

Contribution of farm power to smallholder livelihoods in sub-Saharan Africa

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Foreword

At the beginning of the new millennium, rural livelihoods in many parts of sub-Saharan Africa are under considerable strain and, in many countries, poverty remains endemic. Agriculture lies at the core of rural livelihoods and has a major influence on the standard and quality of lives of millions of people. Farm power – or the availability of people, animals and machines to carry out work – is a crucial input in the agricultural production process. Although the lack of power affects almost all aspects of rural family life, the effect that a shortage has on a family's ability to cultivate sufficient land has long been recognized as a major contributory factor to the increasing prevalence of poverty in the region. The viability of rural livelihoods is threatened by many factors that reduce the availability of farm power. Addressing these threats constitutes a major challenge for many parts of sub-Saharan Africa today.

For a number of years, the Farm Power and Mechanization Group of FAO has been investigating the problems of farm power and shortages thereof at global, regional, country and farmer levels. This report is the most detailed yet of the work being carried out on this issue and examines the farm-level development of the availability of human power, draught animals and motorized power. Although the availability of these sources of power affects almost all aspects of living, this report focuses on their availability and use for the cultivation of agricultural land. It examines the vulnerability of farm-power systems and the interrelations between farm-power options (hand labour, draught animals, and tractors) as well as the overall farm power and labour base. The funding for carrying out this study has come from the Regular Programme Budget of FAO through the programme entity "Enhancing Small Farmer Livelihoods".

This study is significant in that it may be the first to discuss specifically the farm-power theme through the livelihoods philosophy. In particular, it highlights the overall problem of the availability of farm power and its interrelationships with socio-economic parameters of rural life. The report illustrates the complexity of farm-power interrelations and problem areas that are clustered around the farm-power theme. It makes very clear that farm-power availability is not solely a matter of promoting a certain technology or piece of equipment. It shows that all aspects of the livelihoods of a rural household are interconnected and affected by the available farm-power base.

We hope that this report will contribute to increasing the understanding of the role of farm power and appropriate mechanization for stabilizing the asset base and the source for living of many farming households in sub-Saharan Africa.

Finally, I should like to pay tribute to the author, Clare Bishop-Sambook, for pioneering the methodology used in this study and for leading and motivating all the participants from the seven countries and FAO who were involved in carrying out the fieldwork and finalizing the study.

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List of abbreviations

AGSF	Agricultural Management, Marketing and Finance Service (FAO)
AGST	Agricultural and Food Engineering Technologies Service (FAO)
AT	Appropriate Technology, Uganda
ATN	Animal Traction Network, United Republic of Tanzania
DAP	Draught animal power
FARMESA	Farm-level Applied Research Methods for Smallholders in East and Southern Africa
FHH	Female-headed household
GDP	Gross domestic product
ha	Hectare
HDI	Human development index
HH	Household
IDEA	Investing in Development Export Agriculture, Uganda
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
ILRI	International Livestock Research Institute
m asl	Metres above sea level
MHH	Male-headed household
NGO	Non-governmental organization
PPP	Purchasing power parity
R and M	Repair and maintenance
SCAFE	Soil Conservation and Agro-Forestry Extension, Zambia
SIDA	Swedish Agency for International Development
TSh	Tanzanian shilling (US\$1 = TSh916 as at January 2002)
ULAMP	Uganda Land Management Project
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

Executive summary

Rural livelihoods in many parts of sub-Saharan Africa are under considerable stress. Economies and the political environment are experiencing a period of significant transformation, and poverty is endemic. Agriculture remains at the core of rural livelihoods and farm power (from human, draught animal and tractor sources) is a crucial input in the agricultural production process. Factors that reduce the availability of farm power compromise the ability to cultivate sufficient land and have long been recognized as a source of poverty in the region. This is the challenge facing many parts of sub-Saharan Africa.

Many of the gains made in mechanizing tillage practices were reversed in the closing decades of the twentieth century. At the very time when many communities have been reverting to tilling the soil by hand, the impact of the HIV/AIDS epidemic has also begun to take its toll on the agricultural workforce. An understanding of the interaction between farm power and livelihood outcomes is central to enhancing smallholder livelihoods.

This report presents the findings from a study of farm power and its role in smallholder livelihoods undertaken by the Agricultural and Food Engineering Technologies Service, FAO. Studies were conducted in 14 communities in seven countries (Ghana, Ethiopia, Malawi, Nigeria, Uganda, United Republic of Tanzania, and Zambia) that were broadly representative of the main farming systems in the region, covering the maize mixed system (the dominant food production system in east and southern Africa), and the mixed cereal–root and tree crop systems (typical of west Africa). The study concentrated on the power inputs used for primary tillage; in many farming systems in the region, the use of draught animals and tractors is confined almost exclusively to primary tillage and all other operations rely on hand power. The livelihoods methodology was used to conduct a detailed analysis of the use of farm power at community and household levels.

DEVELOPMENTS IN FARM-POWER SYSTEMS

A feature of farm power in sub-Saharan Africa in the twentieth century was the dominant and persistent use of hand power for primary tillage. In the early 1900s, nearly all of the study sites relied on humans as their sole source of farm power, with the exception of sites in Ethiopia and Zambia where draught animals were already an integral part of the farming system. During the century, draught animals and tractors were introduced in many communities, closely linked to initiatives to accelerate cash-crop production and increase the area under cultivation. In some instances, governments promoted tractor use by building on earlier initiatives that had promoted draught animal power (DAP). In other communities, the private sector was the prime mover in offering tractor-hire services. In this period, agricultural production was generally profitable, households were usually food secure, and farmers earned enough to buy farm implements and improve their standard of living.

However, the majority of the study communities were unable to sustain the use of their new sources of farm power. Structural adjustment left gaps in support for the smallholder sector, with the reduction or withdrawal of agricultural input subsidies and credit, disruption of produce markets, closure of government tractor-hire services, and weakened veterinary services. The situation was often compounded by a lack of basic infrastructure to support mechanized technologies. This resulted in expensive repairs, poor maintenance and repair facilities, and difficulties in obtaining spare parts.

Simultaneously, the stock of draught animals was decimated in many communities by disease, drought, distress sales and theft. Thus, at the beginning of the twenty-first century, humans and draught animals remain as the main sources of farm power, using a limited range of tools and implements. It is in this context that the study of the contribution of farm power to smallholder livelihoods has been conducted.

LIVELIHOODS ANALYSIS OF FARM-POWER SYSTEMS AT COMMUNITY LEVEL

Three farm-power systems have been identified for grouping communities according to the relative significance of humans, draught animals and tractors as power sources for primary tillage. This classification provides the basis for the livelihoods analysis presented in this report. The systems are:

- predominantly hoe cultivation communities, with two distinct subgroups:
 - mixed hand power and DAP,
 - predominantly hand power using hired labour;
- predominantly DAP communities;
- communities with tractors as a significant power source.

There is a sharp contrast between the poverty and general depression associated with the predominantly hoe systems of eastern and southern Africa, where DAP was once more important, and the hoe communities in west Africa, which are quite vibrant and optimistic in outlook. In the former, the loss of cattle undermines the livelihood strategies for the whole community. Hoe cultivation has become commonplace, and households are no longer able to meet their basic needs from their own cash and in-kind resources. Communities are extremely vulnerable and struggle to survive external shocks, such as the drought of late 2002. The gravity of the situation is exacerbated in communities where the labour base is also under pressure as a consequence of schooling, migration, ill health or death (particularly HIV/AIDS).

In the west African communities, there have been fewer opportunities for mechanization owing to the root and tree crops grown, and hand power is an integral part of the farming system even among richer households. Nevertheless, the loss of tractor-hire services has had a significant impact on agricultural activities but this effect has been tempered by substituting hired labour for tractors. The sustainability of this response is dependent on the continued availability of hired labour at affordable prices. In most of the hoe-cultivation communities, the capacity to cultivate land by whatever means (rather than access to land) is a significant constraint on production.

The DAP system has long characterized farming in much of eastern and southern Africa. Households with access to DAP generally cultivate larger areas than hoe cultivators, realize greater yields, improve household food security, and produce a marketable surplus. However, the ability to reap the full benefits of using DAP for cultivating a larger area is only achievable where there is an abundance of labour, especially for weeding. DAP is increasingly being perceived and promoted by governments and donors as a more sustainable farm-power option than tractor-based systems. However, its application is curtailed by: tsetse fly; poor soils and steep slopes where deeper tillage may contribute to soil erosion; small plots; shortage of fodder; and a lack of specialist skills and supporting infrastructure.

Tractor owners represent the commercial face of farming, using their strong asset-based wealth to purchase inputs such as improved seeds, fertilizer and pesticides. They pay more attention to cash-crop production and act as innovators. Their wealth and role as employers enable them to provide a social net for others in the community. The benefits of using tractors for primary tillage are broadly similar to those reaped when using DAP although the scale of operation is significantly increased. Similarly, they are dependent on the availability of labour for subsequent operations and the availability of land for increasing the area under cultivation. To date, neither appears to

have acted as a constraint on production. Indeed, the opportunity to earn cash or food through hiring out their labour and land is an essential survival strategy for many hoe cultivators.

Under conditions of low farm profitability, the outlook for extensive tractor use must be marginal. Tractor owners find it difficult to maintain tractors in an operational state. Demand for hire services is falling in many communities where farmers are unable to afford the full economic cost of ploughing or transporting. In some communities, owners are not replacing their tractors while, in others, former owners have sold their tractors and reverted to DAP.

ROLE OF FARM POWER IN SMALLHOLDER LIVELIHOODS

The household asset base lies at the heart of the farm-power system and is a major determinant of livelihood outcomes. Household composition and group membership determine the labour available for farm work. The education, skills and off-farm employment experiences of the household head are often associated with specific power sources. For example, tractor owners tend to have access to non-farm income or remittances, and most have at least secondary education complemented by formal employment experience outside the local community. Savings, remittances and access to credit determine a household's ability to purchase and maintain tools, draught animals, tractors and implements, and hire farm-power services. Social assets (for example, reciprocal labour groups) play a vital role in enabling poorer households to address their farm-power constraints.

Households using farm-power technologies other than a hoe gain considerable advantages in terms of area cultivated, crop diversity, yields, levels of drudgery, opportunities to redeploy family labour, and household food security. While hoe households typically cultivate 1–2 ha per year, DAP hirers cultivate 2 ha, households owning DAP cultivate 3–4 ha, tractor hirers cultivate about 8 ha, and households owning tractors cultivate more than 20 ha. Households relying on family labour for all their farming needs survive at the margin of subsistence. Households headed by women tend to be overrepresented among this group, partly as a result of the loss of assets typically associated with widowhood.

There is a natural ceiling of DAP ownership or tractor hire beyond which ordinary smallholders are unable or unwilling to pass. Tractor ownership is generally unattainable from farmers' own resources and, even where they have the financial capacity, they usually prefer to diversify into non-farm activities in order to spread their livelihood risks.

ROLE OF GOVERNMENT AND THE PRIVATE SECTOR

Governments traditionally played a pivotal role in introducing new sources of farm power to communities through providing information, developing the skills of operators, subsidizing inputs and credit, supporting veterinary services, and operating tractor-hire schemes. These activities were usually linked to the promotion of cash crops and much of this support was withdrawn during the process of structural adjustment. Recent support for farm power, specifically DAP, has been in parallel with initiatives to promote sustainable farming practices, such as reduced tillage and conservation agriculture.

While government has often acted as the catalyst, the ability of the private sector to follow through these initiatives is essential for their sustainable use. This is in terms of both private purchases of DAP and tractors by individuals and groups, and also the service sector. Without a skilled and well-equipped supporting infrastructure, existing DAP and tractor owners are extremely vulnerable to the withdrawal of government support. Similarly, the absence of an enabling policy environment curtails initiatives by would-be adopters, particularly given the weak state of agricultural profitability.

THE IMPACT OF HIV/AIDS AND OTHER DISEASES ON HUMAN-POWER RESOURCES

Humans remain the fundamental source of power in all farm-power systems in sub-Saharan Africa. On average, one-third of households in a community rely entirely on labour for primary tillage but this figure can be as high as 70 percent. Moreover, the ability to reap the benefits of mechanization depends on the availability of labour for all other operations.

However, the availability and productivity of the agricultural workforce in many parts of sub-Saharan Africa is under severe stress. In particular, HIV/AIDS will continue to have a devastating impact on agriculture. All five study countries in eastern and southern Africa are expected to lose 10–20 percent of their agricultural workforce to HIV/AIDS by 2020. In the absence of the widespread adoption of alternative cropping systems and practices, improved access to farm power for primary tillage and subsequent cropping activities (in particular, weeding) will be vital to overcoming constraints on the agricultural workforce.

OUTLOOK FOR FARM-POWER SYSTEMS IN THE STUDY COMMUNITIES

In the absence of a concerted effort by government, NGOs and the donor community to address some of the vulnerabilities of the farm-power systems, it is likely that communities where the farm-power base has been damaged (for example, former DAP communities in Ethiopia, Malawi and Zambia) will face a continuing state of collapse. The recovery of the DAP base is not technically feasible in Kokate Marachere (Ethiopia) because of the population pressure on land. In Malawi and Zambia, it is very likely that livelihoods in the mixed hand-power–DAP communities will deteriorate further as AIDS takes its toll on the agricultural workforce.

The extent to which the other communities are able to maintain their existing farm-power base and possibly achieve further mechanization beyond primary tillage will depend on the state of their economies and supporting infrastructure, the profitability of farming, and the buoyancy of the rural non-farm economy. Opportunities for agricultural growth may exist in countries where per capita incomes are reasonably high and growing (for example, Ghana and Uganda), there is effective demand for agricultural produce from a sizeable urban population (Nigeria), and an effective supporting infrastructure (United Republic of Tanzania). However, farmers need security (such as land tenure and good governance), the confidence to invest in agriculture, and the means to do so. The process of farm-power mechanization could act as a catalyst if it reduces costs and improves returns to investment in agriculture. This may lead to a more commercially-oriented agriculture sector that is more competitive on international markets. For households entirely reliant on their own labour, it is difficult to move beyond subsistence agriculture in arable crop-production systems. These farmers need alternative enterprises that are suited to their labour resources, or opportunities for redeployment in the non-farm sector.

RECOMMENDATIONS

Four recommendation domains have been identified to improve the contribution of farm power to smallholder livelihoods. They represent only one aspect of an integrated response that may be implemented over different time periods. In the immediate and short term, priority is placed on protecting livelihoods through reducing the vulnerability and ensuring the survival of households most at risk from losing their farm-power assets. In the medium to longer term, the profitability of agriculture is vital if farm-power mechanization is to contribute to enhancing livelihoods. Although the recommendations stem from a livelihoods analysis of 14 communities, they are considered to have a wider resonance. The study sites covered six of the principal farming systems in the region and the conditions

encountered are typical of those in much of sub-Saharan Africa.

The first priority is to enable the most vulnerable households (headed by widows and orphans) to survive in the short term by addressing their most pressing time and energy constraints, including household tasks, with immediate solutions: supporting labour brigades to maintain crop production in the seasons during severe sickness and following bereavement; and providing vouchers or grants to households to hire farm-power services and to buy technologies to ease their workloads.

The next priority is to ensure that the existing farm-power asset base remains intact and is not depleted during times of crisis. These recommendations are of most relevance to households that have already experienced a shock that places their asset base at risk, and are also relevant for households at risk from falling into this group. Activities include: prolonging the active and productive life of all household members, particularly people living with HIV/AIDS, through good nutrition, hygiene and basic health care, and promoting access to anti-retroviral drug treatment; developing skills in livestock husbandry, veterinary care and use of draught animals; reducing the threat of further losses to the asset base by providing access to short-term credit for household needs to avoid distress sales, encouraging communities to examine norms and practices which place livelihoods in jeopardy, supporting paralegals and encouraging succession planning; establishing a functioning infrastructure to ensure tools and equipment are maintained in working order; and strengthening local safety nets to enable households to overcome farm-power constraints through reciprocal arrangements, including mutual insurance schemes for oxen owners.

Once the asset base is secure, the next step is to maximize the potential of existing power sources by managing the power requirements of the farming system, and extending the range of uses of existing power sources. Activities include: spreading the labour peaks by growing crops with different seasons, rearing livestock, or engaging in different livelihood activities; spreading or reducing the demand for power inputs through adopting conservation agriculture; using labour-saving inputs, such as herbicides, or growing low labour-input crops; maximizing the value of labour input through the intensive cultivation of high-value crops; improving the quality, range and availability of hand tools; using single animals and non-traditional animals for draught power; extending the use of conventional power sources to secondary-tillage operations, post-harvest operations and transport; and participating in farm-power reciprocal arrangements with others in the community.

A longer-term activity is to support households and communities as they adopt new sources of farm power. Where the state of the economy and the profitability of farming are conducive, households may switch to draught animals or motorized power for primary tillage, either through hiring or owning them. They may also mechanize other operations, such as small-scale irrigation, crop harvesting, food processing and value-adding activities.

An integral part of all four recommendation domains is the need to strengthen farmers' livelihood asset base. Farmers need to be informed, educated and skilled and financially empowered to purchase, repair and maintain farm-power resources. Full attention should be given to ensure that the specific farm-power constraints of women, orphans and the poor are addressed. To underpin these initiatives at the household level, farmers require a supporting infrastructure capable of delivering inputs and services in a timely and efficient manner, and an enabling policy environment.

Chapter 1

Introduction

FARM POWER IN THE CONTEXT OF SMALLHOLDER LIVELIHOODS

Rural livelihoods in many parts of sub-Saharan Africa are under considerable stress. Economies and the political environment are experiencing a period of significant transformation, and poverty remains endemic. In many countries, a substantial proportion of the rural population lives below the poverty line, per capita incomes are stagnant, and life expectancy is often static at best. Agriculture remains at the core of rural livelihoods and has a major influence on livelihood outcomes. Farm power is a crucial input in the agricultural production process, and movement towards market-oriented production often require a greater application of power. Factors that reduce the availability of farm power (from human, draught animal and tractor sources) and compromise the ability to cultivate sufficient land have long been recognized as a source of poverty in the region (Iliffe, 1987). This is precisely the challenge facing many parts of sub-Saharan Africa at present.

Many of the gains made in mechanizing tillage practices during the twentieth century were reversed in the closing decades of the century. Structural adjustment left gaps in support for the smallholder sector, with the reduction or withdrawal of agricultural input subsidies and credit, disruption of produce markets, closure of government tractor-hire services, and weakened veterinary services. Simultaneously, the stock of draught animals was decimated in many communities by disease, drought, distress sales and theft. FAO estimated that, in the late 1990s, 65 percent of the cultivated area in sub-Saharan Africa was prepared by hand, 25 percent by draught animals, and 10 percent by tractor (FAO, 2003). In the next 30 years, FAO projects that, in the absence of change, much of the region will continue to be tilled by hand or draught animals. However, there will be some movement away from humans as the principal source of farm power.

At the very time when many communities have been reverting to tilling the soil by hand, the impact of the HIV/AIDS epidemic has begun

to take its toll on the agricultural workforce. The loss of labour has been compounded by the effects of improved access to primary education and persistent urban migration, drawing children and young adults away from farming. In an era of deteriorating markets for many cash crops, increasing claims on households' meagre financial resources, and the removal of support for purchasing farm inputs, many rural livelihoods are under severe strain. An understanding of the interaction between farm power and livelihood outcomes is central to enhancing smallholder livelihoods.

PURPOSE AND SCOPE OF THE STUDY

The purpose of this study is to increase the understanding of the role of farm power and its implications for smallholder livelihoods in selected farming systems in sub-Saharan Africa. Farm power embraces all forms of power inputs into agricultural production, ranging from human inputs, to animal traction and engine-driven technologies, together with their associated tools and implements. This study has concentrated on the power sources used for primary tillage, namely the activities associated with preparing the land prior to planting, either digging by hand or ploughing using draught animals or tractors. The study originally set out to examine the power inputs and implements relating to a range of field activities in crop production from land preparation through to harvest. In practice, however, in many farming systems in the region, the use of draught animals and tractors is confined almost exclusively to primary tillage while all other operations rely on hand power. Indeed, out of 11 study sites that use draught animal power (DAP), only one community uses DAP for weeding; and out of seven communities using tractors, only one farmer uses a tractor-drawn planter.

The study is innovative in adopting a livelihoods approach to conduct a detailed analysis of the use of farm power at community and household levels. Farm-power strategies

pursued by an individual household are determined not only by its asset base; they are also influenced by the farming system, the profitability of agriculture, the infrastructure and the state of the economy. Hence, a study of farm-power systems is well suited to the holistic and integrated approach provided by livelihoods analysis (DFID, 1998), giving rise to additional insights that would not necessarily emerge when using more conventional approaches.

Field studies were conducted in two communities in each of seven countries: Ghana and Nigeria in west Africa; and Ethiopia, Malawi, Uganda, United Republic of Tanzania, and Zambia in eastern and southern Africa. The communities were chosen to be broadly representative of sub-Saharan Africa. They cover six of the ten principal farming systems, with emphasis on the maize mixed system (the dominant food production system in east and southern Africa), and the mixed cereal–root and tree crop systems (typical of west Africa). The principal omissions were the root crop system (found principally in west and southern Africa) and the forest-based system (predominantly located in central and southern Africa) as both pose natural constraints to mechanized farming; the pastoral system; and smallholders in large-scale irrigation schemes. Some field sites included farmers with land under small-scale irrigation but they were not analysed separately.

STUDY METHODOLOGY

The in-country studies were conducted by two national consultants, combining the disciplines of agricultural engineering with either agricultural economics or extension (Annex 1). The Agricultural and Food Engineering Technologies Service (AGST), FAO, Rome, managed the study with inputs from the Agricultural Management, Marketing and Finance Service (AGSF), through its officer based in the FAO Regional Office in Accra.

A workshop for developing a common methodology for the fieldwork was attended by the country study teams and FAO staff. It was held in October 2001 at the International Livestock Research Institute (ILRI) in Addis Ababa. The fieldwork was undertaken between October and December 2001. More than 1 250 people participated in the fieldwork by attending community meetings and farm-power subgroup meetings, or participating in individual household interviews. Women accounted for

about one-third of the participants at each level of enquiry. Rapid rural appraisal methods were used to collect information at the community level and from different farm-power groups. Individual household interviews focused on livelihoods analysis and included households from each of the farm-power groups present in the community, stratified by the sex of the household head.

A second workshop shared findings from the fieldwork and identified opportunities for farm power and implements to promote smallholder livelihoods; it was held at the ILRI in Addis Ababa in February 2002.

STRUCTURE OF THE REPORT

This report presents the main findings arising from the in-country studies. The study is placed in the context of the principal economic and agricultural characteristics of the seven countries participating in the study, supported by an overview of the 14 field sites (Chapter 2). Chapter 3 presents the key developments in farm-power systems experienced in the twentieth century as communities moved from total reliance on hoe cultivation to the use of DAP and tractors, with varying degrees of sustainability. The field sites have been grouped according to their predominant power source, and this provides the basis for the livelihoods analysis of different farm-power systems (Chapter 4). Chapters 5 and 6 focus on the livelihoods systems of individual farm-power groups, reviewing their assets base, livelihood strategies and outcomes. The report concludes with a summary of the main findings and recommendations for strengthening the contribution of farm power to smallholder livelihoods (Chapter 7).

Annex 2 presents an overview of the conceptual framework, adapting the livelihoods approach to analyse farm-power systems, together with details of the field methods. It also contains detailed case studies of the three main farm-power systems and reviews the social mechanisms used to mobilize farm-power resources in different communities. The full findings and site-specific details may be found in the individual country reports, as listed in the References. Supporting data are presented in Annex 3.

Chapter 2

Country and field-site characteristics

This chapter sets the study in context, reviewing some of the key characteristics of the economies and agriculture sectors of the seven countries participating in the study and specific field-site characteristics. Further details about individual field sites are presented in the case studies in Annex 2.

NATIONAL ECONOMY

The study includes the two most populous countries in sub-Saharan Africa (Nigeria and Ethiopia) and some of those with much smaller populations (Malawi and Zambia) (Table 1). Together they are among the poorest countries in the region with only Ghana exceeding the regional average annual per capita income of US\$1 600. Although most economies grew at about 3 percent a year or more in the 1990s, none matched this growth in per capita incomes in the same period. Indeed, income per head declined in Nigeria and Zambia, and remained static in the United Republic of Tanzania. Poverty is widespread and more than two-thirds of the populations of Nigeria, Malawi and Zambia survive on less than US\$1 per day.

In the last two decades, most of these countries

have witnessed a fundamental restructuring of the role of government within their economies. Exchange rates, interest rates and markets have been liberalized; trade restrictions removed; many state-owned industries privatized; government services decentralized and downsized; and private sector investment encouraged. In some areas, economic activity has also been disrupted by civil war, and the collapse of markets and prices for major commodities (agriculture and minerals).

All countries are in the lowest quartile of ranking of the Human Development Index (HDI), which is prepared annually by the United Nations Development Programme (UNDP). Ghana achieved the highest HDI ranking among the study group, reflecting its relatively high per-capita gross domestic product (GDP), high literacy rates and reasonable life expectancy, whereas Malawi and Ethiopia were ranked among the weakest.

AGRICULTURE SECTOR

The significance of the agriculture sector varies considerably. In Ethiopia, Malawi, Uganda and United Republic of Tanzania, agriculture is the backbone of the economy, generating more

TABLE 1
National economies

	Ethiopia	Ghana	Malawi	Nigeria	United Republic of Tanzania	Uganda	Zambia
Total population (millions) 2000 ¹	63	19	11	114	35	23	10
Average annual growth rate in population (%) 1975–2000 ¹	2.6	2.7	3.1	2.9	3.1	3.1	2.9
GDP per capita US\$ (PPP US\$) 2000 ¹	668	1 964	615	896	523	1 208	780
Average annual growth rate in total GDP (%) 1990–2000 ²	4.7	4.3	3.8	2.4	2.9	7.0	0.5
Average annual growth in per capita GDP (%) 1990–2000 ¹	2.4	1.8	1.8	-0.4	0.1	3.8	-2.1
Incidence of poverty (% population below US\$1 a day (1993 PPP US\$) 1983–2000 ^{1, 3}	31	45	65	70	20	no data	64
Adult literacy rate (aged 15 and above) 2000 ¹	39	72	60	64	75	67	78
Country ranking by HDI, 2002 (out of 173 countries) ¹	168	129	163	148	151	150	153

Notes:

PPP = purchasing power parity

Sources:

¹ UNDP (2002).

² World Bank (2002).

³ National Statistical Office (1998).

TABLE 2
Changing role of agriculture in the economy

	Ethiopia	Ghana	Malawi	Nigeria	United Republic of Tanzania	Uganda	Zambia
Contribution by agriculture to GDP (% total GDP) 1998 ¹	50	35	36	32	46	45	17
Average annual growth rate in agriculture GDP (%) 1980–1990 ²	0.2	1.0	2.0	3.3	no data	2.1	3.6
Average annual growth rate in agriculture GDP (%) 1990–2000 ²	2.1	3.4	7.6	3.5	3.2	3.7	3.9
Percentage of workforce engaged in agriculture ³	83	57	84	35	81	81	70
Population residing in rural areas (% total population) 2000 ²	82	62	85	56	72	86	56
Population residing in urban areas (% total population) 2000 ²	18	38	15	44	28	14	44
Rural population density (people per km ² of arable land) ²	520	325	458	250	640	368	105

Sources:

¹ World Bank (2000).

² World Bank (2002).

³ FAO (2001).

than 35 percent of GDP and employing more than 80 percent of the workforce; and at least 70 percent of the population live in rural areas (Table 2). In Ghana and Nigeria, agriculture is still significant but no longer the dominant sector, generating one-third of GDP and employing less than 60 percent of the workforce; about 40 percent of the total population live in urban areas. The contribution by agriculture to GDP is least significant in Zambia owing to the dominance of the mining sector; nevertheless, 70 percent of the workforce still work in agriculture. In all the study countries, agricultural GDP grew faster in the 1990s than the preceding decade and, in several places, the rate of growth in the agriculture sector exceeded overall growth in the economy (most

notably in Malawi, Zambia and Nigeria).

Structural reform has had a dramatic impact on the viability of rural livelihoods. Without access to seasonal credit or subsidies, the majority of smallholders are unable to purchase fertilizer. The withdrawal of government from trading in agricultural inputs and produce marketing has made it more difficult for farmers in remote areas to access markets and services. Produce prices tend to be variable and low, particularly immediately after harvest when many smallholders are obliged to sell a proportion of their crop in order to generate urgently needed cash.

HIV/AIDS is a major challenge facing the agriculture sector in many countries in sub-Saharan Africa. To date, the impact of the disease has been

TABLE 3
Health dimensions

	Ethiopia	Ghana	Malawi	Nigeria	United Republic of Tanzania	Uganda	Zambia
People living with HIV/AIDS (% aged 15–49) 1999 ¹	10.6	3.6	16	5.1	8.1	8.3	20
Losses in agricultural workforce due to HIV/AIDS by 2000 (%) ²	4.9	no data	5.8	2	5.8	12.8	3.5
Losses in agriculture as % of losses in total labour force, 2000 (%) ²	82	no data	83	33	80	80	69
Losses in agricultural workforce due to HIV/AIDS by 2020 (%) ²	9.5	no data	13.8	7	12.7	13.7	16.6
Losses in agriculture as % of losses in total labour force, 2020 (%) ²	72	no data	74	18	70	68	57
Life expectancy (years) 1970–75 ³	42	50	41	44	47	46	47
Life expectancy (years) 1995–2000 ³	45	56	41	51	51	42	41

Sources:

¹ UNDP (2001).

² FAO/ILO (2002) unpublished data.

³ UNDP (2002).

markedly lower in west Africa than other parts of the continent in terms of the proportion of adults living with HIV/AIDS and the relatively small loss borne by the agricultural workforce (Table 3). In eastern and southern Africa, the disease has already started to affect the agriculture sector. In these regions, it is estimated that at least 70 percent of the total losses experienced by the workforce by 2000 were borne by agriculture. The toll of the disease is reflected in the extremely low (and sometimes falling) life expectancy of about 40 years.

Despite the general lack of profitability in agriculture, many countries rely on the sector to play strategic and multiple roles in securing economic growth and development. The sector is expected to grapple with the challenges of environmental degradation, population pressure, persistent poverty, the HIV/AIDS epidemic, and urban migration (particularly among the young), while simultaneously moving communities towards food security and commercial production, providing the base for development in the manufacturing sector through crop processing and value-added activities, and generating export revenues.

There is a crucial role for the state to play in terms of ensuring an enabling environment for business and growth, for example, by providing infrastructure (such as roads and markets), regulating traders, and providing market information and extension and advisory services.

It also has to be alert to the actual and impending impacts of HIV/AIDS on: the institutional capacity of the extension service and ministries of agriculture, livestock, forestry and fisheries; the relevance of the policy environment; and the productive capacity of the agricultural workforce.

FIELD-SITE CHARACTERISTICS

The 14 field sites capture both the diversity as well as some of the similarities found in the farming and livelihood systems of sub-Saharan Africa. In terms of diversity, the sites range from the highlands of Ethiopia (2 600 m above sea level), to Kapchesombe on the slopes of Mount Elgon in Uganda, to lakeshore communities adjacent to Lake Malawi and Lake Kariba (Zambia), to a coastal community in Ghana. Most field sites experience an annual rainfall of about 1 000 mm; more arid sites include Kacaboi in eastern Uganda and Msingisi in eastern United Republic of Tanzania (600–900 mm per year), and Simupande in southern Zambia (less than 500 mm per year). Population density varies considerably from fewer than 100 people per km² in many of the study communities to 270 people per km² (Ojo, Nigeria) and 350 people per km² (Kokate Marachere, Ethiopia).

The farming systems covered by the study vary from the cereal–root crop mixed systems and tree crop systems of west Africa, to the highland mixed and highland perennial systems of Ethiopia,

TABLE 4
Selected farming systems in sub-Saharan Africa

Farming system	Distribution in sub-Saharan Africa	Land area (percentage of region)	Agricultural population (percentage of region)	Field sites
Highland perennial	Humid areas in Ethiopia, Uganda, Rwanda, Burundi	1	8	• Kokate Marachere, Ethiopia
Highland mixed cereals-roots	Temperate highland areas in Ethiopia, Eritrea, Lesotho; also Kenya, Angola, Nigeria, Cameroon	2	7	• Habru Seftu, Ethiopia
Cereal–root crop mixed	Dry subhumid areas from Guinea to Ghana, Nigeria and northern Cameroon, Zambia, Malawi and Mozambique	13	15	• Babatokuma, Ghana • Gyangyanadze, Ghana • Sanchitag, Nigeria
Tree crop/cereal–root crop mixed	Humid areas from Côte d'Ivoire to Ghana, Nigeria and Cameroon to Gabon, Congo and Angola	3	6	• Ojo, Nigeria
Maize mixed	Dry subhumid plateau and highland areas (800–1 500 m asl); western Cameroon, Nigeria, Kenya, Uganda, United Republic of Tanzania, Zambia, Malawi, Lesotho, Swaziland, Zimbabwe, South Africa	10	16	• Lodjwa, Malawi • Mwansambo, Malawi • Mvomero, United Republic of Tanzania • Msingisi, United Republic of Tanzania • Kacaboi, Uganda • Kapchesombe, Uganda • Nteme, Zambia
Agropastoral millet/sorghum	Semi-arid areas in Senegal, Mali, northern Nigeria, Sudan, southern Zambia, Zimbabwe, Kenya, United Republic of Tanzania	8	9	• Simupande, Zambia

Source: FAO/World Bank (2001).

to the maize mixed farming system typical of eastern and southern Africa, and the agropastoral millet/sorghum system found predominantly in southern Africa (Table 4). The principal cash crops vary accordingly. In west Africa, the main cash crops are: yams, maize, cassava, cashew, oil-palm, cocoa, citrus and rice. In eastern and southern Africa, the main cash crops are maize, wheat, groundnuts, beans, rice, coffee, sunflower, cotton, sweet potatoes and vegetables.

Reflecting the very small proportion of irrigated land found in sub-Saharan Africa generally, only six field sites in three countries have land under informal irrigation and no formal irrigation schemes were encountered during the study. Farmers in Nigeria practise recession agriculture adjacent to rivers and streams on residual floodwaters (*fadama*). In Malawi and Zambia, valley bottoms or depressions that retain moisture and form natural drainage systems, called *dambos*, are utilized for dry-season farming.

Poultry and goats are the most common livestock kept for both home consumption and sale. In addition to farming, communities engage in a wide range of non-farm livelihood activities, which are usually demarcated along gender lines. Remittances from relatives living and working elsewhere are commonplace.

Further details about the field sites are presented in the case studies in Annex 2 of this report.

Chapter 3

Developments in farm-power systems

The twentieth century witnessed changes in the source of farm power for primary tillage. Many communities moved from total reliance on hand power to using draught animals and tractors to varying degrees. Modest changes also occurred within each power source in terms of the quality and diversity of the tools and implements in use. These two themes are explored in this chapter. It should be noted that the observations are specific to the field sites and do not necessarily reflect experiences elsewhere in each country.

CHANGES IN SOURCES OF FARM POWER FOR PRIMARY TILLAGE

An enduring feature of any study of farm power in sub-Saharan Africa in the twentieth century is the dominant and persistent use of hand power for primary tillage. In the early 1900s, nearly all of the study sites relied on humans as their sole source of farm power (Table 5). The exceptions

were both sites in Ethiopia and one in Zambia where draught animals were already an integral part of the farming system. During the century, many communities experimented with alternative power sources and their experiences of farm mechanization may be divided into two phases. The first phase was one of expansion followed by a brief period of stability; this covers the period when DAP and tractors were first introduced into rural communities, and it reached its peak in the 1960s and 1970s.

The second phase was generally one of contraction. This commenced in 1980 in some communities when the new power source proved unsustainable in the face of drought, insecurity, and low farm profitability. Many households reverted to their previous sources of power. Other communities sought sustainability by introducing draught animals to replace tractors (the sites in Ghana and United Republic of Tanzania). At the two sites in

TABLE 5
Changes in farm-power sources for primary tillage during the twentieth century

Field site	First era: expansion (switching to)			Second era (switching from)		
	Hand	DAP	Tractor	Tractor to hand	Tractor to DAP/ hand	DAP to hand
				No change		
Habru Seftu, Ethiopia	-	pre-1900	-	-	-	-
				Change sustained		
Sanchitag, Nigeria	pre-1900	-	1984	-	-	-
				Seeking sustainability		
Msingisi, United Republic of Tanzania	pre-1900	-	1967	1983	1988	-
Mvomero, United Republic of Tanzania	pre-1900	-	1972	-	1990	-
Babatokuma, Ghana	pre-1900	-	1972	-	1992	-
				Contraction		
Gyangyanadze, Ghana	pre-1900	-	1970	no date	-	-
Ojo, Nigeria	pre-1900	-	1985	1995	-	-
Simupande, Zambia	pre-1900	1965	1970	-	1985	1995
Nteme, Zambia	pre-1900	pre-1900	1965	-	1990	1980
K Maracherere, Ethiopia	pre-1900	pre-1900	-	-	-	1985
Lodjwa, Malawi	pre-1900	1942	-	-	-	1995
Mwansambo, Malawi	pre-1900	1968	-	-	-	1995
				Contraction and partial/full recovery		
Kacaboi, Uganda	pre-1900	1910	1955	-	1980	1986-92
Kapchesombe, Uganda	pre-1900	1950	1960	-	1985	1980

Source: Based on historical timelines prepared by communities at field sites.

Uganda, the power base declined but DAP resources subsequently recovered. Only in Sanchitagi (Nigeria) did the new power source proved sustainable.

PHASE OF EXPANSION IN FARM MECHANIZATION

Three patterns of mechanization may be identified during the expansion phase:

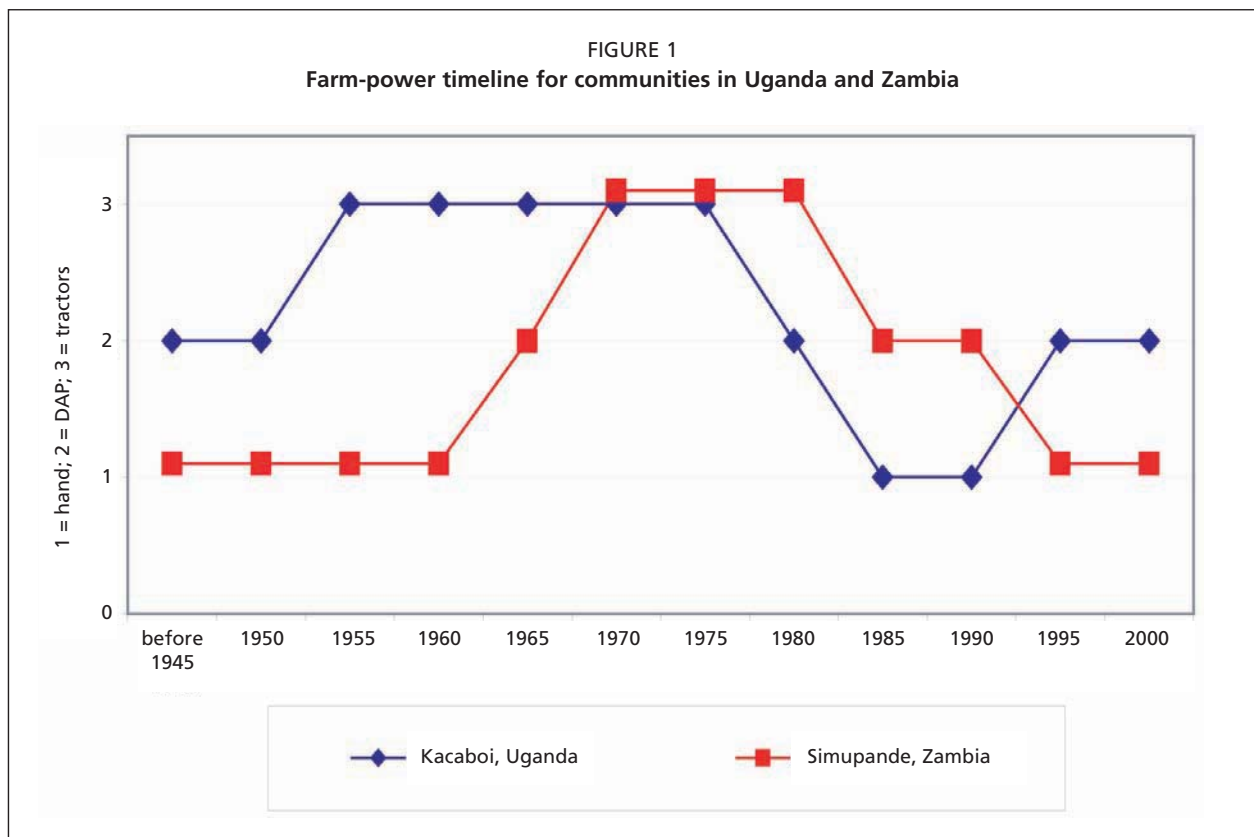
- the classic scenario is represented by the study communities in Uganda and Zambia, moving from hand power to DAP in the early part of the century and onto tractors in the second half of the century (Figure 1);
- some communities (in Ghana, Nigeria and United Republic of Tanzania) moved straight from hand power to tractors in the 1970s and 1980s (Figure 2);
- communities in Malawi moved to DAP in the middle part of the century, but this was not followed by the introduction of tractors and even the use of DAP proved unsustainable for many households (Figure 3).

DAP mechanization

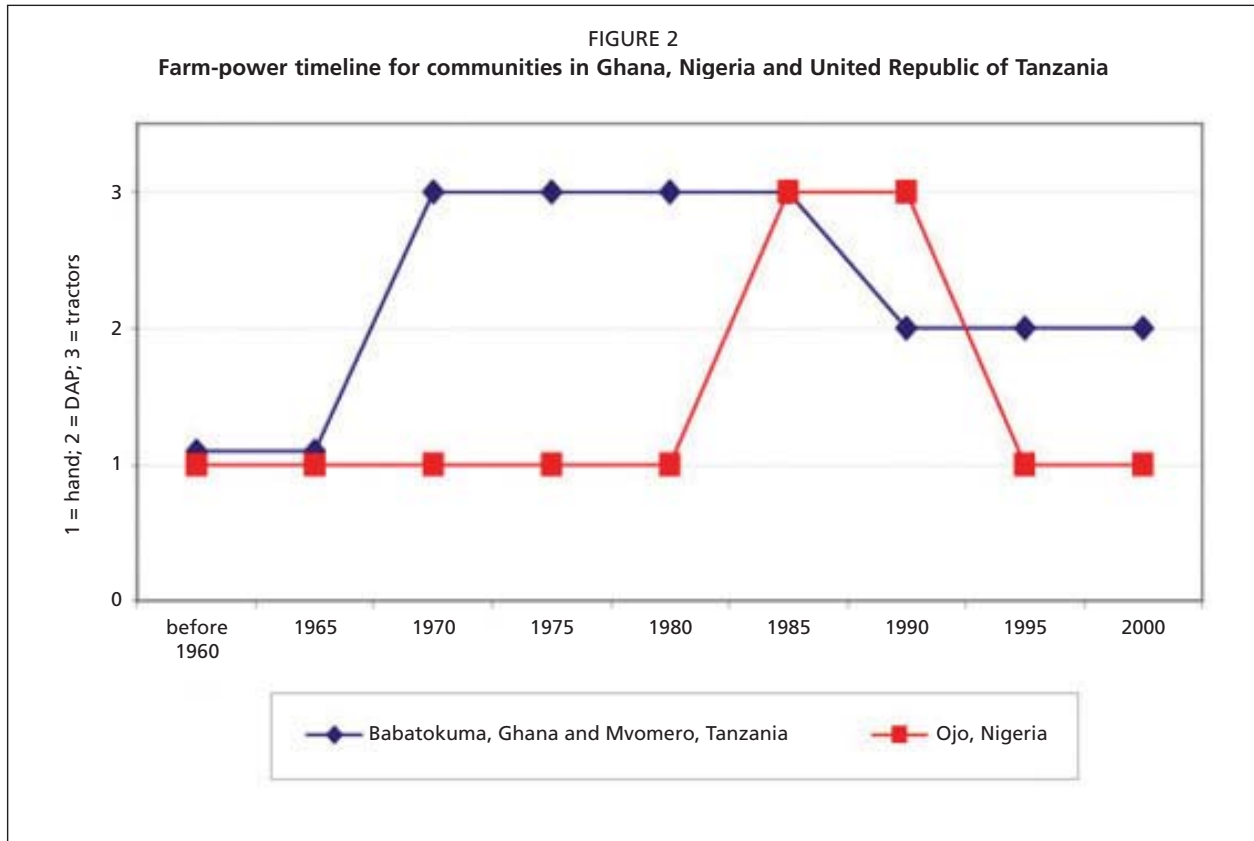
The first wave of DAP-based mechanization occurred in the early years of the twentieth century, corresponding with the arrival of European settlers

and the introduction of draught animals. For example, in Kacaboi (Uganda), horses and oxen were introduced together with the Ransomes ox plough in an initiative to expand the area under cotton – a cash crop produced for export. Table 6 presents a historical review of farm power and mechanization in Kacaboi.

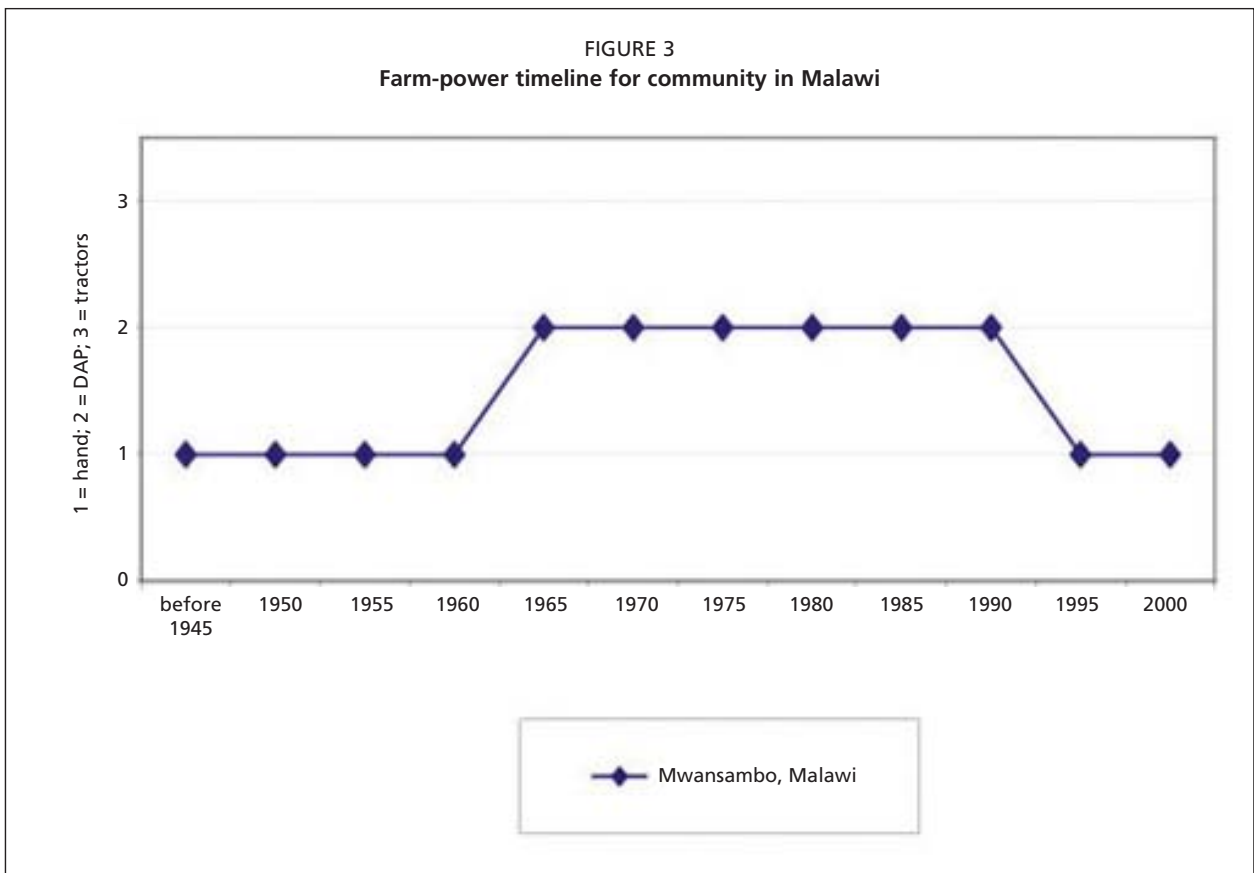
In the second wave (from the 1940s to the 1970s), the use of DAP at sites in Uganda, Malawi and Zambia was stimulated by the introduction of ox-drawn ploughs and other implements from neighbouring countries (Kenya, Rhodesia – now Zimbabwe – and South Africa, respectively). In Malawi, the Government encouraged DAP by opening DAP training centres and providing loans to purchase animals and implements. In Kapchesombe (Uganda) a government district farm institute was established to demonstrate and train farmers in the use of DAP implements. In this period, agricultural production was generally profitable, households were generally food secure, and farmers earned enough to buy implements, as well as improve their standard of living. DAP farmers cultivated larger areas than households relying on hand power and grew cash crops (such as groundnuts in Malawi, and coffee and wheat in Uganda). They were also able to generate additional income through DAP-hire and haulage services.



Note: Data represent year of introduction or decline of power source (to the nearest five years).
Source: Based on historical timelines prepared by communities at field sites.



Note: Data represent year of introduction or decline of power source (to the nearest five years).
Source: Based on historical timelines prepared by communities at field sites.



Note: Data represent year of introduction or decline of power source (to the nearest five years).
Source: Based on historical timelines prepared by communities at field sites.

Tractor mechanization

Similarly, the introduction of tractors was closely linked to drives to accelerate cash-crop production and increase the area under cultivation. In some instances, governments promoted tractors by building on earlier initiatives that had promoted DAP (Uganda and Zambia). In other communities, the private sector was the prime mover in offering tractor-hire services (United Republic of Tanzania).

The earliest record of a tractor demonstration among the study sites was in the mid-1950s at an agricultural show in Kumi town in Uganda (Table 6). Uptake was slow; farmers were uncertain about benefits of tractor use and

were concerned about soil degradation. The Government subsequently introduced a tractor-hire service in 1960 to stimulate the production of cotton and millet. In Zambia in 1965, government hire services were introduced in Nteme to increase maize production while hire services were introduced in Simupande through the Tobacco Board of Zambia to promote tobacco production (by facilitating dry-season ploughing and offsetting labour bottlenecks at the beginning of the season). Tractors were introduced in Gyangyanadze (Ghana) after the Government cleared large tracts of land under a national agricultural mechanization drive in 1970. A tractor-hire scheme was based in the district capital of Babatokuma in Ghana in the

TABLE 6
Historical developments in farm power at Kacaboi, Uganda

Timeline	Change in use of farm power	Reasons for change	Impact on agricultural production	Impact on livelihoods
1900s	Introduction of steel-made hand tools through introduction of smelting and rural blacksmithing. Demonstrations and training in new technologies.	Traditional wooden chisel-shaped tools for digging holes and weeding were labour intensive and of low productivity.	Increased agricultural production and productivity.	Reduced drudgery, reduced labour needs and improved lifestyle.
1910–1950	Work animals (horses and oxen) introduced to district with ox plough. Hoe with metal blade and wooden handle also introduced.	Drive to expand area under cash crop (cotton) stimulated change from low-productivity hand tools.	Increased area cultivated and productivity (especially cotton and millet).	Reliable source of cash income improved purchasing power of households. Some started sending children to school.
1953	First tractor demonstration at an agricultural show in Kumi town.	Continued drive for cash-crop production and export. Low productivity of hand tools and DAP.	Adoption and impact was very slow because communities were uncertain of benefits of tractors and feared they would spoil the land.	No impact on livelihoods.
1960	Government tractor-hire service introduced in district.	Government drive to boost agricultural production and area under cultivation.	Increased area cultivated and productivity (especially cotton and millet).	Improved food security and household incomes.
1960–65	DAP planters, weeders and wooden ox-carts demonstrated and given as prizes to best farmers.	Weeding was major bottleneck in production.	Low usage because of lack of appropriate weeder/planter and difficulties accessing them.	No impact on livelihoods.
1975–1980	Decline in use of tractors in area.	Expensive to hire. Poor maintenance and repair facilities. Few spare parts and few operational tractors.	Area under cultivation and productivity decreased as farmers reverted to hand hoe.	Livelihoods deteriorated.
1985–87	Government tractor-hire service abolished in district and throughout the country.	Lack of transparency by hire-service managers and farmers. Tractors not utilized efficiently. Difficulties accessing spare parts. High service and repair costs.	Area under cultivation decreased.	Livelihoods deteriorated.
1986–1992	Massive cattle loss through rustling in the area. HIV/AIDS epidemic started having an impact on productivity.	Civil strife in area.	Drastic decline in agricultural production, productivity and incomes. Famine largely caused by cassava mosaic virus.	Widespread poverty, disease and death. Poor living standards. Limited education.
1990–2001	Restocking of cattle, initially through Presidential Commission for Teso and later by individuals and NGOs. By 2001, DAP fully recovered.	Recognition of pivotal role of DAP in the area. Need to improve household livelihoods.	Agricultural production recovering.	Improvements in household food security.

Source: Odogola and Olaunah (2002).

TABLE 7
Historical developments in use of tractors at Sanchitagi, Nigeria

Milestones	Change in use of farm power	Impact on agricultural production	Impact on livelihoods
1984: first tractors used	Tractor introduced by Government. Extension agents created awareness of advantages of using tractors. 5% HHs switched from manual to mechanized land preparation.	<ul style="list-style-type: none"> • saved labour and time • increased area cultivated from 1–3 ha to 4–8 ha per HH • increased yield • fewer weeds 	<ul style="list-style-type: none"> • increased income • increased prestige of tractor users • less fatigue • improved well-being
1986: farmer cooperative group purchased first tractor in village	Government introduced subsidy on tractor purchase and encouraged extension workers to assist farmers to form groups to enable easier access to farm inputs on credit. 10% HHs used tractors for land preparation.	<ul style="list-style-type: none"> • increased area cultivated to 8 ha per HH • increased yield • reduced fallow period to 3 years • melon and groundnuts introduced as cash crops 	<ul style="list-style-type: none"> • increased income • less farm work for men • tractor ownership was a status symbol
1990: cooperative group purchased two more tractors	Cooperative group purchased additional tractors to cope with demand of group members and undertake timely land preparations.	<ul style="list-style-type: none"> • increased area cultivated to 20 ha per HH using tractors • more timely planting • could not cope with weeding manually, resulting in reduced yield per ha • increased total output 	<ul style="list-style-type: none"> • increased self-confidence • food security • improved well-being • more processing and transporting by women
1995: individuals purchased tractors	As a result of being able to increase area under cultivation and earn higher incomes, some farmers were able to purchase their own tractors. More than 50% HHs used tractors for land preparation and transporting produce home.	<ul style="list-style-type: none"> • decreased shifting cultivation • fallow periods of 2–3 years • increased area cultivated to 100 ha per HH owning tractors • more cereals and legumes grown • increase in food-crop production 	<ul style="list-style-type: none"> • improved sources of livelihoods • more time spent in off-farm activities • increased well-being • processing equipment purchased for some crops
2000: off-season tractor-hire services commenced	Diversified tractor usage into off-season activities such as haulage (farm produce, sand, fuelwood and water). Ten tractors operating in community.		<ul style="list-style-type: none"> • utilize tractors throughout year • save labour and time in haulage activities • women no longer transporting fuelwood and farm produce on their heads

Source: Ajibola and Sinkaiye (2002).

early 1970s in a drive to increase food production, produce raw materials for local industries, and achieve import substitution. However, the centre was not readily accessible for farmers in Babatokuma (16 km away) and it was only after an individual in the community bought a tractor that their use increased.

Tractors were introduced to the Tanzanian field sites in the 1970s by farmers purchasing tractors for their own use and offering hire services to others. Tractor use at Mvomero accompanied the introduction of cotton as the main cash crop. Farmers hired tractors in order to increase their cultivated area and the process was facilitated by the availability of cheap labour for weeding. Hiring tractors was dependent on the profitability of cotton production and, at its peak in the early 1980s, it is estimated that 80 percent of households in Mvomero hired tractors (with tractors coming from neighbouring areas in order to satisfy demand). This proportion had halved by the close of the century.

Only Sanchitagi (Nigeria) has experienced a sustained change in farm mechanization. Tractors are used by more than 40 percent of the households and, owing to the significantly larger areas cultivated by households using

tractors than hoe cultivators, almost all of the cultivated land is prepared by tractor. The ability of the private sector to follow through the government initiative to introduce tractor-hire services has been a crucial factor in securing their sustained use. This was achieved by purposive state interventions such as extension agents encouraging the formation of farmer groups to purchase tractors, and the provision of subsidies on tractor purchases and credit sales (Table 7). The community was also well located to take advantage of opportunities for training tractor drivers and tractor repair services. However, the substantial rise in prices for tractors and implements experienced in recent years is challenging the long-term outlook for tractor power.

PHASE OF CONTRACTION IN FARM MECHANIZATION

Twelve of the 14 communities covered in the study were unable to sustain the use of their new sources of farm power. The contraction phase for tractors commenced in the early 1980s, 20 years or so after they had first been introduced into various communities. Generally, DAP was used for a longer period but its collapse also started in the 1980s.

Decline in tractor use

The decline in the use of tractors and tractor-hire services was attributed to the poor performance of the economy, weak infrastructure and poor management. Under government hire schemes, the area cultivated per machine was small, fixed costs were high, and the service was usually subsidized. The situation was often compounded by a lack of basic infrastructure to support mechanized technologies. This resulted in expensive repairs, poor maintenance and repair facilities, and difficulties in obtaining spare parts. Government support for tractor services proved unsustainable. From the 1980s (Uganda and Zambia) through to the 1990s (Ghana and Nigeria), government-operated hire schemes were closed and support for private-sector tractor purchases and hire services gradually abolished.

Private-sector providers were also afflicted by the challenging economic times of structural adjustment and currency devaluation. In the United Republic of Tanzania, tractor owners increased hire charges in order to cover the increased cost of imported items (machinery, fuel and spare parts). However, when coupled with low farm-produce prices, many farmers were no longer able to afford hire services. The experiences in Nigeria were similar where, in the 1990s, there was more than a twentyfold increase in the cost of tractors, and a tenfold increase in the cost of implements. In Ghana, it was estimated that tractor-hire charges cover only 63 percent of the full economic cost for ploughing, representing an implicit subsidy from tractor owners to hirers of 37 percent.

Generally, the failure of tractor services resulted in the reduction of the area cultivated as communities reverted to draught animals and hand power. In some communities (Babatokuma in Ghana, and Mvomero and Msingisi in the United Republic of Tanzania), DAP was encouraged as a more sustainable and affordable option to tractor power for smallholder farmers. These initiatives were implemented through awareness campaigns, extension services, operator training, and loans supported by government, non-governmental organizations (NGOs), universities and donor-funded projects (for example, International Fund for Agricultural Development (IFAD) and FAO).

Decline in DAP use

The severe drought in Ethiopia from 1984 to 1986 destroyed the livestock population in the southern

highlands, while cattle diseases, particularly East Coast fever (*Theileriosis*), decimated the livestock population on the plateau in southern Zambia and throughout Malawi. The impact of disease was compounded by an absence of appropriate animal health-care facilities and practices. In addition, cattle thefts have been common in Zambia and Malawi, and cattle rustling by the Karamojong has been widespread in eastern Uganda. Poverty has also contributed to the decline in livestock numbers, forcing farmers to sell cattle and implements in order to generate cash (as noted in Simupande, Zambia, and Lodjwa, Malawi). With market liberalization and the withdrawal of government credit to support the purchase of draught animals and implements, it is now more difficult for farmers to either establish, maintain or expand a DAP base.

Governments, NGOs and individuals have taken steps to restock certain areas. In Kacaboi (Uganda), the number of draught animals had fully recovered by 2000. In Zambia, the Government introduced donkeys in Nteme as an alternative to oxen in the mid-1990s. However, donkeys are also in short supply and the area is now facing a critical shortage of DAP.

At other sites, efforts have been made to help communities to adjust to their new power base. In Kokate Marachere (Ethiopia), international NGOs, such as World Vision International-Ethiopia, have introduced agricultural packages, including seeds and hand tools, to encourage farmers to cultivate their plots using hand tools rather than depending on DAP.

TECHNOLOGICAL DEVELOPMENTS

Developments in hand-tool technology

In the last century, there were two changes in farm hand tools: improvements in the quality of materials used to make the tools; and increased diversity in the range of tools. For example, at Kacaboi (Uganda) the community used wooden chisel-shaped tools for digging holes and weeding prior to 1900. At the beginning of twentieth century, tools made from steel (hoes, machetes and axes) were introduced, supported by the development of local smelting and rural blacksmithing businesses. At the neighbouring field site in Kapchorwa, it was not until the 1950s (when the hunting and gathering community settled down to sedentary agriculture) that hand hoes started to replace traditional implements

made from wood and the ribs of animals.

At Lodjwa (Malawi), the shift from wooden implements to hoes made locally in traditional furnaces occurred in 1915. This was followed by the importation of lighter and more durable tools, initially from Europe and India in the 1920s, and from Rhodesia (now Zimbabwe) in the 1960s. These hoes were easier to handle and enabled farmers to cultivate larger areas. At Mwansambo, the shift from traditional hoes to more durable manufactured hoes occurred in the 1960s. The traditional hoes were heavy, small and became blunt easily. The “Edward” hoes from the United Kingdom were more durable but also heavy and they were later replaced by durable light hoes made in-country.

While all sites have experienced improvements in the basic range of tools, not all have been exposed to a wide range of hand tools. There tends to be more diversity at sites where hoe cultivation has been a predominant feature of the farm-power system. For example, farmers in a traditional DAP community (Nteme, Zambia) commented that although they understood that different designs of hoe were available elsewhere (in terms of the size and shape of the blade, and the length of the handle), they still used one traditional hoe. In contrast, in Sanchitagi in Nigeria (where 60 percent of households rely on hand power for primary tillage), farmers have a choice of five hoes, each designed for a specific task. Since the 1960s, the community has moved from using a similar hoe (with only small adaptations in size) for all operations, to five hoes: a large hoe with wide blade for making yam ridges and heaps; a small hoe with a narrow blade (almost triangular) for planting; a medium-sized hoe with a sharp-edged blade for weeding; a light hoe with a short handle for children; and a special hoe for use in the *fadama*. Nevertheless, even in communities where developments and adaptations have taken place to better suit the range of hand tools to specific uses, hoes are invariably fitted with short wooden handles that affect the standing posture of users (Box 1).

The predominantly hand-power community of Ojo in Nigeria (where 90 percent of households use hand power for primary tillage) also has a diverse range of hand tools. In addition to three different hoes, there are three different cutlasses: a large one for felling trees; a medium-sized one for weeding; and a

BOX 1

Comments by hoe cultivators, Sanchitagi, Nigeria

“Our postures and palms are different from the others. We can no longer stand up straight. Our palms always have sores and our fingers are curved instead of straight. There are aches and pains in our backs and using hand hoes causes pain and fatigue. Those of us using the hoe age faster than those using tractors. We can only work a little land at a time; hence we remain poor.”

Source: Ajibola and Sinkaiye (2002).

small one for harvesting. In the 1940s, a sickle was introduced to replace the small cutlass for cutting grass for thatching roofs. In the 1960s, a pickaxe was introduced (together with cocoa) for digging holes for cocoa seedlings; it is also used for land clearance and harvesting yams. Two innovations have been introduced to the community by migrant labour: a long-handled tool for harvesting tree crops (in the 1930s by Nigerians returning from Côte d’Ivoire); and a large hoe for land preparation for tubers (in the mid-1990s by seasonal labourers from the Middle Belt of Nigeria). Knapsack sprayers, originally introduced in 1980, have undergone several refinements.

The community at Kokate Marachere (Ethiopia) recorded similar developments. In the 1970s, the pickaxe replaced the hoe to enable easier and deeper cultivation of virgin land, and the *machete* replaced the small axe for more effective weed control. In the mid-1980s, the traditional wooden two-fingered hoe was replaced by a metal three-fingered hoe. A flat hoe was also introduced that was better suited than the traditional hoe for digging new land, and resulted in less soil erosion. It was also more comfortable to use (requiring less bending over) than the traditional hoe. A modern, Spanish-made sickle was introduced in the 1980s. It requires less energy and time than the local sickle, hence crops can be harvested more quickly, thereby reducing harvesting losses. Many of these changes have been introduced by World Vision International-Ethiopia, which was working in the area following the drought of the mid-1980s.

Developments in DAP technology

There have been few changes in the technologies associated with the use of draught animals at the field sites. The main DAP implements are the mould-board plough and ox cart. A persistent feature of DAP cultivation in the region has been its almost exclusive use for initial land preparation despite numerous initiatives to broaden the range of operations performed by draught animals. For example, planters and weeders were introduced in Simupande (Zambia) in the 1980s but they are rarely found there today. In Kacaboi (Uganda), secondary-tillage technologies were available in the 1960s focusing on cotton production. However, when cotton was abandoned in the late 1970s, the technologies also disappeared. Ridgers are common in Malawi but the absence of a suitable weeder has hindered farmers in Lodjwa from using DAP for weeding. Farmer groups in Mvomero (United Republic of Tanzania), have received multipurpose tool bars and secondary-tillage equipment (cultivators and ridgers) through the FAO Special Programme for Food Security, but they have not used the equipment for weeding. Farmers have given various reasons for this: DAP planters are not available (although they are not necessary to sow in lines); animals have not been trained for weeding; and intercropping hinders DAP weeding. One farmer in Nteme (Zambia) has a DAP ripper for reduced tillage acquired while acting as a contact farmer under the Soil Conservation and Agro-Forestry Extension (SCAFE) project in the area.

In Ethiopia, where draught animals have been used for thousands of years, the traditional wooden plough with a small metal share (*maresha*) persists as the principal DAP implement. Attempts to introduce steel mould-board ploughs in the 1940s, and broad-bed makers and minimum-tillage systems more recently (through ILRI) have proved largely unsuccessful.

Chapter 4

Livelihoods analysis of farm-power systems at community level

This chapter reviews the livelihoods of different communities according to their predominant source of farm power. The field sites are grouped according to the relative significance of humans, draught animals and tractors as power sources at the beginning of the twenty-first century. The chapter draws on the detailed analysis of the three principal farm-power systems presented in the case studies in Annex 2.

PRESENT FARM-POWER SYSTEMS

During the fieldwork, communities classified their households according to the principal power source they used for primary tillage (Table 8).

A proportion of households at all sites use

hand power for land preparation (except Habru Seftu in Ethiopia). On average, one-third of households in a community rely entirely on family labour for this task but the figure can be as high as 70 percent (in Mwansambo, Malawi). At two sites in west Africa, hired labour rather than family labour is the primary power source.

The use of draught animals is widespread, with only three sites in West Africa never having used them (largely owing to the presence of the tsetse fly). Many households use their own animals but DAP hire is also important (used by 20 percent or more households in four communities).

Tractor use is relatively low, with seven of the 14 sites not using tractors at all at present

TABLE 8
Percentage of households using different sources of power for primary tillage

Field site	Hand power		Draught animal power		Tractor power		Farming system
	Family	Hired	Hired	Own	Hired	Own	
(%)							
Predominantly hoe: mixed hand power and DAP communities							
Mwansambo, Malawi	70	-	20	10	-	-	Maize mixed
Lodjwa, Malawi	55	-	30	15	-	-	Maize mixed
K Maracherere, Ethiopia	50	-	-	50	-	-	Highland perennial
Nteme, Zambia	no data	no data	no data	no data	-	-	Maize mixed
Simupande, Zambia	no data	no data	no data	no data	-	-	Agropastoral
Predominantly hoe: hand power using hired labour communities							
Gyangyanadze, Ghana	27	64	-	-	9	-	Cereal-root mixed
Ojo, Nigeria	11	89	-	-	-	-	Tree/cereal-root
Predominantly DAP communities							
Habru Seftu, Ethiopia *	-	-	7 *	93	-	-	Highland mixed
Kacaboi, Uganda	15	-	10	72	2	1	Maize mixed
Kapchesombe, Uganda	12	9	23	50	5	1	Maize mixed
Msingisi, United Republic of Tanzania	15	15	48	12	9	1	Maize mixed
Communities with tractors as significant power source							
Sanchitagi, Nigeria	58	-	-	-	30	12	Cereal-root mixed
Babatokuma, Ghana **	30	-	8 **	2	59 **	1	Cereal-root mixed
Mvomero, United Republic of Tanzania	55	-	5	5	34	1	Maize mixed

Notes:

No data: percentage data not available for Nteme and Simupande, Zambia: both communities use hand power, hired DAP and own DAP; tractors are not used.

* Habru Seftu: hired DAP represents households which prepare land by sharecropping or occasionally borrowing oxen.

** Babatokuma: the figures for hired DAP and tractors include hiring for transport as well as primary tillage.

Source: Community estimates at field sites.

and only three making any substantial use of motorized power (Sanchitagi, Babatokuma and Mvomero). Tractors are usually hired because few people own them.

Three farm-power systems have been identified for grouping communities according to the relative significance of humans, draught animals and tractors as power sources for primary tillage (Table 8):

- predominantly hoe-cultivation communities, with two distinct subgroups:
 - mixed hand power and DAP: communities where at least 50 percent of households rely on family labour as their sole source of power for preparing the land, and the others use draught animals (either hired or owned);
 - predominantly hand power using hired labour: at least 60 percent of the households use hired labour as their principal source of power for land preparation; the others use family labour and a few hire tractors;
- predominantly DAP communities: at least 60 percent of households in these communities prepare their land using DAP (usually their own); some households hire tractors and others hire labour, while some only use family labour;
- communities with tractors as a significant power source: at least 35 percent of households use tractors for land preparation

(usually hired) and many use family labour;

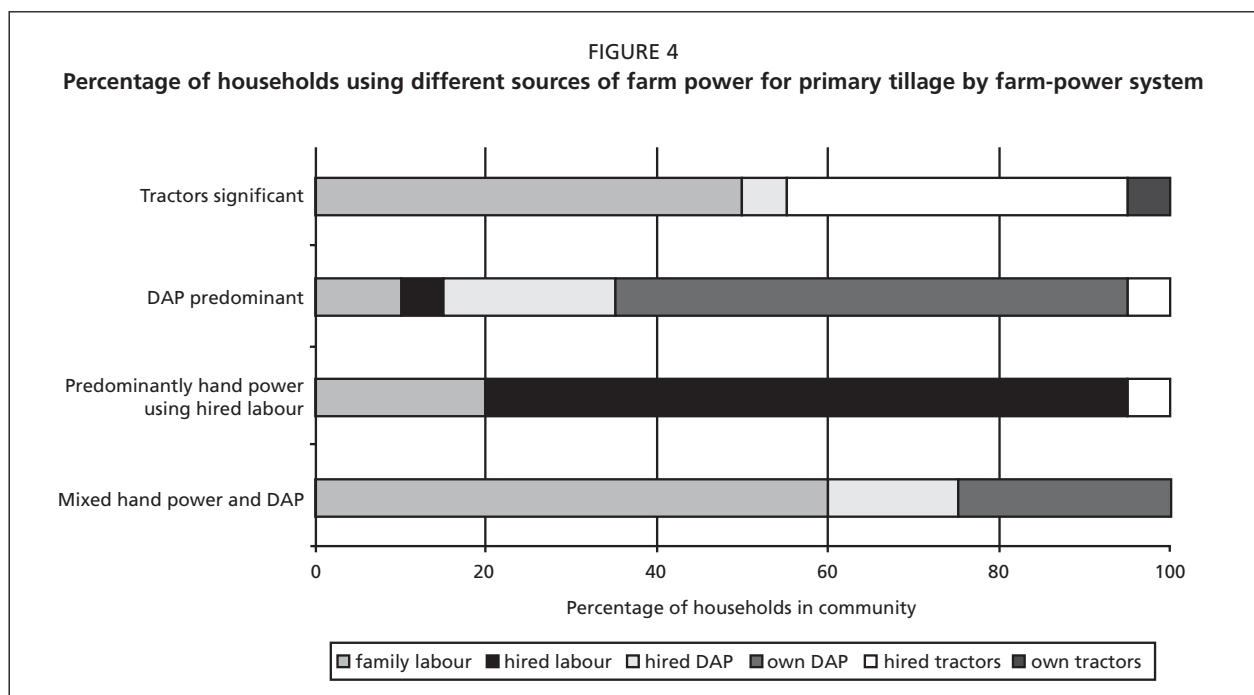
DAP is not widely used in these communities.

Figure 4 presents the relative proportions of households in a community using different power sources in these farm-power systems. This classification provides the basis for the livelihoods analysis discussed below.

LIVELIHOODS IN PREDOMINANTLY HOE-CULTIVATION COMMUNITIES

There are two distinct livelihood systems where humans are the principal power source for all farming operations (full details in Annex 2, Case Study A). One group comprises five communities in east and southern Africa (Kokate Marachere in Ethiopia, Lodjwa and Mwansambo in Malawi, and Nteme and Simupande in Zambia) that once derived most of their power from draught animals but have fallen back on family labour as the main source of power in recent decades. The second covers two communities in west Africa (Gyangyanadze in Ghana, and Ojo in Nigeria) where there have traditionally been few opportunities for mechanization because of the nature of the crops grown (root and tree crops) and hand power is an integral part of the farming system even among richer households.

There is a sharp contrast between the poverty and general depression associated with the predominantly hoe systems of eastern and southern Africa where DAP was once more important, and the hoe communities in west



Africa, which are quite vibrant and optimistic in outlook. In the former, the loss of cattle through disease, drought, distress sale or theft has undermined the livelihood strategies for the whole community and has contributed to a drastic decline in agricultural production. Hoe cultivation has become commonplace, resulting in smaller areas under cultivation, reduced total output, reduced cash cropping, increased food insecurity, reduced farm incomes, and a higher incidence of poverty. Households are unable to meet their basic needs from their own cash and in-kind resources. Communities are placed in extremely vulnerable positions and struggle to survive external shocks, such as the drought of late 2002.

The gravity of the situation is exacerbated in communities where the labour base is also under pressure from schooling, migration, ill health or death (particularly from HIV/AIDS). In the study communities in Malawi and Zambia, the capacity to cultivate land by whatever means, rather than access to land, is a significant constraint on production. At Kokate Marachere in Ethiopia, intense population pressure means that land availability is also a constraint.

In the west African communities, the loss of tractor-hire services has also had a significant impact on agricultural activities, but this has been tempered by substituting hired labour for tractors. The sustainability of this response strategy is dependent on the continued availability of hired labour at affordable prices and there are indications that shortages of hired labour may compromise future agricultural production. Again, most households in these communities have access to land that they are unable to cultivate because of shortages of farm power.

LIVELIHOODS IN PREDOMINANTLY DAP COMMUNITIES

The DAP system has long characterized farming in many parts of eastern and southern Africa (full details in Annex 2, Case Study B). Draught animals are currently used by at least 10 percent of the households at 11 of the field sites; some sites made extensive use of DAP in the past but now derive a significant proportion of their farm power from family labour. Draught animals have never been used at three of the sites in west Africa where the natural habitat, tsetse fly, and farming systems mean that these sites are not well suited to DAP.

Within the communities where draught animals dominate primary-tillage activities, there

are two distinct subgroups: one group where at least 50 percent of the community own their own draught animals (Habru Seftu in Ethiopia and Kacaboi and Kapchesombe in Uganda); and another where the majority of households hire DAP following the collapse of tractor-hire services (Msingisi in the United Republic of Tanzania). In the former, DAP is an established feature of the farming system and is almost the sole source of power for land preparation. The most extreme example is Habru Seftu in the central highlands of Ethiopia where all the land is prepared by DAP and more than 90 percent of households own draught animals. The community has no experience of tractors and there is no tradition of hoe cultivation on croplands.

Households with access to DAP derive significant benefits. They generally cultivate larger areas than hoe cultivators, realize greater yields, improve household food security, and produce a marketable surplus. However, the ability to reap the full benefits of using DAP for cultivating a larger area than is possible by family labour is only achievable where there is an abundance of labour, especially for weeding.

DAP is increasingly being perceived and promoted by governments and donors as a more sustainable farm-power option than tractor-based systems. Draught animals enable households to reap some of the benefits of improved land preparation without the need to accrue a substantial amount of capital to purchase a tractor or to be dependent on tractor-hire services. However, draught-animal owners require specialist skills and a supporting infrastructure, albeit at a more modest level than that required by tractor ownership.

Nevertheless, DAP is not a panacea. Its application is curtailed by: the presence of tsetse fly; poor soils and steep slopes where deeper tillage may contribute to soil erosion; small plots; partially cleared fields; and a shortage of fodder. DAP households are very vulnerable to the effects of personal misfortune and natural calamities. It is all too easy for DAP communities to revert to hoe cultivation because of livestock disease, cattle theft, and the loss of assets principally due to poverty, illness and the death of key household members. Their ability to recover is frustrated by a shortage of healthy animals, a lack of credit, and the low profitability of agriculture.

LIVELIHOODS IN COMMUNITIES WITH TRACTORS AS A SIGNIFICANT POWER SOURCE

Tractors are used by at least 35 percent of the households in three communities (full details in Annex 2, Case Study C). This group comprises one community with a relatively high proportion of tractor ownership (Sanchitagi in Nigeria) and two communities where land preparation is dominated by tractor-hire services (Babatokuma in Ghana and Mvomero in the United Republic of Tanzania). A significant proportion of households in these communities relies on hoe cultivation, more so than in communities where DAP is the dominant power source. Tractors are also used at four other sites but on a modest scale (by 10 percent of the households or less). Some communities used tractors in the past but the services proved unsustainable and they have resorted to hoe cultivation and DAP. None of the sites in Ethiopia and Malawi has used tractors, although hire services are available elsewhere in these countries.

Tractor owners represent the commercial face of farming, using their strong asset-based wealth (often derived from off-farm activities) to purchase inputs such as improved seeds, fertilizer and pesticides. They pay more attention to cash-crop production, either in addition to or in substitution of food crops. Their wealth and role as employers enables them to provide a social net for others in the community who are in a less secure position.

The benefits of using tractors for primary tillage are broadly similar to those of using DAP (in terms of area cultivated, timely and thorough land preparation, and weed control). However, the scale of operation is increased significantly. The benefits are dependent on the availability of labour for subsequent operations and the availability of land for increasing the area under cultivation. To date, neither appears to have acted as a constraint on production. Indeed, the opportunity to earn cash or food through hiring out their labour and land is an essential survival strategy for many hoe cultivators. However, the fieldwork suggests that labour in many communities is becoming scarce as a result of education, migration, ill health and death. As a consequence, labourers are hired from neighbouring communities and further afield. Labour shortages may constrain production in the future.

The viability of tractor power is highly dependent on the profitability of agriculture and the availability and effectiveness of the supporting infrastructure. Under conditions of low farm profitability, the outlook for widespread tractor use must be marginal. Despite the benefits derived from tractor ownership, owners find it difficult to maintain tractors in an operational state because of the weak infrastructure for repairs and maintenance, and the expense. Demand for hire services is falling in many communities where farmers are unable to afford the full economic cost of ploughing or transporting. In some communities, owners are not replacing their tractors and, in others, owners are selling their tractors and reverting to using draught animals.

OUTLOOK FOR FARM-POWER SYSTEMS IN THE STUDY COMMUNITIES

The last century witnessed considerable changes in the composition of power inputs in agriculture. Many farming communities moved from total reliance on hand power for all operations to making selective use of either draught animals or tractors, or both, for energy-intensive tasks, in particular primary tillage and transporting.

Nevertheless, humans remain the fundamental source of power in all farm-power systems in sub-Saharan Africa, regardless of the power source used for primary tillage. There are three reasons why this situation is likely to persist:

- There will always be an element of hand power for land preparation because of the inaccessibility, topography and unsuitability of some soils for mechanization.
- Even in communities where draught animals or tractors are a significant power source for primary tillage, at least 20 percent of households rely solely on hand power and, more typically, this proportion is in the region of 50–60 percent.
- As long as the use of DAP or tractors is confined to primary-tillage operations, the ability to reap their benefits depends on the availability of labour for all other operations.

In the absence of a concerted effort by government, NGOs and the donor community to intervene to address some of the vulnerabilities of various farm-power systems, it is likely that communities where the farm-power base has already been damaged (for example, the former DAP communities in Ethiopia, Malawi and Zambia) will face a continuing state of collapse.

The recovery of the DAP base is not feasible technically in Kokate Marachere (Ethiopia) because of the population pressure on land. Given the high incidence of HIV/AIDS in Malawi and Zambia, it is very likely that the livelihoods in the mixed hand power and DAP communities will deteriorate further as AIDS takes its toll on the agricultural workforce, with estimated losses of at least 14 percent by 2020 (Table 3).

The extent to which the other communities are able to maintain their existing farm-power base, and possibly achieve further mechanization (including mechanization beyond primary tillage), will depend on a number of factors including: the state of their economies and supporting infrastructure; the profitability of farming; and the buoyancy of the rural non-farm economy. Opportunities for agricultural growth may exist in countries where: per-capita incomes are reasonably high and growing (for example, Ghana and Uganda); there is effective demand for agricultural produce from a sizeable urban population (Nigeria); and there is an effective supporting infrastructure (United Republic of Tanzania). However, farmers need security (in particular, land tenure and good governance), the confidence to invest in agriculture and the means to do so. The process of farm-power mechanization could act as a catalyst if it reduces costs and improves returns to investment in agriculture. This may lead to a more commercially-oriented agriculture sector that is more competitive on international markets.

For households entirely reliant on their own labour, it is difficult to move beyond subsistence agriculture in arable crop-production systems. These farmers will need alternative enterprises that are suited to their labour resources, such as animal products or small-scale commercial vegetable production, or opportunities for redeployment in the non-farm sector.



Plate 1
Digging, Ghana.
FAO/18461/P. Ceni.



Plate 2
Fertilizing, Nigeria.
FAO/8074-H-13a/Banoun/Caracciolo.



Plate 3
Weeding, Ghana.
FAO/18315/P. Ceni.



Plate 4
Ploughing with draught animals, Ethiopia.
FAO/C.Bishop-Sambrook.



Plate 5
Digging, Uganda.
FAO/J.Kienzle.



Plate 6
Sowing by hand behind an animal-drawn plough, United Republic of Tanzania.
FAO/J.Kienzle.



Plate 7
Sowing by hand behind a tractor disc-plough, United Republic of Tanzania.
FAO/J.Kienzle.



Plate 8
Weeding, Zambia.
FAO/J.Kienzle.



Plate 9
Irrigating by watering can, Malawi.
FAO/C.Bishop-Sambrook.