1 Coordination among actors

As earlier discussed in chapters 2 and 4, the introduction of zero grazing animals required increasing women's access to other livestock production technologies for them to ably improve their welfare and that of their families. In the introduction of these interrelated technologies, farmers interacted with different actors, facing different demands from different sides. However, in as much as all actors were working within the national objective of fighting rural poverty, there was no coordination among them and the implementations were done independently. SACU focused on the food security aspect, giving out animals for free as one extension person explained:

> *The animal is a gift but the farmers should have constructed the cattle shed before receiving the animals. Since we deal with resource poor farmers, SACU provides some money to operate a revolving fund that farmers can benefit from for the construction of the shed.* (Key informants interview, 2008)

MADDO put emphasis on both food security and income generation, building the farmers' resource base to afford animals as one official explained:

> *Our animals are not for free, farmers are expected to make some counter funding as a means of ensuring their commitment to the project. Since we normally deal with resource poor farmers, we take an integrated approach to build the farmers' resource base, training them in different aspects that can allow them to generate*

an income to be able to cope with the cost of the enterprise. (key informants interview, 2008)

The terms of the two NGOs were such that a farmer could only belong to one of the groups. In fact as it emerged during the farmers' interviews and observations, if one had a cow acquired from other sources, they were required to sell it off before benefiting from the NGO's intervention. On the other hand, NARO's forage chopper was an incentive restricted to a limited number of smallholder dairy farmers as discussed in chapters 3 and 4. Other farmers had to find means of acquiring the forage chopper if they desired a technology change. Three of the eight NARO benefiting farmers had received animals from SACU and the remaining five had incurred the cost of the animals themselves. Beyond the technologies, farmers also interacted with livestock extension persons and veterinary doctors from the district production department, from NGOs and private ones. The quality and quantity of extension services varied across the different extension agents. The poor remuneration and incentives for upcountry government extension staff affected the quality of their services. NGO extension staff were better facilitated and being accountable to the NGOs delivered better services but, farmers had to pay for their services. This limited the service to a few well-off farmers who could afford to pay the service provider.

The NGOs introduced the animals only focusing on the economic empowerment of women without due consideration of the other interrelated technologies that required to increase uptake of the cow. When NARO set in with the forage chopper, emphasis was set on promoting quality feeding without consideration of the other factors (discussed in chapters 2, 3 and 4) that would allow farmers to effectively use the machine. Extension agents too target to solve a given problem without consideration of the other factors facilitating or hindering farmers to access their services. Consequently, faced with different and sometimes incompatible demands for interrelated technologies, involving a number of simultaneous decisions, farmers' uptake and use of the different technologies varied. Any intervention involving different actors, directing their intervention to the same persons always has challenges. This is so because all actors have different programmatic objectives and different ways of measuring objectives and success of interventions. Under this scenario the targeted beneficiaries are likely to end up not effectively benefiting due to a confusion of goals.

This points to the need to have implementation structures for coordinating the actions of different actors, especially for interrelated technologies. Currently, all implementers control their funds, work independently of one another and the farmers hardly have any control over their actions despite the decentralization policy objective that set out to empower citizens to take charge of their own development agenda. The decentralization structures discussed earlier, make the district responsible for overseeing the implementation of policy objectives, with the district production committee being in charge of the agricultural interventions. However, this has remained a paper reality only, and the situation on the ground is different. As one of the district officials explained in a telephone interview:

There are gaps in the structures and we have no control over the different development partners. At the moment there is total confusion between NAADS and the district. NAADS operates at sub-county, controlling activities down there

> *but, the district has no control over NAADS. Other developers also work independent of NAADS. Given our financial constraints, we welcome anyone implementing projects to benefit our farmers.* (key informants interview, 2011)

On the issue of duplicating efforts, given the individual participation, my informant added:

> *We are caught up in a difficult situation, with budget constraints. NAADS offers extensions services and the district also still has extension staff. Since NAADS has the money, they usually take the lead and they have particular interventions they are promoting. Anything outside their priorities, we have to rely on other development partners.* (key informant interview, 2011)

A structure is required that can minimize individual participation of development implementers, minimize bureaucracy and where funds can be put in a common basket by the different funding agents to minimize conflict of interest. Such a structure requires to be independent of the policy makers, development partners and technology developers and linking directly with the targeted beneficiaries. This can minimize the conflicting decisions farmers are faced with due to the different and sometimes incompatible demands from different actors, allowing them to benefit more from the different interventions. However, over and above this, the way the institutional structure is organized for interrelated technologies also deserves attention to understand what can inspire farmers to invest in technologies.

5.4.2 Institutional transformation

Another aspect that the technographic approach stresses is the organization of the different elements of the socio-technical system. Successful use of technology is influenced by how these different elements interact with each other, in particular how and what resources need to be mobilized to use the technology. As earlier discussed, the introduction of the forage chopper was part of the zero grazing livestock package of technologies. Since the demand for agricultural production technologies is derived demand, with their use usually being determined by market opportunities available for farm products, an increase in farm incomes from the livestock enterprise is necessary for farmers to increase the uptake and use of livestock production technologies. The purchase and use of the forage chopper presented a cost which should have been offset either by the income from the sale of milk (ready market and/or high price for their milk) or by profitable alternative use of saved labour for other production activities. If this does not happen, then the cost of production goes up without a change in the net profit hence a dis-incentive for investing in the machine.

Indeed, among the benefits of the forage chopper identified in chapter 3 by the farmers was the forage chopper's contribution to increased milk production with the properly processed forage. However, farmers' benefit from this increase was dependent on the availability of a ready market and a high price for their milk. In an effort to promote livestock production activities in the district, MADDO constructed a dairy processing unit to provide their farmers with a ready market for their milk. SACU's emphasis was on food security and the project had no arrangement to promote income generation for livestock products. However, even with the processing plant arrangement MADDO project still faced some challenges as the coordinator explained:

> *Most of these farmers are still working on individual basis instead of coming together in farmer groups. This has impacted on their marketing power. This is the biggest challenge that we are faced with at the moment and not only for milk marketing but also for the marketing of other agricultural produce. What is happening at the moment with most of these dairy farmers is that they sell their milk locally to the community and they end up getting very little out of their hard work. There are even cases of failed payment for delivered services.* (key informants interview, 2009)

Farmer interviews revealed that the price of milk at home was higher (ranging between 500 – 600 Shs./lt) than MADDO's (ranging between 400 – 500 Shs./lt). The benefit of selling to MADDO was in the form of payment. In as much as home sales offered a higher price per liter, the payments were not consistently made. MADDO on the other hand made monthly lump sum payments that allowed farmers to effectively benefit from sales. However, farmers who could benefit from MADDO's arrangement were either located near one of the collecting points of the project; or organized to collect their milk at one point and then transport it to the plant; or were those who could do it individually. While appreciating the ready market provided by the presence of the processing plant within the district, transporting milk to the plant presented challenges as one farmer explained:

> *Among the benefits we have realized from HPI/MADDO is the construction of a milk processing plant in Nyendo. However, the biggest setback that has limited some of us from benefiting from this arrangement is the long distance we have to commute to and fro. We spend a lot of time on the way which eats into our time for other livestock production activities. Unfortunately, we no longer have hired workers to assist us with some of the production roles. We tried them once but, we were not getting our money's worth. So in an effort to balance between these roles, we settle to sell our milk within the community.* (farmers interview, 2008)

The introduction of the animals also led to the need to address the feeding constraints of these animals which increased the cost of production. The increase in milk production was a good sign, coupled with the construction of the milk processing plant to ensure a ready market for the farmers' milk. However, delivery strategies needed to have been built into this arrangement to ensure quick delivery/collection of milk that would have allowed farmers to increase incomes from milk sales. Unfortunately, farmers were continuously held in a web of un-ending production challenges, solving one problem while creating another which makes it difficult to increase the use of new technologies

Armed with the appropriate implementation strategies and structures to enhance the use of technologies, how then should the technology developers rationalize the design process of labour saving tools to hit women's empowerment strategy? All the implementation strategies and institutional transformations necessary for successful use of labour saving tools have implications on technology developers (or NARO engineers in particular). Earlier sections of this chapter have examined the role of policy makers, along with the policy implementation strategies by the NGOs and technology developers and the impact of these on the uptake and use of technologies. Beyond this, it is also important

to analyze how the engineers need to change to make technology use conducive to broader goals of empowerment, which is the focus of the next section.

5.5 Rationalizing design

Policy implementation requires careful analysis of the target group in its context (women in resource-poor settings in the case of women empowerment policies), it requires incorporation of a proper analysis of the material environment (including use of tools – usually known as technology) and hence a new role for engineers. In actual practice in Uganda, implementation of the women empowerment policy objectives is done by addressing women as individuals, rather than seeing them as social beings. As chapter 3 revealed, isolating the target group from its context risks to target "virtual" users instead of "real" users which results in an ineffective policy implementation. Most implementation strategies discussed above target women who participate in a society (e.g. farmers groups) accessible only for a selected group. Although this can be functional, it relies on an institutional environment in which women are considered to operate relatively independent or have direct access to economic resources and facilities. Analysis of users of the forage chopper however revealed a different context, one in which women are not operating as independently, and where access to economic resources is also limited.

Rationalizing the design process to hit women's empowerment strategy requires a new role for the engineers. The engineer now needs to analyze the users' social context and the material environment. Although the survival of NARO engineers does not necessarily depend on the sales of developed machines, an effective feedback loop in the design and dissemination process can be useful in increasing uptake and use of machines since government holds NARO accountable for the implementation of the research agenda in the fight to reduce rural poverty. Appropriately configured performative mechanisms discussed in chapter 2 are one possible way of organizing effective feedback. Such effective feedback loops in the design process create a process of iteration that can increase the use of technology. Engineering the social will require the reconfiguration of users in the implementation process to ensure that actual users are targeted in the dissemination process of technologies. Engineering the social will also require an understanding of how and what resources technology users mobilize to make technology work for them, an aspect that only emerges from the interactive design process.

5.6 Conclusions

This chapter analysed what is needed to make technology use conducive to broader goals of women's empowerment. The policy environment framing government intent has been examined, and the strategies deployed so far to respond to policy objectives and setbacks encountered in implementation have been noted. The chapter then looked at strategies that might promote successful use of the technologies and how engineers can make this happen. The focus has been mainly on policy formulation and implementation in regard to the case study topic - how to save women from drudgery and to encourage investment of released time into more productive channels. The different analyses showed how the implementation process uncovered a number of difficulties never addressed in policy documents. Policies that give direction are statements of intent, and require others factors to be in place for their effect to take place. Effectively increasing the use of women's labour time in agriculture through the introduction of labour saving tools requires technology to

be embedded within society, and in so doing to trigger virtuous circles of reinforcement in a range of interacting social and technical factors.

Policy commitments have been important in that they encouraged a focus on women that facilitated the development of labour saving technologies. However, there is a danger that when a policy gets translated into practice it tends to seize on what it finds and re-label it in a way as to suggest policy objectives are being met. Using “labels” in this explains the inability of many laudable policy objectives to connect with reality. Consequently, policy tends to circulate at a speculative level "on high" without engaging the practical level. Beyond policy intentions, appropriate implementation strategies are necessary to achieve stated goals. Although information flow is an important aspect of policy implementation, this chapter has shown that acquiring information alone does not do the job. Sharing information is not the same as implementing technology interventions or changing work routines and activities at the farm/household level. Increasing efficiency of use of women’s labour time requires a good understanding of how the activities and work routines are organized and how these will attach themselves (or not) to the new technology. Another crucial aspect of the implementation strategies is materiality. The technographic perspective stresses the importance of materiality. Any implementation process needs to pay attention to factors of materiality because uptake and use of a machine is dependent on the way materialities are organized in the process of making the machine work. Obvious examples of relevant materialities concern labour supply and skill, power or fuel supply, and the quality of basic support for sustainability (such as access to repairers).

Besides policy and implementation strategies, the organization of the institutional environment, both at farmer and actor levels is important to increase the effective use of labour saving technologies. Fairly basically, as this chapter has confirmed, for farmers to effectively increase their use of labour saving technologies, an increase in cost of production needs to be accompanied by an increase in net profit. Some institutional transformations are needed to encourage the better returns necessary to support the cost of labour saving technologies. More efficient transport and communications, cooperative marketing and opening up of new market opportunities for investment of women's labour time reallocated from tedious farm tasks all seem of potential importance. Another critical factor is the degree to which there is coordination among support organizations. This chapter has also shown how farmers are often faced with simultaneous decisions over interrelated technologies. The implementation strategies sometimes pose competing claims on local attention, with the result that farmers face different and at times contradictory conditions. Existing structures are often highly constrained, and development agencies at times place their own programme objectives ahead of farmers’ objectives. So, there is clearly a need for a new implementation structure that will put emphasis on minimizing programme overload on individual participants and cut down on bureaucracy to improve processes of technology uptake and use. In other words, such a coordination structure should minimize conflict of interest and serve as an honest broker, free from political influence.

The conclusion is that making labour saving technology uptake and use conducive to broader goals of empowerment requires engineers to move beyond the technology itself and become “engineers of the social”. This means a new role for technology developers, moving beyond the conventional wisdom in terms of supplying technologies towards a

greater emphasis on "engineering" (or managing) uptake/use based on careful analysis of target group social dynamics and equally careful analysis of the material environment. Understanding users in context allows engineers to know how households are organized in terms of activities and resources and thus opens a window on how new technology might play a transformative role within existing production strategies. Knowing how to mobilize local resources in the making and re-making of technology is important to improve technology uptake and use.

Chapter 6 Conclusions: Can labour saving technologies work for rural women in Uganda?

6.1 Introduction

In an agricultural economy like that of Uganda where women constitute the majority of the production labour force, it is logical to use agricultural interventions as entry points for the empowerment of rural women. Labour-saving technologies have been prioritized in reducing household labour requirements (NARO 2001; MAAIF 2005; Carr and Hartl 2010), especially for the women to help them divert time from farming and domestic activities into more productive income generating activities. The underlying assumption of interventions that seek to increase female access to productive resources and assets is that this will contribute to improving women's autonomy and status within the household (World Bank 2001). Yet whether there is a positive linkage between access to resources (or assets) and women's autonomy depends on the decisions and constraints women face in the household context. Although the policy's emphasis on women has indeed promoted the development of labour saving technologies (MAAIF 2005), this has not necessarily increased the efficiency of use of women's labour time or been enough in itself to guarantee that women benefit. The aim of this thesis was to examine how the design of labour saving technologies can be rationalized to increase chances that these technologies contribute to women's empowerment. The research looked at the design, dissemination, use and impacts of the forage chopper in Uganda.

In Uganda, the emphasis on women in agricultural development interventions aims at promoting women's access to production resources, since they form the largest portion of the agricultural labour force (MFPED 2004). Indeed, mechanization that reduces women's drudgery in agriculture is potentially a step towards their empowerment. However, technology alone is not enough to make empowerment happen. Part of the reason, this thesis argues, is in the notion of technology itself. Technology is often equated with innovation, stylishly designed gadgets based on latest scientific insights. The underlying message, conveyed in popular media as well as in international development policies, is that once technology is adopted, change for the better will follow. As outlined in chapter 1, a more basic understanding of technology, perceived as a process of human-tool interaction, is more appropriate for analytical and design purposes. Thus, to understand and improve the process of technology use, and to increase the chances that it contributes to empowerment, other factors need to be in place or implemented.

Often, empowerment strategies assume that women can and do operate relatively independently from others, or that they have a job or direct access to economic resources and facilities. In other words, the kind of context assumed in women's empowerment policies does not apply to many Ugandan women. Technology development seeks to empower women by reducing their labour time in agricultural production using labour saving technologies and allowing them time to engage in other economic activities (MAAIF 2005). However, to assume this takes place automatically is attaching agency to the tool only, known as technology determinism, and includes women merely as a target group that profits once the tool has created the required change. Nevertheless, the agency of women is as important as the agency of the tools. Therefore, women's role in the technology development process and the way technology embeds with existing

production strategies need to be examined. The thesis has taken this up by looking at how and the extent to which new technologies affect women's lives, lessen or increases their workload, and how women can play a greater role in the development and dissemination of these technologies to increase their use. In short, the way the different elements of the socio-technical system are organized and how they interact with tools and devices determines use and impact.

In this thesis I have shown that it does not make sense to cordon off women as a group and undertake development work with or for them in isolation, because women's activities are integrated in larger systems and processes. My starting point in the thesis was that technology development can benefit from insights from the sociology of technology and science and technology studies, perceiving the process of human-tool interaction as a symmetrical relationship, where the larger context is kept firmly in view, in order better to hit the target of women's empowerment. My question was thus: how then can labour saving technologies really work for rural women in Uganda? I examined four possible approaches for rationalizing the design process: (1) organization of feedback from users; (2) reconfiguring the users; (3) following the domestication process; and (4) enhancing technology use for broader goals of empowerment. In this final chapter, I integrate the findings from Chapters 2, 3, 4 and 5, in which the potential for each of the four approaches has been explored, to answer the overarching question. In the first approach, I examined how feedback is organized in the development of labour saving technologies, focusing on how the designers' training influenced their design behaviour (gaining understanding of users' practices), how their work place framed their participation in the socio-technical system, and how all these combined in the design process.

In the second approach, gender relations and empowerment perspectives were examined to locate the potential of labour saving technologies to empower women. The designers' expectations of how technology will be used, by whom, and in what context, created a "virtual" over in which the influence of other entities in the socio-technical system was minimized. With the sociological approach, I examined how the activities of users were organized, how these then combined with other social entities, and which information flows resulted in concrete input into an interactive design. In the third approach, I examined how the forage chopper was integrated in the daily lives of smallholder dairy farmers by analyzing the different types of use and non-use of the technology. Because technology is about making and remaking, adaptation is a continuous process, and requires the analyst to understand what resources are mobilized to arrive at workable solutions. This was the logic of seeking to follow up on the domestication process of the forage chopper, to explore whether it really did have potential for empowerment of women. In the last approach, I link all the other three themes to the policy perspective. The driving force behind empowering women with labour saving technologies was a policy intention. I examined policy implementation strategies for their potential to bring about real empowerment.

6.2 Change in the technology development process

A design process is a collaborative effort in which many people (engineers, technicians, users) play a role in a range of institutional or social settings. The development of the forage chopper revealed that the interactions between designers and technical networks enabled access to knowledge/ideas and new technologies. This research has shown that

although there was a good representation of the technical people in the development of the forage chopper, user participation was limited to participatory needs assessment and on-farm evaluation of the finished technology (chapter 2). If labour saving technologies are to carry meaning for rural women, the development process for these technologies requires change in two elements: users' capacity to demand has to be built up and the feedback process strengthened.

6.1.2 Building users' capacity to demand

"Empowerment" has been the driving force behind targeting women with labour saving technologies. The core aspect of empowerment is to build individuals' ability to drive their own agenda. If labour saving technologies are to carry meaning for rural women, the development process must build their capacity to make demands on engineers. A starting aspect in building users' capacity to demand lies in the way the designers perceive the actual users of the technologies. The role of users in the technology development process is very much a function of how designers frame the users. In most of the technology development interventions, it has been assumed that women would benefit if they are specifically targeted in the design process. However, as this research has shown, targeting in itself does not necessary increase women's use of technologies. Efforts to target women are very often framed in a way that extracts the women from their work environment, creating wrong ideas about who the actual users are, and resulting in an ineffective policy implementation.

This research has shown that women and their households are not fixed entities in composition and activities, and their interaction with technology is structured by other dynamic social relations. The thesis has further shown that whereas it is important to place emphasis on women individually in technology development to increase their access to technology, a detailed understanding of the social construction of gender within households is also essential. It is important first to understand the context in which women are situated and how gender relations are negotiated and transformed within households. Designers always have expectations of how the technology will be used, by whom and in what context. For the case of the forage chopper, the "virtual" user pictured by designers was the overburdened women with multiple roles. However, as it emerged from the sociological analysis of the users, households were not fixed in terms of composition and activities. The overall gender ideology simply provides a general normative and ideal frame of reference but is not the actual determinant of what men and women actually did. Daily life and its contingencies was the actual driver, implying that designers need to associate with this world of practice before finalizing design choices.

The interactive design process discussed under building feedback is one possible approach to help designers reconfigure their relations with users. Another approach for reconfiguring the designer-user relationship so that it more effectively informs the design process is sociological analysis. The research has shown that sociological analysis helps the analyst understand how users' activities are organized, how these combine with other social tasks and agents, and how new technology can be better embedded within existing production strategies. Using "woman" as a label without understanding first the social construction of gender falls short of revealing how men and women are often assigned certain traits and attributes that may or may not be limiting to their development. Therefore, sociological analysis is a crucial aspect in reconfiguring the designer-user

interface, by drawing attention to context, including how distinct elements within the overall situation faced by women are mobilized for different solutions.

Another aspect of building user capacity to demand lies in giving women an active role in the design process, which is very much a function of building feedback. The emphasis here, though, is in building users' capacity for collective action. The issue here is to understand how users can be mobilized to demand technology developers address their concerns. Presented individually these demands will not make much impact but when women organize in groups, and present a collective response, this can be more powerful. If women are to be organized to demand more from technology developers, part of the women's empowerment process needs to target this process of collective mobilization. This research showed that an aspect that the NGOs took advantage of when introducing technologies was the organization of users in farmer groups. With some external support, these groups can also function as "client groups" helping to commission and evaluate the design process.

6.2.2 Building the feedback process

Although the planning of interventions excluded the users, this research has shown that NARO's involvement of users in the evaluation process yielded suggestions that could be incorporated into an iterative design process (chapter 3). Also, drawing lessons from the domestication process of the forage chopper (chapter 4), it became clear that users were actively re-shaping the technology better to secure its practical usefulness, and this has been offered as clear evidence of their capability to participate in design processes. These findings point to the desirability and feasibility of increasing users' participation in the design process. The role of users in the design process and the dynamic inter-dependence of design and use now needs to receive more attention as a means of developing workable technologies.

In order to achieve this, a possible strategy would be for designers to open up the technology design space, and to create opportunities for users to participate in the design process itself. A lesson of the design of the forage chopper is that the networks of designers did not incorporate other social entities, being based on a distinction between the "protected spaces where technology was made" and the "protected space where technology was used". One immediate improvement would be to increase the time given to users to interact with the technology. But this thesis has shown that time alone is not the only requirement. The way designers organize feedback from the users during the design process also has a great deal of significance for the relevance, efficiency and effectiveness of technology in use.

How best can users' feedback in the design process be organized? If (as shown) users are not merely passive recipients of technology but actively involved in the process of making and re-making tools and machines then it follows that there should be some strategies for tapping into this innovativeness as part of an organized feedback process. Designing feedback mechanisms is an important aspect of the iterative design process. Feedback not only shapes the tool but also the organizational context of technology for designers and users. Feedback from users is also important because they experience problems designers have not fully conceptualized. These problems often surface in workplace or domestic

environments, and reflect social considerations. This suggests that a social learning perspective would be an important addition to iterative design.

Social learning perspective

One suggested way of organizing feedback is to use observational feedback with "appropriately configured" performative mechanisms (Richards 2007). With the limited feedback from the users in the co-design process, the social learning perspective can be employed as a performative mechanism to bridge an evident gap. Social learning has been variously defined, but broadly speaking refers to the idea that the tool or machine user rarely works alone. Co-workers or clients constantly moderate and hold accountable the actions of the worker, and validate or modify the approach used. Not only does this result in changes to the use of a tool or machine, but it also generates group norms. Knowledge of technique builds up in a group setting, and this social knowledge affects rates of transmission as the technique spreads. The social learning approach to technology makes it clear that all technologies are unfinished when newly introduced into the users' social setting, whether a domestic environment or a formally-constituted workplace.

Thus it becomes necessary to follow through with the users. This approach recognizes that users engaging with a new technology also contribute to redefining it, through shaping its use and social significance, even when nothing substantial happens to the tool or machine itself. Picking up on this social learning process is an important way of instructing designers about the unanticipated potential or drawbacks to their design. The approach needs to go beyond the nominal owner of the machine, to look at how the technology is impacting on group relations. This seems especially important for women's "labour saving" technologies, where any innovation has to find its place in a complex cooperative environment based on informal mutuality and multi-tasking. This is why it is especially important to involve rural women in the design process, and to give consideration to group as well as individual perspectives. Observational feedback (discussed in chapter 2) based on direct immersion in the social learning process seems important.

Improving the evaluation process

Another way to improve the feedback process is to improve the evaluation process. In the evaluation process for the forage chopper, farmers were presented with one design as the only alternative to the traditional hand chopping method. However, this research has shown that in the domestication process of the forage chopper, other designs emerged, to increase the choices that farmers could make. When technological interventions are introduced as prescriptions, choice is limited. Non-use emerged as a result of limited choice. Women's involvement in evaluating technologies could be increased by developing multiple prototypes. There are cost and human resource implications to fabricating more than one prototype for evaluation, but the benefits of avoiding non-use and abandonment can be off-set against these costs. It would be a good step forward to think about how to evaluate these costs and benefits. If taking more than one design to different evaluation groups of women is to be tried, what would be the rough cost implication? From the farmers interviews, the cost of the different prototypes I encountered in the field was as follows:

- NARO's prototype : 110,000/=
- The all metal prototype: between 25,000 – 70,000/= (Ave. 45,000/=)
- Combination of metal and wood: 20,000 – 50,000/= (Ave. 35,000/=)

- Wooden prototype: 10,000 – 20,000/= (Ave. 15,000/=)

If on average 2 farmers groups are selected in each of the four sub-counties, taking out 4 different prototypes would bring the cost of each group to about 205,000/=. Covering 2 groups in each of the 4 sub-county would imply a total cost of 1,640,000/= as the cost of production for different proto-types. Of course there are aspects of the quality of material that was used in the quoted cost, utility and administrative costs that AEATREC might need to build into this total. If for argument's sake we incorporated 10% - 20% to cover for these, it would imply a total budget of between 1,804,000/= and 1,968,000/= for the design phase. An economic analysis would be needed to take this further, since at present we simply do not know the costs associated with introducing a prototype that fails to take off. It would also be interesting to know what percentage of total R&D funding large commercial companies invest in "market research". But even without this further analysis it can be concluded that there was a hidden economic flaw in the original forage chopper project, since too high a price was one of the factors accounting for non-use of the NARO design. The NARO design was superior in quality, but this research revealed that the other low-cost design alternatives worked fairly well. Most importantly, they were within the farmers' financial capacity, and this promoted their use.

Chapter 4 showed the value added when users took part in the interactive design process in making the forage chopper work for them. Users mobilized resources within their financial means, ending up with other prototypes to add to the one that engineers had taken out, increasing the choices other farmers could opt for. This leads us to an interesting conclusion - that one of the values of the formal design process was in stimulating local interest in the problem, resulting in low-cost alternatives. This says something about the complexity of cost-benefit calculations in design, since even a bad design can be valuable in stimulating thought directed towards better alternatives. Following up different users, former users and non-users revealed the real constraints farmers were encountering limiting the use of the technology and accounting for the different user trends. It is such revelations that can inform and enrich the design process in the further developments of the technology. The same approach proposed earlier in this chapter (of having women groups commission the design process) is one that might also usefully be extended to the evaluation of the designed prototypes Such "women's design panels" might be set up as part of the participatory process of identifying women's needs, so that the same people or groups take part in the entire process. The question that then comes to mind is how the process of organizing women into these kinds of groups can be handled.

In chapter 5 I proposed a restructuring of the implementation process to include an independent "implementing body" to work between the governing committee (with policy makers, development partners etc.) and the users. Among its roles, I proposed that the implementing body can be charged with the control of the pooled resources and hiring service providers. The issues of organizing women into "design panels" can be handled at this level by the implementing body as one of the means of holding the developers accountable. Since the implementing body controls the funds and can hire in trainers to get the women well equipped for their role, this minimizes any power over the women from the individual developers, as was problematic in the case of women's groups re-organized by the NGOs. These women would need some training to build their

individual capacities to act as a reference group. Collective organization of the women users calls for social mobilization, to build alliances and coalitions, as well as some degree of technical aptitude and capacity. To lay the groundwork for this to happen, however, some attention needs to be paid to individuals, by encouraging participation and acquisition of skills.

Both building users' capacity to exercise effective demand and the building of feedback are interrelated. When users have the capacity to articulate their demands from technology providers or exert pressure on designers, their participation in the actual design process can then be enhanced. A question is whether users' involvement in the design process will then make technologies more socially friendly. This research offers some support to bolster the belief that Ugandan rural women are capable of "adding value" to an iterative design process, even at present levels of organization and skill. Much more could be achieved if design projects build into their budgets the need to prepare users to contribute to iterative design. One day, this might even become part of the school curriculum for girls in rural Africa.

6.3 Change in the dissemination process

For developed labour saving technologies to effectively benefit rural women they have to be disseminated in a way that will ensure their use. Increasing women's use of labour saving technologies requires a detailed understanding of the organization of the social, material and institutional context within which rural women live. Two important changes are needed to the dissemination process. These can be summed up as scale down the designers, and review implementation strategies.

6.3.1 Scaling down the designers

Evidence from this research has shown that NARO does not have the capacity for mass production of proven technologies. Part of AEATREC's efforts to link research to practice has been lack of success in involving the private sector in ensuring technology availability. This research has shown that farmers' search for other services providers was partly due to the limited availability of NARO's machines. Not only was capacity implied in the production of the technologies but also in the after sale services for repairs and maintenance. As this research has shown, non-use, and an expelled group of former users, was the result of failed repairs, due to limited or missing after sale services. In the absence of after sale services for repairs and maintenance of the machines, even those who had acquired the NARO design had to find their own means of solving this problem. Simply put, the engineers had too much work to handle. They could be freed to elaborate alternative prototypes and focus on feedback better if local fabricators became part of the process at an early enough stage.

This research has shown that local welders were among the community resources that farmers mobilized in the use of the forage chopper. In their effort to avert constraints of technology availability and maintenance, farmers turned to local welders both as a source of the technology and for after-sales service. The welders thus formed an important element in the socio-technical system that facilitated use of the technology. The farmers ability to mobilize local resources was important in getting the technology work for them. As earlier discussed in chapter 2, farmers' engagement with the local welders points to one way that NARO can effectively tap manufacturing capacity. Availability of technologies was

one of the key aspects covered in chapter 5 among the strategies for increasing uptake and use of labour saving technologies for women. The presence of local welders in the socio-technical system is because they provide various services - not least repairs - and are a cheaper alternative. Their importance to the process suggests that, too, should be incorporated in the design process, since they have important knowledge about functionality and also about client needs and complaints.

Chapters 2 and 4 offered a picture of how "design" proceeds at village level. Farmers in most cases produced a picture as a guide for a welder to reproduce the machine required. Or where distance permitted, welders made a visit to the farmer whose machine was to be copied. However, these welders were mainly engaged in the fabrication of window and door frames, with limited precision, which affected the quality of turned out machines. If these welders are brought on board early enough in the design process, they can be trained in the fabrication of these technologies, to perfect their skill. But even after such training, the development process may need to build an effective monitoring of the proto-typing process to ensure quality of production is maintained. For this scaling down of designers to come to fruition, a formal relationship between NARO and the local fabricators may have to be established. This issue needs further exploration, to discover what information and skill levels fabricators already have, and what they now need, and also to work out a proper incentive structure for supply of local fabricators' knowledge and experience.

6.3.2 Reviewing the implementation process

Increasing the efficiency of use of women's labour time in agriculture requires both a good embedding of the technology in the existing production strategies and strategies for successful uptake and use of technology. A good embedding of technology within existing production strategies requires understanding of the social and material context, as already discussed. In addition, there needs also to be coordination and institutional transformation among the different development agencies responding to the empowerment objective. This research has shown that farmers have very often been faced with different and sometimes incompatible demands from different but interrelated technologies, involving a number of simultaneous adjustments. This limits how much the users can benefit from the different interventions because all the different actors tend to focus on achieving their own objectives rather than meeting farmers' objectives.

The research has further shown that current implementation structures are crowded with emphasis on individual participation. Any intervention involving different actors directing their intervention to the same persons is likely to face challenges because all the agency actors have different programmatic objectives, and different ways of measuring objectives and success of interventions. Under this scenario the targeted beneficiaries are likely to end up not effectively benefiting due to a confusion of goals. Over and above this problem, the research has also shown that there has been too much bureaucracy and political influence/interference in the implementation of development initiatives, and that this hampers the uptake and use of technologies. The policies put in place have often been speculative, and consequently as chapter 5 has shown, there has been competition for power and resources which has affected development efforts. There is need to rethink this approach, and to develop better coordination of efforts among the various stakeholders.

The demand for agricultural production technologies is a derived demand, usually determined by market opportunities for farm products. Reforms may thus be needed to allow farmers to increase sales from farm products or to engage in other income generating activities. This further stresses the importance of understanding how women's various production activities and work routines are organized, and how they would interact with the new technology. The implication of all these changes, however, is that if labour saving technologies are really to work for rural women, engineers will need to coordinate their design efforts with other agencies working in rural development, to ensure that all the relevant contextual factors are addressed. There is no case for simply launching a design as a silver bullet, hoping it will change the context by magic.

6.4 The future of labour saving technologies for rural women

This thesis has argued that the existing technology development processes take a wrong approach to women and technology, targeting women without necessarily giving them a role in the development process. The thesis has consequently shown that it does not make sense to ring women as a category and target them in isolation, since their activities are integrated into wider wholes. This is where technology development processes can benefit from sociological and STS insights in order to develop a more comprehensive women's empowerment strategy. Therefore, the implementation of policies aimed at empowerment of women, requires careful analysis of the target group in wider social context. This implies a broader, developmental role for engineers, with implication for training as discussed in chapter 2.

Implementation of the women's empowerment policy objectives in rural Uganda is currently done by addressing women as individuals rather than in terms of their social roles. However, this research has shown that the social and material context both need to be taken into account. The analysis of the material environment revealed that technology is a complex process of making that involves getting things done effectively, not simply a device to be used in plug-and-play mode. This requires consideration of a great deal more than the simple notion of uptake. A possible element to include in policy implementation therefore is an updated idea of technology – technology as a process of making and re-making. Rationalizing the design process, therefore, to address women's empowerment requirements broadens the role of engineers. The engineer now needs to analyze the users' social context and the material environment. They become implicated in managing social as well as technical processes. A review of the training of NARO engineers revealed that at present they are not competently trained to handle the social demands of engineering for rural development.

Current engineering training lacks components not directly related to technical concerns. This sustains a narrow concept of design that focuses largely on technical issues without taking account of social context. This certainly calls for a change in the engineering curriculum to incorporate training modules on the social aspects of design. In an effort to expand students' social responsibility, a recent curriculum development at Makerere University has been the incorporation of gender studies to strengthen cross-cutting issues in development (Makerere University 2001). The university has provided an excellent model for incorporating gender into most of its curriculum, with the Faculty of Agriculture playing a pioneering role. There is now a faculty-wide gender in development course running for all students in the Faculty of Agriculture to which the department of

agricultural engineering belongs. This kind of approach will broaden the perspective on engineering design, especially if the participatory design approach can now be implemented to allow designers to understand users practices. The benefit of such an approach will be to enhance the students' ability to turn out more socially acceptable technologies. The challenge that still remains is to convince senior engineers with many years of practice, and occupying positions of authority in centres of engineering design, to adopt a similar approach.

It is the conclusion of this thesis that in spite of the complexity of the relationships between technology design and the social organization of users, the design process for labour saving technologies can still be rationalized to meet the needs of a women's empowerment strategy. This thesis has offered four strategies to rationalize the design process so that labour saving technologies for women have their desired effect: organizing effective feedback, reconfiguring the user, following up the domestication process and enhancing technology use for the broader goals of empowerment. Appropriately configured performative participation can yield effective feedback to inform an iterative design process. The iterative design process is the "heart" of the interactive design model in that it enables a hands-on process of remodeling the technology by the users, creating practical usefulness. Reconfiguring the users is useful in understanding the actual user being targeted for labour saving technologies - a necessary step in building users' capacity to exercise effective demand. Following up the domestication process provides an understanding of what factors facilitate or hinder technology use. Beyond increasing women's access to technologies, strategies for improving the processes of technology uptake and use are necessary to increase women's efficiency of use of labour saving technologies. It is concluded that it is now necessary to look at the development of technologies for women in Uganda differently. Instead of focusing on women as individual entities, technology development and dissemination processes should focus equally on the social and material context, in order to achieve the goal of technologies that are of truly transformative potential.

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Definition of Key Concepts

GENDER – "Refers to the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context or time-specific and changeable. Gender determines what is expected, allowed and valued in a women or a man in a given context. Gender is part of the broader socio-cultural context. Other important criteria for socio-cultural analysis include class, race, poverty level, ethnic group and age"

GENDER EQUALITY – "Refers to the equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration – recognizing the diversity of different groups of women and men. Gender equality is not a "women's issue" but should concern and fully engage men as well as women. Equality between women and men are seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centered development"

GENDER MAINSTREAMING – "Mainstreaming a gender perspective is the process of assessing the implication for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality"

WOMEN'S EMPOWERMENT - "The concept of empowerment is related to gender equality but distinct from it. The core of empowerment lies in the ability of a woman to control her own destiny. This implies that to be empowered women must not only have equal capabilities (such as education and health) and equal access to resources and opportunities (such as land and employment), they must also have the agency to use those rights, capabilities, resources and opportunities to make strategic choices and decisions (such as are provided through leadership opportunities and participation in political institutions.

GENDER ANALYSIS - The systematic gathering and examination of information on gender differences and social relations in order to identify, understand, and redress inequalities based on gender (Reeves and Baden 2000).

HOUSEHOLD – In this thesis a household is defined as a group of persons who were answerable to the same head, joining together in activities of production, reproduction, co-residence, consumption, bargaining (co-operating & competing/conflicting) for resources but, with socio-cultural structures that defined the choices available to each person. This included members of the household not physically present, particularly the household head, but playing an important role in decision making as well as economic

function in the household; and the hired workers sharing residence and consumption with the family. It however excluded school going children fostered in but, in boarding schools, who spent less than half a year in the household, as well as the youth fostered out (who had migrated to the urban centers).

Appendices

Appendix 1

Table 1: Sampling Frame for respondents

Unit	Item	Description	Sampling Method	Reason for selection
Population	Smallholder Dairy farmers of Masaka district	Dairying area	Purposive	Targeted in the development of the forage chopper
	4 sub-counties (Strata)	Bukulula, Mukungwe, Kkingo & Kabonera	Stratified	Highest concentration of NGO/project zero grazing animals
Sampling units	Villages	♦ Easily accessible ♦ Remote access	Purposive in each stratum	To determine how distance affects technology dissemination
Sample	Household (unit of analysis)	♦ With chopper (A) ♦ Without chopper (B) ♦ Local cattle (C) ♦ Forage sellers (D)	♦ Purposive ♦ Random ♦ Random ♦ Purposive	Unit of analysis ♦ A for the social & material context users of the technology ♦ B – inference for smallholder dairy farmers (social and material context of non-users of the technology) ♦ C – for social context before the introduction of zero grazing animals & how this influences uptake of zero grazing animals ♦ D – for inter-household interactions & their influence on technology dissemination ♦ A and B – for comparison of factors for use, former use and non-use of the forage chopper
	Key informants (unit of analysis)	♦ MAAIF - District ♦ SACU officials ♦ HI officials ♦ MADDO officials ♦ NARO officials	Purposive	♦ Profiling actors, farmers ♦ Project assessment ♦ Project assessment ♦ Project/organization assessment

Appendix 2: Interview Protocols

a) Individual household

Introduction to the study

The National Agricultural Research Organisation (NARO) developed forage choppers for the smallholder dairy farmers to address the constraints of forage chopping. The choppers have been disseminated to some farmers in the district but some still use the conventional manual chopping method and there are farmers who have made their own choppers from other sources as a way of addressing the constraints of forage chopping. The purpose of this study is to follow up on all the farmers using improved choppers as well as those not yet using the choppers to understand how the chopper is affecting or transforming the gender relations in households and in the community.

1. Household information

- County
- Sub-county
- Parish
- Village
- Name of respondent
- Sex of respondent
- Age of respondent
- Household headship
- Marital status of household head
- Level of education
- Total number of persons living in the household (ratio of male to female)
- Years of farming experience
- Main source of income in the household

2. Farmer group dynamics

- Farmer group(s) respondent belongs to
    - Name
    - Composition of the group
    - Activities bringing them together
    - How do they work together?
    - Group's contribution to community development
    - Advantages of being in the group
    - Any set backs

3. Gender relation in Production

- Gender division of labour in agricultural production
    - Who does what, when, where by what means?
    - How do they work together
    - Decision making in household on labour division
    - Who decides on the enterprise to engage in

4. Gender relations in household resources

- Sources of income by gender (how do people make a living)

- Survival goals for the household (being able to meet basic needs)
- Economic assets by gender
- Use, access, ownership and control of key resources
- Benefits and incentives by gender
- Social support systems (informal credit, relatives, friends)

5. Gender relations in labour saving production technologies (*Farmers with forage choppers*)

- Available labour saving production technologies
- Targeted users by gender
- Technologies currently in use by farmers
    - decision on what to use
    - decision on what to buy
- Sources of these technologies
- Role of farmers in technology production
- Benefits from these technologies
- Constraints posed by the technologies
- Any adjustments/changes to the original design to suit your mode of operation
- Reasons that favoured the adoption
- Use, access, ownership and control by gender

6. Gender relations in labour saving production technologies (*Farmers without forage choppers*)

- Technologies currently in use by farmers
    - decision on what to use
    - decision on what to buy
- Targeted users by gender
- Benefits from these technologies
- Constraints posed by the technologies
- Any modifications made to suit your mode of operation
- Any lessons learnt from other advanced smallholder dairy farmers
- Reasons for non-adoption (Prohibiting factors to technology change)
- Use, access and control by gender

7. Gender relation in livestock production (*Farmers with local cattle*)

- Livestock ownership by gender (inheritance pattern in the event of death)
- Routine of local cattle system
    - Labour spent on local cattle
    - Gender roles (who does what)
- What are the important quality features?
    - Milk production, meat, manure, other (specify)
- What do you see as improvements for their local cattle?
    - What would you do when you have the opportunity to improve?
- Interactions with the zero grazing farmers
    - Own views on the project
    - What benefits has the project brought to them?

- What constraints has the project brought them?
- Lessons drawn from other livestock farmers
- Reasons for non-adoption

8. Gender relation in forage production (*Forage growers*)

- Gender division of labour in agricultural production
  - Who does what, when, where by what means?
  - How do they work together
  - Decision making in household on labour division
  - Who decides on the enterprise to engage in
  - Ownership and control of project
  - Available acreage
  - Benefits of the project
  - Constraints in production
  - Prospects of the project (future plans)

b) Key informants

Introduction to the study

The National Agricultural Research Organisation (NARO) developed forage choppers for the smallholder dairy farmers to address the constraints of forage chopping. The choppers have been disseminated to some farmers in the district but some still use the traditional hand chopping method and there are farmers who have made their own choppers from other sources as a way of addressing the constraints of forage chopping. The purpose of this study is to follow up on all the farmers using improved choppers as well as those not yet using the choppers to understand how the chopper is affecting or transforming the gender relations in households and in the community.

1. General information

- Name of respondent
- Sex of respondent
- Organisation
- Position in organization
- Working experience (No. of years) with organization
- Individual's role(s)

2. Background information

- Initiative / Conception of project (when, by who, basis)
- Role of the project
- Organisation of the project (mode of operation)
  - How does project target its technology design?
  - Replacement Vs. Introducing entirely new technology
  - What's wrong with existing ones (Technologies)?
  - Describe the development routine
  - Feedback process in technology development

3. Networking of the group

- Level of collaboration (National, Regional, International)
- Interaction with farmers / farmer groups (levels of interaction, impact on farmers, impact on community)
- Interaction with other actors in the network (NGO's, Researchers, Extension agents, Government)
- Challenges and opportunities

3. What makes the organization / project tick?

4. Lessons learnt

5. Future plans / Way forward

c) Focus Group Discussions

Introduction to the study

The National Agricultural Research Organisation (NARO) developed forage choppers for the smallholder dairy farmers to address the constraints of forage chopping. The choppers have been disseminated to some farmers in the district but some still use the conventional manual chopping method. The purpose of this study is to follow up on the farmers using the choppers as well as those not yet using the choppers to understand how the chopper is affecting or transforming the gender relations in the community.

TOOL A: Gender role(s) in the development and dissemination processes

a) Free listing

- Roles in production by gender
- Available labour saving production technologies (resources)
- Targeted users by gender (for whom and in what circumstances?)
- Benefits from these technologies
- Constraints posed by these technologies
- Use, access and control of these technologies by gender

b) Discussion

- Division of labour for production activities
- How do they work together in production
- Their role in the development process of these technologies
- How do they work together with the developers of these technologies
    - Where &Why are they weak?
    - How can they be improved?

TOOL B: Household and community dynamics

a) Free listing

- Production activity profile by gender (seasonal calendar)
- Income profile (village social map)
- Economic assets by gender
- Communal support systems
- Resources, access and control of resources by gender (village resource map, resource picture cards)
- Benefits and incentives by gender

b) Discussion

- Livelihood logics (communal survival goals)
- Factors influencing bargaining positions (intra- and inter-household)
- Influence of technological intervention on gender division of labour and roles
- Changing roles as a result of the introduction of the forage chopper
- Constraints resulting from technology change
- Opportunities resulting from technology change

TOOL C: Institutional Challenges

a) Free listing

- Important institutional / social patterns in the village (institutional profiles)

- Services provided

b) Discussion

- Links between the important institutional / social patterns in the village
- What's is getting better
- What is getting worse
- Challenges

Appendix 3: Individual respondents' categorization

Location	Household category												Total
	Male headed				Female headed				Female managed				
	FC	WFC	LC	FG	FC	WFC	LC	FG	FC	WFC	LC	FG	
Bukulula	5	5	5	3	4	1	2	3		1		1	**30**
Mukungwe	4	3	5	1	2		1	3	2	1			**22**
Kkingo	10	7	5			1	2						**25**
Kabonera	7	9	6	6	1	2	1	2					**34**
Total	**26**	**24**	**21**	**10**	**7**	**4**	**6**	**8**	**2**	**2**		**1**	**111**

FC: with forage chopper (35 hholds) **LC**: with local cattle (27 hholds)
WFC: without forage chopper (30 hholds) **FG**: forage growers (19 hholds)

Summary

Labour-saving tools have been advocated as an important means of increasing production and improving the quality of life of rural Africans. They can be very useful in reducing household labour requirements, especially during the peak production season when these requirements are high. Women have been specifically targeted in the development and dissemination of such tools, with the aim of helping them reassign time from farming and domestic activities towards income generating activities. Many technology development efforts have assumed that women would benefit if designs simply took into account women's roles, but this research shows that this is not sufficient. Developing tools to improve women's wellbeing poses a much more difficult challenge because women are part of a socio-technical system, and it is the combination with other actors and the machine that determines its use and impact. Sometimes labour saving tools have even failed to save women's time and labour and even worsened their social and economic conditions.

Although the policy's emphasis on women has indeed promoted the development of labour saving tools, this has not necessarily increased the efficiency of use of women's labour time or been enough in itself to guarantee that women benefit. Engineers have always assumed that taking women into consideration in the development and dissemination processes of labour saving tools will guarantee their use and reduce women's labour time in agriculture, but this has not been effectively achieved. Most existing women's empowerment strategies target women from a social stratum accessible only for a selected group of Ugandans. Although these strategies can be functional, they rely on an institutional environment in which women are considered to operate relatively independently or have a job or direct access to economic resources and facilities. In other words, the kind of context assumed for women's empowerment policies is not the context for every Ugandan woman. Furthermore, existing technology development processes focus on the technology and the problems it is supposed to solve, targeting women without necessarily giving them a role in the development process. This takes a wrong approach to women and to technology; the right approach requires development solutions that women themselves have helped to shape. In relation to labour-saving technology the thesis tries to arrive at an understanding of how women themselves can be incorporated in reshaping technological solutions.

In this thesis I argue that if the empowerment of women with labour saving tools is to be realized, the design process needs to focus on an integrated approach, grounded not only in engineering but also in the sociology of gender, and insights from Science and Technology Studies (STS). Instead of examining technologies for women, this research took a different approach, by examining how the dissemination of new technology affects women's lives and the gender division of labour in the household. This meant looking at the extent to which new technologies improve women's lives by lessening their workload, and how women can play a greater role in the development and dissemination of these technologies, to increase their use. The approach taken is one that moves beyond the technology itself, and the problems technological applications are supposed to solve, to an understanding of the parties and interests mobilized in arriving at key allocative decisions, as a framework for understanding the scope for women to use machines.

Women's activities are part of a wider fabric of social agency and it this broader picture on which technology designers and development agents needs to focus.

In this thesis I have shown that it does not make sense to cordon off women as a group and undertake development work with or for them in isolation, because women's activities are integrated in larger systems and processes. A technographic approach was used, focusing on a socially active labour saving tool to explore how technologies contribute to the empowerment of women. I draw from my experience of co-designing a forage chopper aimed at reducing women's labour burdens, and indeed empowering them, only to find out that realities of use are much more complex. The high labour demands, coupled with a lack of sufficient land for forage production and forage scarcity for dry season feeding, means that available forage must be efficiently used, and waste minimized. Traditionally, the farmers chop forage with a panga (a machete), cutting it into small pieces for easy consumption by the animal. In addition to low output capacity and lack of uniformity in length of cut, the hand method is tedious, time consuming and quite dangerous to the operator. A labour-saving chopping technology (the forage chopper) was therefore developed by NARO to make this arduous task easier. Using this case study, the present research explored an integrated approach for rationalizing the design process, by focusing on how the different elements of the socio-technical system might be better organized to ensure that labour saving tools work for rural women. I used four techniques (or approaches) to make the topic researchable, viz.: organization of feedback from users, reconfiguring the users, following the domestication process, and enhancing technology uptake and use for the broader goals of empowerment.

Chapter 1 offers an introduction to the thesis, with relevant conceptual framework, discusses literature dealing with conceptual issues of importance to the thesis, and picks out insights to be followed up in later analysis. The analysis is elaborated in four empirical chapters (2-5), framed according to four different approaches to rationalizing the design process for labour saving tools. Chapter 6 integrates findings from chapters 2-5 to arrive at overall conclusions. To rationalize the design process for labour saving tools we need to examine the different social elements at play in the social-technical system, how they are organized, and how they might be re-organized to achieve women's empowerment.

One possible way of rationalizing the design process lies in the way feedback is organized between the technology designers and the targeted users. Very often the network of engineers does not recognize the other social entities in the socio-technical system. Chapter 2 explores the design process and what needs to be done to improve on the interaction between technology designers and users to develop workable technologies. An approach to rationalizing the design process lies in improving the way designers configure users, and this is the focus of Chapter 3. Many development interventions focused on women have used "woman" as a label without analyzing the social construction of gender to reveal how men and women are assigned certain traits and attributes that may or may not be limiting to their development. Designers always have expectations of how the technology will be used, by whom and in what context. By so doing, they construct a "virtual" user, extracted from her work environment. But in technology development, women (users) are part of a socio-technical system, and within this system social elements and machines combine or intertwine to determine usage and outcomes. Users are not fixed entities in terms of composition and activities, and their

interaction with technology is structured by dynamic factors relating to both technology and society.

Armed with a knowledge of the role of the users and of ways of reconfiguring users, it is still necessary to know how use is framed when the technology is released. Social practices of technology use cannot be fully anticipated in the design phase; they only emerge during the integration process of the technology. This makes it necessary to follow through with the users when new technology is introduced, to understand how people use the new technology. Chapter 4 focuses on what the thesis terms the "domestication process" for labour saving technology, and the implications of this process for wider socio-technical configurations. The relevance of this lies in the fact that processes of interpretation and integration of technologies by users are influenced by the social formation, circumstances and cultural conceptions of households. Hence the way users are organized in terms of activities and composition, the community resources available to the different users, their ability to mobilize these community resources, and eventually the way all these intertwine with the technology, will determine actual usage.

In an effort to understand the role of users (as captured through feedback, reinforced by reconfiguring users) and usage (as captured in the domestication process) it should be remembered that technology is embedded in the wider socio-technical configurations according to various stabilizing and directive forces. The focus of chapter 5 is on the strategies needed to improve processes of technology uptake and effective use to achieve a saving of women's labour through new technologies, focusing on the social, material and institutional context for effective implementation of the empowerment policy objectives. Mechanization that reduces women's drudgery in agriculture is one step towards their empowerment, but increasing the efficiency of use of women's labour time in agriculture requires a detailed understanding of the embedding of a new machine in existing production strategies, and also demands good coordination among different developers. Policy implementation requires careful analysis of the target group in its context (women in resource-poor settings, in the case of women empowerment policies), and also requires incorporation of a proper analysis of the material environment (including use of tools and technology), and hence a new role for engineers

In spite of the complexity of the structural relationships linking technology and the social organization of users, the design process for labour saving tools can still be rationalized to better support a women's empowerment strategy. Rationalizing the design process requires a new role for the engineers. The analyses of the users' social context and the material environment in this thesis point to the need to move beyond design and development of technologies for women, and for engineers themselves to become "engineers of the social". In conclusion, the research points to the need to look at the development of technologies for women in Uganda differently. Instead of focusing exclusively on women as individual entities, technology development and dissemination processes should focus as much or more on the social and material context, in order to achieve the goal of technologies that are of truly transformative potential.

Samenvatting (summary in Dutch)

Arbeidsbesparende technieken worden vaak gezien als een belangrijk onderdeel van productieverhoging en, meer algemeen, rurale ontwikkeling in Afrika. Dergelijke technieken verlagen de arbeidsdruk in gezinsbedrijven, wat vooral van belang is in drukke periodes. Vrouwen vormen een specifieke doelgroep. Arbeidsbesparende technieken kunnen de huishoudelijke taken van vrouwen verlichten, waardoor ze tijd vrij maken voor het genereren van een eigen inkomen. Vanuit die gedachte is er de laatste decennia meer aandacht gekomen voor vrouwen in technische ontwerpen. Dit proefschrift laat zien dat een dergelijk redenatie veel te simpel is. Het introduceren van arbeidsbesparende technieken voor vrouwen is een complexe problematiek omdat vrouwen onderdeel uitmaken van een sociaal-technisch systeem. Dat betekent dat het geheel aan beschikbare technieken in wisselwerking met de werkzame personen in een gezinsbedrijf bepalend is voor het effect van een nieuw-geïntroduceerde techniek. Daardoor kunnen de gevolgen van nieuwe technieken soms een averechtse uitwerking hebben en vrouwen juist meer werk moeten verrichten.

De meeste bestaande strategieën om vrouwen te versterken en ondersteunen, richten zich vaak op een bepaalde sociale laag binnen de bevolking, vooral vrouwen die toegang hebben tot de arbeidsmarkt. Hoewel deze strategieën zeker functioneel kunnen zijn, is het uitgangspunt een institutionele omgeving waarin vrouwen worden beschouwd als relatief zelfstandig opererend, met directe toegang tot economische middelen en faciliteiten. Maar veel vrouwen in Oeganda verkeren in een heel andere situatie en ontberen toegang tot en zeggenschap over financiële middelen. In het ontwerpen van arbeidsbesparende technieken is het cruciaal om aandacht te besteden aan het verschil in context en de wensen van de vrouwen zelf. Dit onderzoek richt zich op de vraag hoe een dergelijke 'inclusieve ontwerpmethode' er uit zou kunnen zien.

In dit proefschrift beargumenteer ik dat een inclusieve ontwerpmethode gebaseerd moet zijn op een aanpak die zich niet alleen richt op techniek, maar ook gebruik maakt van inzichten uit de sociologie en wetenschaps- en technologie-studies (WTS, beter bekend onder de Engelse afkorting STS). In plaats van technologie-voor-vrouwen te onderzoeken, moet technologie-met-vrouwen worden onderzocht. Technologie-voor-vrouwen impliceert dat technologie, mits technisch goed ontworpen, gevolgen heeft die positief uitpakken voor vrouwen. Technologie-met-vrouwen impliceert een voortdurend proces van ontwerpen, aanpassen en veranderen waarin de vrouwen een actieve rol hebben.

In dit proefschrift heb ik laten zien dat het niet zinvol is vrouwen als groep af te zonderen omdat activiteiten van deze doelgroep zijn geïntegreerd in grotere systemen en processen. Een analyse van techniek-in-gebruik (technografie) is gehanteerd om na te gaan hoe technologie bijdraagt aan de versterking van vrouwen. Ik putte uit mijn ervaring als ontwerper van een snijmachine voor gras dat aan koeien wordt gevoerd (een type gras dat alleen in gesneden vorm verteerbaar is). Deze machine werd gemaakt om de arbeidslasten voor vrouwen, die de verzorging van de beesten tot taak hebben, te verlichten. De realiteit van het gebruik van de snijmachine bleek veel complexer. De hoge arbeidskosten, in combinatie met een gebrek aan voldoende land voor het produceren van gras en schaarste tijdens droge seizoenen, betekent dat het beschikbare voer efficiënt

moet worden gebruikt en afval tot een minimum beperkt. Traditioneel gezien hakken de boeren het voer met een kapmes (*panga*). Naast de lage capaciteit en gebrek aan uniformiteit in de lengte van de snede, is de handmethode vermoeiend, tijdrovend en gevaarlijk. Een handbediende mechanische snijmachine is ontwikkeld door de het nationale landbouwkundig instituut van Oeganda (NARO) om deze taak te verlichten. Met behulp van deze studie is nagegaan hoe een geïntegreerde aanpak voor het rationaliseren van het ontwerpproces, gericht op een analyse van de verschillende elementen van het socio-technisch systeem, beter kan worden georganiseerd om ervoor te zorgen dat de arbeidsbesparende technieken ook daadwerkelijk toepasbaar zijn voor vrouwen op het platteland. Ik heb hierbij gebruik gemaakt van vier benaderingen om het onderwerp onderzoekbaar te maken, namelijk: 1) de organisatie van de feedback van de gebruikers, 2) de configuratie van de gebruikers, 3) het verbeteren van technologie opname en 4) toepasbaarheid voor de bredere doelstellingen van versterking.

Hoofdstuk 1 biedt een inleiding van het proefschrift en ontwikkeld een relevant conceptuele kader met behulp van de literatuur. De analyse is uitgewerkt in vier empirische hoofdstukken (hoofdstuk 2 t/m 5), elk met een van de vier bovengenoemd benaderingen. Hoofdstuk 6 integreert de bevindingen uit de hoofdstukken 2-5 en trekt enkele algemene conclusies. Om het ontwerpproces voor arbeidsbesparende techniek te rationaliseren, is het noodzakelijk de verschillende sociale elementen die een rol spelen binnen het sociaal-technisch systeem nader te onderzoeken. Hoe zijn bijvoorbeeld de vrouwen georganiseerd? En hoe kunnen ze anders worden georganiseerd om hun positie te versterken?

Een manier om het ontwerpproces te rationaliseren is een verandering van de manier waarop feedback wordt georganiseerd tussen ontwerpers en de beoogde gebruikers. Vaak komt het voor dat het netwerk van ingenieurs de verscheidenheid aan betrokken personen in het socio-technisch systeem niet herkent. Hoofdstuk 2 onderzoekt om die reden het ontwerpproces en wat er gedaan moet worden ter verbetering van deze interactie tussen ontwerpers en gebruikers om werkbare technologieën te ontwikkelen. Een twee benadering tot rationalisatie van het ontwerpproces ligt in het verbeteren van het 'configureren' van de doelgroep. Dit wordt uiteen gezet in hoofdstuk 3. Veel interventies gericht op vrouwen hebben gebruik gemaakt van 'vrouw' als een label, zonder de sociale constructie van gender te specificeren en daarmee helderheid te krijgen over hoe mannen en vrouwen bepaalde eigenschappen en kenmerken hebben, of verondersteld worden te bezitten, die van belang zijn voor hun ontwikkeling. Ontwerpers hebben altijd bepaalde verwachtingen van de manier waarop de technologie zal worden gebruikt, door wie en in welke context. Die verwachtingen creëren een 'virtuele gebruiker'. Een gebruiker is echter geen vooraf vast te stellen sociale actor omdat juist in de interactie met de techniek (die er vooraf nog niet is) wordt bepaald wat een gebruiker is. Het is de dynamiek tussen gebruikers en techniek en de invloeden van de wijdere context die meer centraal moet staan.

Gewapend met kennis over de rol van de gebruikers en van de mogelijkheden tot configuratie, is het dus van belang om te weten hoe het de interactie tussen techniek en gebruiker zich ontwikkeld in een bepaalde context. Hoofdstuk 4 richt zich op deze domesticatie van de snijmachine. Hoe gebruikers de machine interpreteren (wat ze er mee kunnen doen) en integratie van de snijmachine door gebruikers in de context (wanneer ze

wat doen) wordt bepaald door de materiële en sociale omstandigheden en culturele opvattingen. Vandaar dat de manier waarop gebruikers worden georganiseerd in termen van activiteiten, de samenstelling, gemeenschap beschikbare middelen voor de verschillende gebruikers, hun vermogen om deze gemeenschapsmiddelen te mobiliseren, en uiteindelijk de manier waarop al deze verstrengelen met de technologie, het werkelijke gebruik zal te bepalen.

In hoofdstuk 5 wordt gekeken naar nieuwe mogelijkheden en strategieën om op een andere manier om te gaan met technologie. De inzet is, zoals in vorige hoofdstukken uiteen gezet, een effectief gebruik te realiseren waarmee vrouwen daadwerkelijk worden geholpen. Behalve een aangepast ontwerpproces, heeft dit ook gevolgen voor de wijdere context, met name het overheidsbeleid, vorm gegeven door NARO. Het mechaniseren van bepaalde arbeid waarmee werkzaamheden in de landbouw voor vrouwen worden verlicht, is een stap op weg naar hun versterking. Het verhogen van de efficiëntie van het gebruik van de arbeidstijd van vrouwen in de landbouw vereist een gedetailleerd inzicht in de inbedding van nieuwe techniek in bestaande productiestrategieën. Dit vereist tevens een goede coördinatie tussen de verschillende personen en instellingen die bij dit proces betrokken zijn. Uitvoering van het beleid vereist een zorgvuldige analyse van de doelgroep in zijn context (vrouwen die leven en werken in rurale gebieden met weinig publieke voorzieningen en nauwelijks toegang tot de arbeidsmarkt). Dit vereist, tenslotte, ook integratie met en een goede analyse van de materiële omgeving, inclusief het gebruik van technieken, en dus een nieuwe rol voor ingenieurs.

Hoewel de bredere beleidscontext, het proces voor het ontwerpen van technologie en de sociale organisatie van gebruikers een complex geheel vormt, kan het ontwerpproces voor arbeidsbesparende middelen verder worden gerationaliseerd tot een betere ondersteuning van vrouwen. Rationalisering van het ontwerpproces vereist een nieuwe rol voor de ingenieurs. De analyse van de maatschappelijke context en de materiële omgeving waarin gebruikers opereren, zoals uiteen gezet in dit proefschrift, wijzen op de noodzaak verder te gaan dan het ontwerp en de ontwikkeling van technologieën voor vrouwen. Ingenieurs moeten niet alleen technisch ontwerpen maar ook socioloog zijn en gebruikers de ruimte geven om techniek te domesticeren. Tot slot, het onderzoek wijst op de noodzaak anders te kijken naar de ontwikkeling van technologieën voor vrouwen in Oeganda. In plaats van zich uitsluitend te richten op vrouwen als individuen, met technologische ontwikkeling en verspreiding van techniek als externe processen, moet de sociale en materiële context veel meer centraal staan.

About the author

Florence Lubwama Kiyimba was born in Mengo, Kampala District in Central Uganda. She holds a Bachelor of Science Degree in Agricultural Engineering from Makerere University (1995), and a Master of Science Degree in Agricultural Engineering, majoring in Agricultural Processing and Farm Structures from the University of Nairobi (1998). She started her career as a Research Assistant at the Agricultural Engineering and Appropriate Technology Research Centre (AEATREC) of the National Agricultural Research Organization (NARO) in 1997 as she awaited her MSc. Graduation. After her graduation in 1998, she continued working at AEATREC as a Research Officer until October 2007 when she enrolled for a Sandwich PhD. Program at Wageningen University, The Netherlands. Besides the research work, she worked as a Part-time Lecturer in the Department of Agricultural Engineering, Makerere University from 2003 till 2008.

She has worked as part of the engineering team designing and developing simple, appropriate and gender sensitive technologies to reduce the energy and time intensity on women and children, as well as minimize losses in processing and add value to the products. During the ten years of working on appropriate technologies for smallholder farmers, she realized that women's use of appropriate technologies was still very low. Women continued to struggle with labour and time intensive production activities, in spite of all efforts to reduce women's time in agricultural production. This is what inspired her to enroll for a doctorate program to research on the issue of technologies for women and what was constraining women's use of the technologies. Her PhD on "Tools for women's empowerment? *The case of the forage chopper for smallholder dairy farmers in Uganda*" focused on approaches for rationalizing the design process of labour saving tools to hit the women's empowerment strategy. It was done under the supervision of the Technology and Agrarian Development (TAD) group and Irrigation and Water Engineering (IWE) group.

Name Florence Lubwama Kiyimba
PhD candidate, Wageningen School of Social Sciences (WASS)

Completed Training and Supervision Plan

Wageningen School of Social Sciences

Description	Department/Institute	Year	Credits
I. Orientation			
CERES orientation programme	CERES, Utrecht	March - May 2009	5
CERES presentation tutorials	CERES, Utrecht	May 2009	5,5
II. Research Methods and Techniques and Domain Specific Theories			
Research Methodology I: From Topic to Proposal	MG3S, Wageningen	Nov – Dec 2007	4
Quantitative Research Methods	MG3S, Wageningen	Nov – Dec 2007	4
Technography, Researching Technology & Development	CERES, Wageningen	December 2007	6
Competencies for Integrated Agricultural Research	WGS	1 – 5 June 2009	1
III. Academic Skills			
Scientific Publishing	WGS	November 2007	0,5
Information Literacy, Including Endnote	WGS	November 2007	0,5
Science Writing, Communication and Presentation Skills Course	AWARD, Arusha	20 – 26 Feb. 2011	4,3
IV. Presentations of research results			
Impact of Gender Dynamics on Agricultura Technology Development & Dissemination The case of the forage chopper for smallholder dairy farmers in Uganda.	EASST Conference	August 2008	2
Presentation of preliminary research findings	TAD Seminars	2009-2011	3
V. Others			
WTMC Summer School	WTMC	25 – 29 August 2008	3
WTMC Workshop (User-Producer Relations)	WTMC	1-3 April 2009	1,2
WTMC Workshop (Research for Development	WTMC	13 – 15 Oct. 2010	3
TOTAL ECTS			**43,0**