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# Strategies of Agricultural Development in Angola
## Case study: Catabola municipality

Dissertation thesis

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# Declaration of authorship

I, Kristina Rušarová, hereby declare that this thesis entitled “Strategies of Agricultural Development in Angola. Case study: Catabola municipality” submitted in partial fulfillment of the requirements for the degree of Ph.D., in the Faculty of Tropical AgriSciences of the Czech University of Life Sciences Prague, and the work presented in it is entirely my own work. Information derived from the published or unpublished work has been acknowledged in the text and in a list of references is given.

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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| AfDB | African Development Bank |
| ADAC | Associação do Desenvolvimento das Actividades do Campo (Association of Field Activities Development) |
| AKZ | Angolan Kwanza |
| AM | Farmers using animal traction and/or mechanization, in addition to hand-tool technology |
| ATNESA | Animal Traction Network for Eastern and Southern Africa |
| BMR | Basal metabolic rate |
| DAP | Draught animal power |
| EDA | Estação de Desenvolvimento Agrário (Station of Agricultural Development) |
| ENSAN | Estratégia Nacional de Segurança Alimentar e Nutricional (National Strategy for Alimentary and Nutritional Security) |
| EPAC | Escola de Práticas Agrícolas de Catabola (Vocational Agricultural School of Catabola) |
| FFS | Farmer Field School |
| HP | Human power |
| HT | Farmers using hand-tool technology only, with solely human power of the family members |
| HTH | Farmers using hand-tool technology only, with human power of the family member and hired labour |
| IDA | Instituto de Desenvolvimento Agrário (Institute of Agricultural Development) |
| ILO | International Labour Organization |
| INE | Instituto Nacional de Estatística (National Statistics Institute) |
| MINADER | Direcção Provincial de Agricultura e Desenvolvimento Rural (Provincial Directory of Agriculture and Rural Development) |
| MINAGRI | Ministério de Agricultura, do Desenvolvimento Rural e das Pescas (Ministry of Agriculture, Rural Development and Fishery) |
| PAL | Physical activity level |
| SANAT | South African Network of Animal traction |
| TEE | Total energy expenditure |
| WE | Working energy |

# Abstract

Catabola municipality is one of the most damaged areas of civil war in Angola. Although the climatic as well as soil conditions are favorable for intensive agriculture, small farmers in the municipality are subsistence with the main income source of dried beans, dried cassava and vegetables. Hand-tool technology prevails in the Catabola municipality as it is employed in 95.38 % of the cultivated land of small farmers. The majority of small farmers uses only power of their family members (with a mean of 1.80 kW and standard deviation of 2.37 kW), hired labour is used by 38.0 % of small farmers. In addition, high engagement of child work was found out as 63.88 % of the children age 5-14 are involved in field operations. Primary data collection was conducted in the Catabola municipality in the period July - August 2011, semi-structured questionnaires and focus group discussions were the most frequent methods used. In total, 151 small scale farmers out of 9 villages participated in the survey. 10 factors that influence the dependent variable – type of farmer regarding technology used on field in combination with hiring of extra labour – were defined. The factors were statistically analyzed with use of ANOVA. Out of the factors expected to influence adoption of more sophisticated technologies than the hand-tool, increasing in size of the cultivated land and enhancement of education of both parents and children are found to be the limiting factor in the adoption process for use of animal traction or mechanical power from small farmers in the Catabola municipality. Strategy was formulated with use of simplified quantified SWOT analysis separately for animal-draught and mechanical-power technologies. The result can be interpreted as 8.0% assumption of success in animal traction adoption, contrary to 10.1% assumption of failures in mechanization adoption by small farmers in the Catabola municipality. Thus, tractors are not considered as an appropriate technology for small farmers in the Catabola municipality. The most critical criteria in animal traction adoption that should be considered are support of farmers' cooperatives and associations, FFSs, education in the form of general schooling as well as trainings for farmers, blacksmiths, extension workers and animal breeders.



# Keywords

Human power; hired and child labour; hand-tool technology; animal traction; technology adoption

# Preface

The idea of the agricultural development strategy of the Catabola municipality in relation to technologies use was developed during my participation in the development projects implemented by CULS in Catabola. For almost two years, in the position of the projects' coordinator, I was in daily contact with the reality of agricultural development; either from the point of view of small farmers or the governmental officials – direct partners in the project activities implementation – heads of provincial MINADER and IDA, administrator of the Catabola municipality and head of EDA Catabola. During my work in Angola, above-standard relationships based on trust have been created, especially with the extension workers of EDA Catabola. The extraordinary relations with the officials were essential during the data collection for the survey purposes. Without them, data collection with the help of the EDA extension workers would not be possible and the majority of the official data provided at both the municipal and provincial level would be completely inaccessible. In addition, long-term coexistence with the community in Catabola could be considered as crucial for the interpretation of the agricultural development context in the municipality, reflecting its actual situation as well as formulation of the strategy.

# 1 Introduction

Angola is a country recovering from the almost thirty-year long civil war, which strongly affected all society, development of the country and paralyzed its agricultural and commercial activities. There has been a critical loss of assets and capacity – key agricultural, health, education and transportation infrastructure have collapsed or been destroyed. Much agricultural land has been untended and left fallow for years or rendered useless by landmines (with about 2000 communities affected by landmines, Angola is thought to be one of the most mined countries in the world, and the most mine contaminated country in sub-Saharan Africa (Unruh, 2011)). Livestock herds were decimated and fields were abandoned. Seeds, tools (including animal traction) and labor are scarce (Clover, 2005).

Currently, smallholder farming system is practiced at 97 % of arable land in Angola, the technology prevailing is the hand-tool technology; use of draught animal power is limited, as well as mechanical power technology. Smallholder farms production could be transformed from subsistence to market oriented when higher technological levels are used, with consideration to the statement of Crossley (1983) that farming carried out on a hand tool technology seldom exceeds subsistence levels, and of Sims and Kienzle (2006), that typical farm family using only hand tools cultivates on average 1.5 ha, the 1.5 ha will rise to 4 ha if draught animal power is available, and to over 8 ha if tractor power can be accessed. Nevertheless, the technologies composition at the proper farm should be designed according to their appropriateness in the specific development situation. Actual researches from southern Africa (O'Neill et al., 1999; Teweldmehidin and Conroy, 2010) proved that the use of animal power performs better in terms of physical productivity per ha compared to tractor usage. Animal traction is generally considered as an appropriate, affordable and sustainable technology for small scale farmers (Ramaswamy, 1994; Starkey and Koorts, 1995; Starkey, 1996; Sims and Kienzle, 2006). Agricultural development related to technologies use improvement will only be viable when it is supported and implemented through complex governmental agricultural strategy. Nevertheless, animals and humans as a source of power are often not considered in policy recommendation (Fuller and Aye, 2012).

Catabola municipality belongs to the areas that are most favorable for agriculture in Angola and, at the same time, agriculture in the municipality still remains underdeveloped in comparison with the pre-war situation. Thus, designing of a strategy of effective use of technologies and adoption is of high potential to be applied by the government in the strategy for agricultural development in Angola.

# 2 Literature Review

## *2.1 Agricultural technologies in sub-Saharan Africa – choice of the most appropriate option for small farmers*

Based on the source of power, the technological levels of mechanization have been broadly classified as hand-tool technology, draught animal technology and mechanical power technology (Sims and Kienzle, 2006). The power sources are ‘energy’ converters, transforming chemical energy in the form of food or fuel into mechanical energy (FAO, 1995). After biomass, human and animal power are the most important sources for the development countries’ population (Fuller and Aye, 2012).

Hand-tool technology is the simplest and the most basic level of agricultural mechanization. The term refers to tools and implements which use human muscle as the power source. In Africa, agriculture is still carried on by a majority of farmers with entire reliance on the human energy using very simple hand tools (Commonwealth, 1991). Draught animal technology refers to equipments, machines and implements powered by animals, cattle are usually used in Angola. Mechanical power technology as the highest level of mechanization takes many forms: wide range of tractors used as mobile power units for field operations and transport, stationary power for many machines, engines and motors using petrol, diesel fuel or electricity to power threshers, mills, irrigation pumps and other stationary machines, aircrafts for application of crop protection or fertilizers and self-propelled machines. It is believed that this technology is used to cultivate about 24 % of the agricultural land in less developed countries and more than 90 % in the developed countries (Havrland et al., 2003).

Mozambique is, similarly to Angola, a country suffering from post-war consequences, as a Portuguese ex-colony could be compared to Angola as socio-economic bases are resemble. The technologies division seven years after the war termination was as follows, according to Toro and Nhantumbo (1999): 87 % of households used only hand-tool technology, 8 % utilized animal traction as well (owned, borrowed or hired) and 5 % tractor mechanization, mainly from hiring.

In sub-Saharan Africa, human muscles contribute about 65 % of the power for land preparation, typical farm family using only hand tools cultivate on average 1.5 ha in the region (Sims and Kienzle, 2006). Farming carried out on a hand tool technology seldom exceeds subsistence levels (Crossley, 1983). Animal power allows greater and more timely production than is possible with human labour alone, thus, leading to a higher standard of living (Starkey et al., 1995). According to Sims and Kienzle (2006), the 1.5 ha will rise to 4 ha if draught animal power (DAP) is available and to over 8 ha if tractor power can be accessed.

In many areas of developing countries, two or even three technologies may be used on a single farm unit while in other areas; only one technology prevails in the existing farming system (Havrland and Kapila, 2000). The coexistence of livestock and man can be regarded as symbiotic, meaning that they both derive benefit from the association (James and Krecek, 2000). In several parts of South Africa farmers consider tractors and work animals to be complementary, with tractors (if available) used for rapid power-intensive ploughing and animals for subsequent control-intensive seeding, weeding and year-round transport (Starkey et al., 1995; ATNESA, 1998; Sims and Kienzle, 2006). The key factors influencing farmers' choices between tractors and animal draught power are household income, size of the cultivated land and number of draught animals owned by the household (Mabuza et al., 2013).

During the 20$^{th}$ century, the large scale farming sector moved from almost total dependence on animal power to dependence on tractors. Human and animal-powered technologies are not very fashionable; they lack big company support; there has been a decline in their use in industrialized countries; and finally, perhaps their reputation has been blemished with misconceptions about appropriate technology (Fuller and Aye, 2012). In urban and peri-urban areas, animal power is often perceived as an old-fashioned, backward and outmoded technology, particularly among the young (Starkey and Koorts, 1995). Almost all farmers, whatever their scale, would like to own or to use tractors preferably. However, animal power has remained crucial to smallholder farming and rural transport. Recent experiences declare that the tractor's superiority consideration over animal traction has started to turn over. The research of Teweldmehidin and Conroy (2010) in Namibia's Eastern Caprivi found that the use of animal power performs better in terms of physical productivity per hectare compared to tractor usage. Similar results were obtained in Nigeria by Abubakar and Ahmad (2010). Simultaneously, smallholder farmers from former Ciskei and Transkei that rely on DAP (draught animal power) provided by their cattle prefer it to tractor for most of their agricultural tasks and believe the use of these animals to be profitable because of the low outlay (O'Neill et al., 1999).

The technologies composition at the proper farm should be designed according to their appropriateness in the specific development situation. When the planning of appropriate technology selection, factors such as climate, soil and cropping patterns have to be considered (FAO, 1990). Climate has a major influence on possible working days for field operations, which, in turn, influences the size and number of power units and implements needed. Soils have influence over the choice and size of power and implements to meet draught requirements. Cropping patterns reflect optimum growing conditions for specific crops, thus creating time boundary of the operations which, again, influence the size and number of power units and implements needed. Except for these, general economic data of the region and specific data for all three types of technology have to be taken in the consideration as well.

Similarly, gender context has to be considered in the context of appropriate technologies. In many African cultures and societies work is clearly distributed between men and women and it is often the case that both refuse to do work traditionally allocated to the other (FAO, 2012). On the contrary, in Angola, both men and women tend to work on the same farm plots and engage in largely the same agricultural activities (Nielsen, 2008). Nevertheless, men are more likely to engage in activities that involve the use of small machinery and clearing and preparation of land; collection of natural resources for subsistence (e.g., fuel wood, water) is primarily the responsibility of women and children. In rural areas, male labor migration and engagement in the cash economy are placing an increasing amount of household and farming responsibilities of women and children (IFAD, 1998; Nielsen, 2008). Continuously, women are increasingly the major beneficiaries of animal power (Starkey and Koorts, 1995), although men and youths generally work with draught animals, and women are leading or encouraging the animals, as a man ploughs (Starkey et al., 1991).

Chosen farm technology will only be viable in sub-Saharan Africa, according to Ker (1995) and Sims and Kienzle (2006), if it contributes to the following:

(i) increase in the labour productivity,

(ii) increase in the area under cultivation,

(iii) increase in land productivity by facilitating the timeliness and quality of cultivation,

(iv) increase in profitability from increased crop production and reduced costs of cultivation and

(v) reduction of the drudgery associated with human powered farming, transport and processing.

### 2.1.1 Hand-tool technology

Hand-tool technology is the level of mechanization most widespread in the traditional small-scale farm sector in developing countries. Hand tools are the most important implements for smallholder farmers throughout sub-Saharan Africa (Ker, 1995; Sims and Kienzle, 2006), the power and tools available often limit the user to subsistence farming. Productivity of human power is generally low because of the lack of physical energy available and the limited range of hand tools; the situation has been exacerbated by the HIV/AIDS and migration as number of young healthy people available for farm work is getting reduced (Sims and Kienzle, 2006).

The most commonly used implement are the hand hoes (Crossley, 1983) and machete which are usually of local design and fabrication. They are easy to maintain, repair and fabricate and do not require much effort or time to learn their use. As women tend to use lighter hand tools, men use to pass their hoes to women once much of the original weight has been lost through wear (IFAD, 1998). Although women have special needs with regard to the tools and implements they use, manufacturers usually do not produce lighter tools determined for mainly women use. On the other hand, to avoid loss of implement durability, higher-quality and more expensive steel need to be used for their manufacture; generally can be stated that there is a lack of communication between producers and users in order to implements could meet their actual needs.

Except for the simple ones, more sophisticated hand tools (e.g. sprayers, rotary injection planters, star-wheel weeder) are used in sub-Saharan Africa as well, experiences have shown that cash or credit are often not available for their purchase (FAO, 1990).

Time of implements' replacement differs significantly according to the manufacture quality. According to IFAD (1998), hoes of poor steel quality have to be replaced every year, in comparison with high-quality steel of industrially produced hoes that can resist from two up to fifteen years, machetes last four to six years on average; hand tools used by small farmers are replaced every one to three years. The tools are usually purchased at stores or markets in the nearest town with price oscillating from 5 to 8 USD per imported hoe. In countries where there is a choice between industrially produced implements or those made by local blacksmiths, majority of farmers prefer to buy the local ones, as price is more affordable and farmers can negotiate credit or discounts, barter farm products for tools and additionally, blacksmiths could provide repair services more easily (IFAD, 1998).

Blacksmiths are much more numerous and active in western Africa in comparison with southern Africa, one reason may be that the early colonial regime in southern Africa imposed a ban on village blacksmiths because they made also arms and village blacksmith has never truly recovered from that ban. Thus, blacksmiths training programmes should be expanded to provide guidance in the design of tools and implements; the most respected training institutes in southern Africa are Palabana Farm Power and Mechanization Centre in Zambia and Institute of Agricultural Engineering in Zimbabwe. (IFAD, 1998)

The capacity of hand tool technology is limited by the physical power that can be released by human beings. High temperatures, altitudes and humidity can reduce the power available to only 50 % of the "normal" potential. The power also depends on the individual: physical conditions, age and sex. An adult man in good health and well fed has a power capability of about 0.07 to 0.1 kW (Crossley, 1983). According to Tiwari et al. (2011), a continuous output of 0.06 kW pedaling at 50 revolutions per min for a long duration is reasonable; such an output is ideal for many other agricultural operations like thrashing, maize shelling or water pumping. When working continuously, an adult man produces about 0.08 kW, for shorter periods he can develop up to 0.3 kW (Havrland et al., 2003). Havrland et al. (2003) defined powers for adult women, men of age 16-18 and men of age 14-15 as 0.06 kW, 0.064 kW and 0.04 kW respectively. Although power is not defined by for age category of women under 18 years (Crossley, 1983, Havrland et al., 2003; Tiwari et al., 2011) and the power of men under 14 years was set at 0 kW (Havrland et al., 2003), these power sources are commonly used in sub-Saharan Africa and in Angola particularly.

There is a severe constraint on the area that can be prepared by hoe; more than 60 person-days per ha are generally required for the job. Weeding is an absolutely critical operation in the cropping cycle, more than 30 % of yield is commonly lost because of weed infestation; some crops require more than 50 person-days per ha of weeding (Sims and Kienzle, 2006). Similarly, according to the studies' results of FAO (1995), principal labour-demanding peaks in the farming cycle are for land preparation and subsequent weeding.

According to FAO (1995), the main potential constraints for hand-tool technology are labour availability, followed by costs of labour, tools and socio-cultural traditions. Nowadays, especially in the region of southern Africa, the use of hand-tool technology can be limited, resulting from health problems, particularly HIV/AIDS (Mabuza et al., 2013).

Hired labor is widely spread only in richer villages, usually for shorter periods in the peak season: commonly for few person-days. Most households have both hired people to work for them as well as they have worked for other households in the village, even though the frequency of working for others is most prevalent among the poorer households. In this context, the system of hiring labor is much more than an economic institution since it may be as much a response to various types of social obligations (Jul-Larsen and Bertelsen, 2011). In Mozambique, use of hired labour is quite common, the percentage of agricultural households that hired non-family labour was 16 % in 2002, in comparison with 19 % in 1996 (World Bank, 2006). Similarly, according to the survey of Toro and Nhantumbo (1999) from Mozambique, 19 % of the household sample required to hire labour for agricultural tasks, mainly for weeding and primary cultivation. Most of the households required one or two person-weeks of hired labour, with a mean of 3.4 person-weeks and standard deviation of 7.0 person-weeks.

### 2.1.2 Draught animal technology

Animal traction is generally considered as an appropriate, affordable and sustainable technology for small scale farmers (Ramaswamy, 1994; Starkey and Koorts, 1995; Sims and Kienzle, 2006). In the farming smallholder system in southern Africa, the majority of the animals used for work are cattle, mainly for ploughing and transport (Rocha et al., 1991; Starkey et al., 1991; Starkey et al., 1995). Use of ridgers and weeders is low (Starkey et al., 1991). Row planting should be preferable when using draught animal power (DAP) as pulled cultivators can be utilized to increase weeding efficiency (Sims and Kienzle, 2006). Unusual applications of animal power include mill power, road maintenance or timber extraction (Starkey et al., 1991).

It is generally believed that animal traction for tillage and wheel transport was introduced in the majority of the sub-Saharan Africa during the colonial period (Starkey et al., 1995; Ker, 1995), with the exception of Ethiopia, where animals are commonly used for draught for thousands of years. In Angola, DAP was introduced at the end of the 19$^{th}$ century. In Zambia, animal traction is extremely important, particularly in south and west, about 90% of smallholder farmers uses animal traction and in most other regions, animal traction is clearly increasing (Starkey et al., 1991). In Mozambique, only 4 % of small-scale farmers own cattle, of that, 60 % is using them for animal traction, the majority of cattle owners are in the south of the country; additionally, draught animals worked on total 12 % of the total area cultivated (Toro and Nhantumbo, 1999). Ownership of animal traction does not seem to have had a big impact on increasing the area cultivated; the Toro's survey results show that mean area cultivated by such farmers is 3 ha.

The most common DAP implements in sub-Saharan Africa are disc ploughs, harrows, ridgers and cultivators. In South Africa, most farmers use factory-made implements imported from urban areas (Starkey et al., 1995). Thus, farmers may lose from high transport costs of finished products and lack of opportunity for easy feedback to the manufacturer; rural areas lose the employment opportunities associated with possible implement manufacture. Increasingly, rural workshops could provide repairs and spare parts services (Starkey et al., 1991). The main constraints in animal traction implements manufacture are based on lack of raw material; mainly steel (Starkey et al., 1991; Ramaswamy, 1994; Starkey and Koorts, 1995; Chipaco, 2010). Still, most of the animal traction users have to repair and maintain their own implements by themselves.

In some African countries, including Zimbabwe and Malawi, most farm households own a cart; in Zambia, ownership of cart is limited (Starkey et al., 1991). In South Africa, most carts are locally made by artisans using materials derived from road vehicles; they carry both goods and people (Starkey et al., 1995). The practice of manufacture carts from road vehicles parts is quite common in the whole southern Africa. The most demanded parts, representing a limiting factor of the carts multiplication, are axles, wheels and tires of pick-ups. There are some tendencies of better – 'appropriate' cart design development but these have usually serious problems with wheels and bearings made of wood (Starkey et al., 1991). Vast majority of the carts used in southern Africa is two wheeled.

The type and breed of draught animals which can be used depends on the conditions in the area (e.g. climate, water availability, farmers' customs and preferences, animal diseases). The use of locally adapted animals is strongly recommended (Starkey et al., 1991; Starkey and Koorts, 1995) because these are used to the climate, farmers are experienced in feeding and maintaining the animals and the local breeds are, to a certain extent, resistant to local diseases and parasites. Particularly in smallholder farming systems, the ability of animals to survive within a stressful environment is important.

Nevertheless, some authorities have been promoting exotic breeds (Starkey et al., 1995) like Brahman, Sussex, Afrikander and Boran which are larger and more powerful than indigenous breeds (Starkey et al., 1991). In Zambia, the local cattle breed predominantly used for draught is ‘Barotse’; its live weight differs from 500 to 600 kg (FAO, 2010).

Oxen are perceived as powerful draft animals for ploughing, but quite slow and labour-intensive. Cows, heifers and bulls are also being used for work, although oxen are prevailing (Starkey et al., 1991; Ker, 1995; Starkey and Koorts, 1995) as females cannot work for approximately two to four months per annum around calving (Faftine and Mutsando, 1999). According to Faftine and Mutsando (1999), farmers in Mozambique use cows only temporarily to ensure the fast rebuilding of the herds in case of droughts or before, after the civil war termination. Cattle are yoked in pairs with use of wooden yokes, number of animals working together varies, but the most common is in only one pair. Usually two or three people work with the oxen together (Starkey et al., 1995). The training of cattle starts when the animals reach two or three years, the most difficult task to be trained is ploughing (ATNESA, 1998). The training takes three months, cattle is able to plough or pull cart after the training (Keyserlingk, 1999). Although oxen were historically the main work animals in southern Africa, use of donkeys is substantially increasing.

Donkeys are used mainly for transport purposes as their carrying capacity reaches 60-65 % of their live weight. These animals are renowned for their exceptional survivability, longevity, low cost and low management requirements; and they can be used by men, women and children (Starkey and Koorts, 1995). Currently, donkeys are increasingly being used in Africa (Sims and Kienzle, 2006). Although in southern Africa donkeys are cheaper to buy, easier to train and more resistant to draughts than oxen and easily manageable by women and children, cattle are still preferred by farmers, as donkeys have no other social and economic value in rural life except for providing draught power: for instance, they cannot be eaten or given as a wedding present (IFAD, 1998). Other animals which are used for animal traction in southern Africa are horses, mules, hinnies or zebras.

Work-rates achieved with draught animals vary widely and can be 5-20 times higher than those of hand tool technology, especially for heavy tillage operations. Table 1 shows the work capacity of animals relevant for Africa (Crossley, 1983) and Angola (Chipaco, 2010) in terms of physical quantities related to animal traction.

Hiring of work animals is common in southern Mozambique (Rocha, 1991). Farmers hiring draught animals cultivate 2 ha on average (Toro and Nhantumbo, 1999). All hires of the draught animals have to be realized when it is convenient for the owner, which may well be after the ideal time (Starkey et al., 1991).

**Table 1: Work potential of selected animals**

| **Item** | **Oxen** | **Cow** | **Local cattle breed in Huambo province 'Crioula'** | **Donkey** |
|---|---|---|---|---|
| Source | Crossley, 1983 | Crossley, 1983 | Chipaco, 2010 | Crossley, 1983 |
| Weight [kg] | 300-900 | 400-600 | 362.94 | 100-300 |
| Pull [N] | 600-800 | 500-600 | 356.04 | 300-400 |
| Speed [$m.s^{-1}$] | 0.60-0.85 | 0.70 | - | 1.00 |
| Power [kW] | 0.56 | 0.35 | 0.35 | 0.25 |
| Daily work hours [h] | 5 | - | - | 4 |
| Distance of travel [$km.day^{-1}$] | - | - | - | 35-40 |

Livestock can play a critical role in improving the livelihoods of rural people engaged in smallholder agriculture, generating cash income from sales and making a wider input to crop production through the provision of both draught and manure (Ellis-Jones et al., 2005). Animal power could be considered as a renewable source of power. Most developing countries, except oil-producing nations, are extremely short of petroleum. Thus, for small-scale agriculture and transport in rural areas, DAP is an alternative which is available within the financial and organizational means of most farmers (Ramaswamy, 1994; Abubakar and Ahmad, 2010; Chipaco, 2010). This statement is applicable in Angola as well: although the country is the second biggest oil-exporter in Africa, rural areas far from the coast are suffering from petroleum lack significantly as well.

DAP can be sustainable, affordable and appropriate, requiring few external inputs; nevertheless, there are challenges in improvement of its productivity, which requires an integrated and participatory approach, for instance to increase DAP availability, use existing animals more effectively, improve animal health and their ability to work (Ellis-Jones et al., 2005). As draught animals often have multiple social and economic functions, a large number of smaller animals are preferable for economic flexibility (Starkey et al., 1991).

The benefits obtained from cattle for smallholder livestock farmers are as follows: (i) meat consumption and selling, (ii) wealth, status and savings, (iii) socio-cultural activities and (iv) draught power (Ker, 1995; Stroebel et al., 2008). According to Reardon et al. (1997), economics of animal traction are problematic for farmers producing only subsistence food grains (such as millet or sorghum) but become more favorable in cash-cropping areas.

The main constraints of draught animal technology are diseases and availability of veterinary service and medicines; medium impact factors include tradition in the use of animals for traction, husbandry practices, feed availability, and access to training for animals and operators and equipment services (FAO, 1990), and additionally, availability of animal traction implements (Starkey and Koorts, 1995; Abubakar and Ahmad, 2010). Legislation regarding health care and welfare of draught animals could influence the conditions of the animals and continuously their work performance as well. Unfortunately, in Angola, this type of legislation is still missing (Chipaco, 2010). In Zambia, the biggest constraints to animal traction are generally economic problems rather than technical ones (Starkey et al., 1991). James and Krecek (2000) identified the availability of stock remedies, availability of sufficient animal health advice, adequate extensional information, stock theft and accidents of animals with vehicles as the main constraints in South Africa.

Lack of capital or credit is considered as a serious constraint to animal traction ownership as well. According to Starkey and Koorts (1995), subsidies relating to purchase of cattle are particularly dangerous, as they can tamp people to cash in their benefits early (through slaughter or faked insurance loss). Thus, loans provided to farmers' groups and associations are preferable by the financial institutions. According to Woodhouse (2010), the key factor determining the viability of the cattle-draught system for small farmers is access to off-farm (especially wage) income with which to finance the purchase of cattle and equipment and to hire additional labour.

In some parts of rural Africa, superstitions about working animals still exist. For example, according to Starkey et al. (1995) and James and Krecek (2000), some farmers think that use of cattle to work reduces the meat quality and quantity.

Draught condition of draft animals is closely affected by their nutritional and health status. One of the main problematic issues regarding animal nutrition is lack of feed, only a few farmers conserve forage for their animals (Starkey et al., 1995; Abubakar and Ahmad, 2010). Draught animals in most developing countries are fed on crop residues and leftover stubble from agricultural land; there is no organized cultivation of fodder crops, nor is there adequate land for grazing (Ramaswamy, 1994; Abubakar and Ahmad, 2010), although communal grazing systems are common throughout sub-Saharan Africa (James, 2000). Even though feed requirements for work are generally low, feed quality can be so poor that animals are unable to eat enough to meet energy needs for work, and so lose weight during the work season (Pearson and Vall, 1998). Thus, supplementary feeding, especially during dry periods are recommended (Starkey et al., 1991; James and Krecek, 2000). Farmers whose cattle were in too poor condition for effective work due to lack of feed often responded to the problem by buying donkeys to undertake the work (Starkey and Koorts, 1995).

Health and welfare condition of work animal influence significantly work performed by the animals (Starkey and Koorts, 1995; James and Krecek, 2000; Abubakar and Ahmad, 2010). Working animals are susceptible to the major cattle diseases, only few diseases are specific to draught animals. In Zambia, typical veterinary problems specific to animal traction are yoke galls and harness sores (Starkey et al., 1991). Most common diseases of cattle in southern Africa are trypanosomiasis, contagious bovine pleuropneumonia (CBPP), tick-borne disease and hemorrhagic septicaemia. Thus, dipping is commonly practiced. When importing, all cattle are subject to quarantine. Traditional or home-made remedies are often used to treat animals (Starkey and Koorts, 1995; James and Krecek, 2000). Nevertheless, poor cattle survival was attributed to pasture problems rather than disease (Starkey and Koorts, 1995).

The importance of disease risk is greater, however, for smallholder farmers who risk losing not only the capital value of the animal, but also the income-generating work potential (Starkey et al., 1991). Still, farmers sometimes regard the veterinary services with great suspicion (Starkey and Koorst, 1995); some of the reasons are as follows: farmers have not been informed of the value of veterinary services as a whole or some of the later problematic governmental strategies (such as exotic breeds' distribution) have been implemented by the veterinarians. On the other hand, veterinarians are not well prepared to work with small farmers. Members of veterinarian services usually do not receive trainings relating to smallholder farming system, and related multipurpose uses of animals and non-monetary roles of livestock (Starkey and Koorst, 1995). Lack of finances and availability of veterinarians, particularly in the remote areas is probably the reason why very few people use veterinarians (James and Krecek, 2000).

In Africa, work animals are often goaded to beating, to make them carry loads beyond their capacity or work longer hours (Ramaswamy, 1994), to hanging, burning with oil and stoning; donkeys are the ones most often attacked (James and Krecek, 2000). Generally, animal welfare is not considered as a priority for farmers, and additionally, adequate legislation is lacking (Ramaswamy, 1994).

The post war situation of Mozambique is comparable to Angola, despite the war's duration reached in only 16 years in comparison with 30 years in Angola. Nevertheless, as scientific data about animal traction for Angola are missing, the ones from Mozambique could be replaceable. Seven years after the war termination, Keyserlingk (1999) identified four main constraints to the development of the animal traction sector:

(i) An acute lack of animals due to depletion during the war,
(ii) lack of implements as Mozambique's local hardware production has not reached large-scale production, and what is produced is mostly very expensive,
(iii) lack of credit schemes which makes very difficult for local farmers to buy animals or tools even when they are available; and
(iv) lack of an extension network to disseminate animal traction technology.

During the war, cattle population significantly decreased from 196,000 heads in 1973 to 33,000 in 1992; since then, the cattle population has been slowly recovering. The ministry of agriculture defined restocking as a priority for rural Mozambique, for this purpose, breeding cattle (of which 95 % were female) was imported, mainly from Zimbabwe (Keyserlingk, 1999).

### 2.1.3 Mechanical power technology

In most countries of sub-Saharan Africa, the first part of agricultural production system that are successfully mechanized are usually various aspects of crop processing, particularly grain milling in the form of hammer-mills powered by small gasoline, diesel or electric engines (Ker, 1995). Water pumps appear to become popular as well.

In the past – and sometimes today – the application of tractors and heavy mechanization in unsuitable situations has led to heavy financial losses, lower agricultural production, and environmental degradation. In these circumstances, tractor mechanization can easily become a burden to national economies, and to individuals, rather than being an essential input with the potential to increase productivity (Sims and Kienzle, 2006).

Tractors are extremely effective at ploughing large areas in a short time. However, they are expensive and economically justified only on large farms or farms with high net income. Even when hired out, they tend to be unsustainable and capital depleting. Despite their lack of economic viability of small farms, tractors are very popular and convey high status as most farmers would like to own tractors (Starkey and Koorst, 1995; Ker, 1995). A major reason why engine-powered technology has spread to large extent worldwide is that it provides a different order of magnitude of power output compared with a human worker. Nevertheless, mechanical power technology still remains inaccessible to small farmers in developing countries.

According to FAO (1995), the main potential constraints of mechanical power technology are availability of appropriate machinery, supplies (fuel, lubricants and spare parts), repair and maintenance services, followed by accessibility of trained operators and training. Maintenance facilities, operator skills, repairs and spare parts have been (and still are) a major headache associated with operating internal combustion engines at the smallholder level (Crossley, 1983). Agricultural mechanization will not be successful if the local economy is unable to deliver services, fuels and spare parts for both imported or domestically produced machines and implements (Sims and Kienzle, 2006).

Experience of tractor hire service provided by the Nigerian government indicates that farmers as well as the governmental rental units face various types of problems in tractorization. Farmers face a problem of the untimeliness of services which may be due to a shortage of tractor operators, irregular supply of diesel oil in the rural areas, the frequent breakdown of tractors and equipment coupled with a shortage of spare parts. The farm mechanization owned by the government in the state is merely skeletal, restricted to disc ploughing and disc harrowing; the main reasons are poorly developed farmlands, rough handling of tractors and implements and negligence of regular maintenance (Haque et al., 2001). According to Akinola (1987), private hire operators are found to be more economically efficient in running their units than are governmental officials since the former operate at a lower costs, handle more work per year than governmental units, make efficient use of tractor operators and make prompt management decisions.

In Swaziland, governmental tractor hire service is based on subsidization for small farmers, charges are about 48 % below charges from the private sector; nevertheless, farmers often complain that tractors are not available when required (Mabuza et al., 2013). In Punjab (India), hiring of machinery is realized by cooperative centres – each of the centres has a high powered tractor with rotavator, leveller, disc harrow and cotton drill as the most common implements; annual usage of tractors is 900 h and 550 h of the implements (Parminder et al., 2012).

Government-run tractor hire schemes in sub-Saharan Africa, never widely effective in contributing to poverty alleviation or farm production increase, are now in a state of collapse as government tractor-hire schemes have been highly subsidized (Feder, 1981; Starkey et al., 1995; Ker, 1995). Tractors’ hire services could, theoretically, be provided by the private sector. Private sector tractors have been profitable on large landholdings, but they have seldom proved viable for the smallholder sector in sub-Saharan Africa, whether in individual or group ownership, or in private hire services (Sims and Kienzle, 2006). The concept of a rental market for privately owned and operated tractors has possibilities that may cause its increase in the future.

In those areas where there has been some success with private tractor hire, there appear to be specific economic conditions. These include profitable cropping systems with good rainfall and/or irrigation on fertile soils, large individual farm areas (e.g. sugar cane farms) or land that is consolidated (or not badly fragmented) and nearby infrastructural backup. Such conditions are very rare in the smallholder farming area (Starkey and Koorst, 1995). The unsustainability of smallholder tractor-hire schemes is true not just for South Africa, but elsewhere in Africa and the world. When tractor schemes prove unsustainable, it is much more difficult to restart animal traction. Not only skills have been lost in the intervening years, but farmers do not like to move ‘backwards’ from tractor to animals. In some cases, farmers reported that when tractor services failed, fields remained uncultivated for a time, before animal traction was seen as the only viable option (Starkey et al., 1995).

## 2.2 Strategies of agricultural development in sub-Saharan Africa

As the majority or rural poor across the developing world are small farmers whose economic activity might aliment either aggregate economic growth or poverty (Mendola, 2006), design and successful implementation of a Strategy of agricultural development focused on sustainable agriculture should be, and usually is, part of the strategy-complex of government in developing country. Sustained agricultural performance plays a significant role in the improvement of food security and livelihoods in the sub-Saharan region (Van Rooyen and Sigwele, 1998). According to Africa Progress Panel (2010), key elements essential for agriculture progress are economical stability and favourable investment climate needed for private investment and innovation; the state has to invest in physical infrastructure such as roads, power lines and irrigation system as well as to rural schooling, health care and clean drinking water.

Strategies of agricultural development could vary significantly in their approaches, but the main objective could be generally formulated as increased food security based on enlarged agricultural productivity and increased living standards of farmers through their increased income. In developing countries, an approach that requires transforming subsistence farming into market-oriented farming is considered desirable as communication and transport facilities are regarded by Ker (1995) to be the main constraints in the surpluses production increase; difficulty in access to markets in the remote areas causes preferable subsistence farming system in those areas.

Strategy of agricultural development is always composed of more components parameters and approaches divided into specific areas, for example, farmer productivity, market access, technology adoption or policy; strategic development options can be accessed through interdisciplinary research based on coupling of human and natural systems approaches (Ruben et al., 2006).

The most complex agricultural strategies are typically developed for particular countries by the proper government and/or Ministry of agriculture.

The Angolan Ministry of Agriculture designed programmes focusing on the problems in agriculture and rural development. The programmes are consolidated in Strategy for Struggle against Poverty (Estratégia de Combate à Pobreza). One of the basic parts of the Strategy is management of Agricultural Campaigns which concentrate main activities planned for agricultural season, planning is realized at the national and provincial level. Direct implementation in the municipalities is realized by EDAs.

Another strategy developed by the Ministry of Agriculture in Angola is a National Strategy of Food and Nutrition Security (ENSAN) that was formulated for the period 2009-2013. The main objective was increased access of the Angolan population to food of good quality. The strategy was composed of five areas:

(i) increase, diversification and sustainability of agricultural and livestock production and fishing;

(ii) strengthening and consolidation of organizational and productive capacity of farmers and agricultural, livestock and fishing associations;

(iii) strengthening of social protection of children and vulnerable groups, strengthening of family competencies and education of the communities' alimentation;
(iv) promotion of the agricultural scientific investigation, and
(v) establishment of SISAN, the information system about food security.

Relevantly to the agricultural technologies' approach, only animal traction was considered in the ENSAN, namely in the form of aim to increase animal traction in tillage activities. For the period 2014 and/or further, no similar strategy was developed. Likewise, no results or data reflecting ENSAN 2009-2013 are available.

The agricultural development strategy can only be appropriately executed if all stakeholders work together at all levels: country, provincial and municipal level; farmers, communities, private business, NGOs, local governments and central government have to participate. The principal role of government is to provide the conditions for a largely self-sustaining development of the agricultural engineering sector; policies must be aimed at removing the most damaging forms of market restrictions (such as import duty on steel), leaving market forces to operate where they can be effective in promoting both growth and rural poverty alleviation (Sims and Kienzle, 2006).

Participatory approaches are an increasingly prominent technique for designing agricultural strategies in sub-Saharan Africa; however, they are frequently criticized for either not involving enough stakeholders or limiting the scope of their participation (Resnick and Birner, 2010). This approach leads to relatively high adoption rates, as in case of locally adapted varieties of seed and planting material supply in Angola and Mozambique (Rohrbach et al., 1997). According to Resnick and Birner (2010), the real challenge lies in transforming the outcomes of participatory processes into policies that can be feasibly implemented. In implementing the programme, efforts should be made to build on indigenous knowledge, while benefiting from the lessons and experiences of other countries (Starkey et al., 1995).

Pender and Gebremedhin (2008) defines opportunities for improvement of crop production in low-external input investments and practices, such as reduced tillage, reduced burning and stone terraces as in case of Tigray highlands. In case of seeds, not only better-quality seeds or new varieties, but new potential crops (such as *Lupinus sp.* in

Angola according to Van der May, 1996) could influence positively farm production in Africa.

Thunen in Reardon et al. (1997) added that markets and the proximity of cities influence productivity in agriculture. The constraints to increase farm production according to Sims and Kienzle (2006) are: (i) an excessive reliance on human power, (ii) the low productivity of human labour and (iii) a decrease in the labour available.

Making more efficient use of human power, together with the efficient application of draught animal power, provides the best immediate strategy for reducing the problem of farm power shortage in sub-Saharan Africa, thereby increasing agricultural productivity and improving the livelihoods of millions of families in the shortages time (Sims and Kienzle, 2006).

Giles (1975) established a correlation between available power per hectare and crop yield, which indicates a high rate of increase in yield for increasing power inputs up to a level of approximately 0.4 $kW.ha^{-1}$ corresponding to a crop output of about 2.5 $tons.ha^{-1}$. Typically in Africa, one adult works about half a ha of land providing about 0.1 $kW.ha^{-1}$. Then, power supplementation of 0.3 $kW.ha^{-1}$ is necessary. A pair of oxen would provide each supplementation for about 3-4 ha of land, about one smallholder farm. This is economically the best solution to increase the productivity of the smallholder farmer, but in areas where there is no tradition among farmers of animal ownership and care, it is extremely difficult to instill in them the necessary management skills and sympathy that the use of animals demands (Crossley, 1983).

Rušarová et al. (2010) formulated agricultural development strategy for Angola based on the increase of installed power in order to reach self-sustainable agricultural production, when most significant deficits are in production of cereals, namely wheat and rice and in production of pulses. To ensure food security in Angola, it is required to increase the production of the cereals and pulses by 100 %. To ensure this, the installed power should increase up to 0.36 $kW.ha^{-1}$ from actual 0.20 $kW.ha^{-1}$. Thus, technology structure in 2020 should be the following: 25.56 % hand-tool technologies, 13.40 % draught animal technologies and 61.04 % mechanical power technologies. As the average tractor in Angola is estimated at 58.13 kW, the number of tractor should rise from 1,308 up to 22,513 units. The strategy of the government regarding technologies use in agriculture focuses mainly on mechanization use increase within soil preparation campaign.

Particularly for Umbundu traditional land-use system, Delgado-Matas and Pukkala (2014) suggests that future policy should support changes in the traditional diet to promote more diverse sources of carbohydrates and proteins, diminish cattle need by increasing the productivity of labour and draught animals, and decrease the workload of women especially during the harvesting season; new technologies and crop varieties that increase yields in ombanda and naca can guarantee food security for most of the local rural families.

Associations and cooperatives can be considered as more successful in technologies spread and adoption in the context of smallholder farming systems in Angola (Chipaco, 2010). Still, in developing countries, there are some constraints on efficient use of associations or cooperatives. To be effective, cooperative must strike a delicate balance of the state support and the absence of state intervention (as described by Akwabi-Ameyaw (1997) in the case of Zimbabwe). Judging from the often disappointing performance of cooperatives, this blend is difficult to achieve. Support needs to be in the form of managerial assistance, training of officials, and ensuring compliance with the bylaws. Typically, in situations where the government sees cooperatives as policy tools and thus seeks to control operations, the nature of the cooperative is corrupted and benefits for members are eroded (Lele and Christiansen, 1988).

In order to increase development of agricultural production, the government of Angola has cooperated with abroad governments on large scale projects' implementation. In cooperation with USAID, project oriented on supply of modern varieties of maize, potato and beans was successfully realized in southern Angola; local seed producers were trained and fertilizer experiment was conducted in the framework of the project (Asanzi et al., 2006).

The Aldeia Nova project in the Kwanza Sul province, a joint initiative of the Angolan government and the company LR Group from Israel, is probably the most successful large-scale agricultural project implemented in Angola, in which the government of Angola has invested about 100 million USD. The project, based on the experiences from the Israel Moshaw, was focused on economic and social development of rural families, with special regard to ex-combatants; the project provided modern infrastructure, housing, farm buildings and equipment, agricultural technology, livestock, production inputs, guidance and institutional support to families involved in the project. In total 600 farmer families were settled in 15 restored villages in the Wacu-Cungo valley, each village includes approximately 30 households. Each household/family farm, and usually the whole village, are specialized in specific livestock production. In total, there are 160 dairy farms, 120 egg farms, 120 poultry-fattening farms, 20 pullet farms and 80 pig farms in the Aldeia Nova. Remaining 100 families are employed in the service facilities: churches, schools, medical clinics, infrastructure facilities and mainly in the Logistic Centre which encompasses ‘input’ facilities: nursery for trees and vegetables, egg hatchery, livestock feed facility, milk products production plant, butchery for cows, pigs and chicken, and storage facilities. Today, the Aldeia Nova produces 36,000 liters of milk and 300,000 eggs per week and is the only source of fresh milk in Angola (Khimli, 2009). The aim of the project is that farmer families will be able to purchase their farms from the project administration. The project was planned to expand to other Angolan regions, including Bié province, nevertheless, the expand initiative has been terminated. There is no official explanation available, nevertheless it could be assumed that either the governments of Angola and Israel did not agree on the form of follow-up projects realization or the possible expansion threatened interests of owners with large areas of arable land (usually governmental officials).

### 2.2.1 Technology adoption process

Hossain and Sen (1992) in Mendola (2006) divided household characteristics that influence wellbeing into four major groups:

(i) demographic characteristics such as family size and number of children,

(ii) human assets as education and age,

(iii) institutional assets like NGO or cooperative belonging and

(iv) land assets and new technology: land owned, land cultivated, cattle, area irrigated and adoption of new technologies.

Determinants of innovation should not be viewed individually, but within the context of a complex agricultural innovation system (Larsen et al., 2009). Innovation in agriculture is not only about what happens at the farm level, there needs to be innovation all along the value chain, including at the policy level in agribusiness and government (Vanclay et al., 2013). While ministry staff has tended to emphasize extension-led innovations, there is much evidence of changes introduced by farmers, perhaps the most obvious is the use of cows for work (Starkey et al., 1991). In contrary, Ker (1995) declares that although farmers would be expected to seek new technologies that would reduce their own production constraints, this does seem to happen slowly.

Increasingly, according to Boserup (1965), agricultural production intensification and change in agricultural technologies use are dependent variables on population growth. Only when land becomes limiting because of population pressure, farmers would intensify their production, and even then they would continue to use techniques adapted to more extensive systems as long as possible, until forced by starvation to adopt more labour-intensive techniques such as manuring or soil conservation, and only after then they would adopt or invent labour-saving technologies such as ploughs.

The constraints to the adoption process of innovation include according to Feder (1981) following: lack of credit, limited access to information, inadequate farm size, insufficient human capital, absence of equipment to relieve labour shortages, chaotic supply of complementary inputs and inappropriate transportation infrastructure. Aversion to risk is an important factor in explaining farmers' adoption behaviour; lack of adoption or slow adoption patterns is expected where risks, subjective as well objective, are high. Another limitation factors in the improved technologies adoption are cost of improved technologies (Fuller and Aye, 2012; Awais and Khan, 2014) and isolation of farmers (Fuller and Aye, 2012). However, FAO (2010) believes that the constraints are rather psychological or social than technical or economic.

The adoption behaviour differs across socioeconomic groups and over time (Feder, 1981). According to Feder (1981), larger farms – early adopters – will start with experimentation by applying the new technology on part of the land and using the traditional techniques of cultivation on the rest of the land; farms below a critical size will not use the new technology. Even more, new technologies are according to Gaemelke (2001) a major driving force behind structural change resulting in fewer and larger farms, more machinery and less manpower used on farms as farmers tend to expand with investment in the new technology.

### 2.2.2 Education as a determinant factor for technology adoption

The agricultural productivity is directly related to the technology adoption. In the case of a traditional production system based on the peasant family, production could be increased by the provision of new technology, in the form of knowledge and of capital goods, to peasant producers (Ntsabane, 2006).

Technology adoption by individual farmers is in direct relation to their level of education. No new agricultural technology, however modern and effective, can improve the situation if people are unable to access it and use it; farmers need to have the capacity to adopt and understand new technologies, and the system needs to be developed to meet their needs and to enable them (Juma, 2011; Awais and Khan, 2014). A low level of education could impede adequate awareness of animal draught farming which may result in a conservative approach to the use or adoption of draught animals for farming (Bawa and Bolorunduro, 2008; Abubakar and Ahmad, 2010).

According to Mittal and Kumar (2000), education is the most crucial resource which explains the changes that take place in individuals in their various stages of development. In agriculture, education creates conditions that enable farmers to acquire and use knowledge for decision-making regarding allocative and technical matters effectively. In agriculture, in particular, most of the studies on the subject have established that the education and skills of the agricultural workers are significant factors in explaining the inter-farm, inter-regional and inter-country differences in agricultural performance, along with the availabilities and potentials of natural resources of land and water, and infrastructure and institutional investments in inputs, credit, research, etc. (Singh, 2000). Human resource development requires, among other things, considerable investment in education, health and nutrition (Singh, 2000).

Some of Africa’s most persistent agricultural challenges lie in the educational system. The current gaps in educational achievement and the lack of infrastructure in many African school systems are an opportunity for governments to adopt more community driven models that prioritize education in a holistic way that improves community involvement, child achievement, agricultural production, and the standard of living for rural population (Juma, 2011). Approaches to agricultural development have tended to ignore the social complexity of rural communities and neglect the importance of indigenous knowledge and skills (Starkey and Koorst, 1995). Animal power is now missing from the educational curriculum and people generally lack relevant understanding and knowledge (Ramaswamy, 1994; Starkey and Koorst, 1995), animal traction has only recently become an important element of agricultural education and training (Starkey et al., 1991). In South Africa, the first post-graduate course in DAP was held in 1998 in Animal Traction Centre at the University of Fort Hare, it extended over four weeks (James and Krecek, 2000). Other usual constraint in education about animal traction is that educators tend to prefer the more sophisticated modern technologies connected with mechanized agriculture (Starkey and Koorst, 1995).

Some literature considering animal traction reviewed expressed need to incorporate animal traction into government policy as well as into training and education curricula of schools, agricultural colleges and universities (Starkey et al., 1995; ATNESA, 1998) as most farmers know more about animal traction than the potential trainers. During the preparation of the courses, special emphasis should be on community-based participatory approaches, concepts of broadly-based production within the environment are essential (Starkey et al., 1995). The message dissemination should be done in the appropriate language for the different areas – educational pamphlets, videos, television and newspapers/magazines, posters, verbal presentation, training courses and in schools (James and Krecek, 2000). International experiences could be valuable as well, for instance, of training centers in Zimbabwe and Zambia as Wichmann (1996) pointed out that countries with similar climate can better adopt agricultural technologies from each other.

**Education through agricultural extension services**

Agricultural extension and advisory efforts have significant and positive effects on knowledge, adoption and productivity (Davis, 2009), and are essential for the success of any mechanization and sustainable farming system particularly (Sims and Kienzle, 2006). In Mozambique, the access to extension introducing new varieties, promoting natural pesticides and promoting commercialization increased farm production by 8.4 % (Davis, 2009).

Extension originally was conceived as a service to 'extend' research-based knowledge in the rural sector to improve the lives of farmers. It thus included components of technology transfer, broader rural development goals, management skills, and non-formal education. Today's understanding of extension goes beyond technology transfer to facilitation; beyond training to learn, and includes assisting farmer groups to form, dealing with marketing issues, and partnering with a broad range of service providers and other agencies. Set of organizations that support and facilitate people engaged in agriculture production to solve problems and to obtain knowledge, skills or technologies in order to improve their livelihoods can include governmental organizations, NGOs, producer organizations, other farmer organizations and private sector actors such as purchasers of agricultural production, input suppliers and training organizations. (Davis, 2009)

The technology transfer should involve key concepts as follows: participation, collaboration, adoption, performance, and impact. These definitions involve shared values, expectations, competencies, ideas, resources, meaningful interactions, tension reduction/conflict resolution mechanisms, results, benefits shared among the various actors, and a clear vision of the future. All these factors can be pulled together to make up what is known as the technological transfer mix or the foundation of programme impact planning and impact assessment (Nyemba, 1997).

Farmer field schools (FFS) are broadly adapted extension model in sub-Saharan Africa, for example, in Angola, this model is the one officially supported by the government (Davis, 2009). FFS are used for a variety of activities, including food security, animal husbandry, soil and water conservation, and even beyond agriculture for health issues like HIV/AIDS and other relevant rural topics. FFS have shown the remarkable impact in sub-Saharan Africa in terms of pesticide reduction, increases in productivity, knowledge gain among farmers, and empowerment (Davis, 2009).

A related concept to FFS is the farmer study circle which is more informal than FFS when a group of farmers meet regularly, with no external expert, to learn and solve their problems by them own. Other innovative extension methods applicable according to Davis (2009) in sub-Saharan Africa should be related to information and communication technology sector or to the Agricultural Technology Management Agency which is oriented to market-driven extensions and use bottom-up planning procedures. Nevertheless, generally can be considered that there is no best practice for modifying extension programmes in sub-Saharan Africa, still, participatory extension approaches are strongly recommended.

The success of the extension activities depends on many factors, including networking, well-organized dissemination of information, well-planned contents of courses meeting the needs of the local population, etc. (Mazancová and Havrland, 2010). The extension agents in sub-Saharan Africa will need special skills that go beyond the basic technical skills, such as skills in group dynamics, marketing, information and communication technologies and skills in connecting farmers in their areas to markets and other institutions that are demanded by farmers (Davis, 2009).

Extension organizations in Angola face the major problems of professional incompetence and lack of motivation among their employees, which, consequently, leads to very poor extension services that are under no interest of farmers, and to stagnation of rural development process. According to the survey in Bié province, the lowest satisfaction of farmers was reported in the case of comprehensibility and language (as the majority of farmers prefers their mother tongue over Portuguese), followed by training methods. Thus, clearness, adequacy and comprehensibility of the training topics content are the fundamental factors influencing farmers' acceptance process. To provoke motivations in farmers' attitude to attend training or courses, a crucial factor lies in successful information transfer process (Mazancová and Havrland, 2010).

The highest payoffs to extension occurred in developing countries that are catching up with industrialized countries and with farmers who have access to schooling, technology, and extension (Davis, 2009).

### 2.2.3 Child labour

Norman (1981) in Ker (1995) pointed out that farmers attempt to increase productivity in several ways, including: (i) expecting children to help with certain types of farm work, (ii) hiring extra labour, (iii) growing crops in mixtures, (iv) using mechanization or (v) using herbicide.

International Labour Organization (ILO, 2002) defines that the highest child labour rate is in Sub-Saharan Africa where the majority of the working children are unpaid family workers involved in agriculture. Child labour is used in backward agriculture where primitive techniques of cultivation are applied (Dwibedi and Chaudhuti, 2014). The issue of child labour is critical since children are often recruited to the farm tasks resulting in decreased school attendance (Delgado-Matas and Pukkala, 2014).

Empirical evidence by ILO (2002) shows that there is no gender difference in the global incidence of child labour for the age category 5 to 14 years; gender differences are only observed as boys and girls grow older. The same result was obtained by Badmus (2011) in Nigeria. Contrary to this, Psacharupoulos and Arriagada (1989) and Grootaert and Patrinos (1998) argue that boys are more likely to be involved in child labour. According to Badmus (2011), households headed by females have a higher dependency ratio, which increases the probability of child involvement to work.

The likelihood of child working is negatively affected by the level of parents' education (Psacharupoulos and Arriagada, 1989; Grootaert and Patrinos, 1998; Badmus, 2011). On the other hand, it is positively affected by the age (Cockburn, 1999; Grootaert and Patrinos, 1999; Badmus, 2011). From the household income point of view, Baland and Robinson (2000) argue that child labour is a device for transferring resources from the future into present; as poor families have no reason to expect any change in their future income, they have no motivation for putting the children in work. High involvement of children in field operations might be caused by lack of adults staying on farms caused by migration to urban areas, as well as by civil war consequences (Delgado-Matas and Pukkala, 2014).

According to Delgado-Matas and Pukkala (2014), children in the traditional Umbundu system of Angolan highlands are participating in the farming activities mainly in harvest seasons.

### 2.2.4 Hand tool technology improvements

Improvements in the design of hand tools, made be possible by fairly simple and ergonomically sensible changes, could make a big difference to the productivity and health of farm families; this is particularly true in the case of women (Sims and Kienzle, 2006). Approaches to identifying ergonometric problems and producing solutions may lead in reducing unnecessary drudgery. Essential ergonomic concepts that need to be considered according to Sims and Kienzle (2006) are: (i) type of work, (ii) work intensity, (iii) physical work capacity, (iv) how hard people can work and (v) gender specific effects of agricultural work.

Regarding load carrying, a handcart can carry double the load of a wheelbarrow and is already an important part of the transport system of some countries; handcarts are even superior to animal carts for small loads and short distances because it is simpler than hitching up an animal (Fuller and Aye, 2012).

### 2.2.5 Animal traction adoption

The relationship between the land, draught animals and man is highly complex. For both food and energy, the renewable draught animal power system, integrated with the milk and meat production systems, has no equal (Ramaswamy, 1994).

As draught animal power (DAP) is regarded more important than human power, particularly in the context of smallholder farming systems, animal traction resource centres are crucial in the spread of the DAP use. According to Starkey et al. (1995), animal traction resource centres should be established within national and provincial institutions, emphasis should be on on-farm training and interaction with farmers. In the case of South Africa, Starkey et al. (1995) recommend series of animal training centres establishment for training purposes; the centres should be closely associated with existing agricultural education institutions and with local farmers as well. Fuller and Aye (2012) suggest portraying of animal power as a “renewable technology that is relevant to the modern world” through various media and educational outlets to change the not favourable image of animal-draught technology.

Broader DAP adoption in southern Africa is supported and facilitated by the animal traction programme as a regional initiative that emanates from the 2004 Southern African Development Community (SADC) declaration on agriculture and food security (Mabuza et al., 2013).

For adoption of animal traction in South Africa, Starkey et al. (1995) defined various actions relevant to time scales. In the short-term, emphasis should be on training of trainers, international information exchange through networking and preparing educational materials, including books and videos. In the medium-term, a cadre of trained personnel should be developed, benefiting from training resources in neighbouring countries such as Zambia (centres in Palabana and Mpika) or Zimbabwe. In the long-term, animal traction should be part of the revised curriculum of primary and secondary schools and tertiary colleges. For farmers out of school, the topic should be included in the extension curricula. Farmer-to-farmer approach could be preferable in the areas where the knowledge of animal traction is limited. The combination of extension work (farmer training), provision of inputs and the availability of credit can lead to adopting of animal traction technologies by farmers (Starkey et al., 1991; Bawa and Bolorunduro, 2008).

Starkey et al. (1995) defines key issues in animal traction education as follows:

(i) preserving and transmitting traditional knowledge on animal traction; (ii) changing the attitude of officialdom to officialdom; (iii) changing the attitude of youth to animal traction; (iv) bringing animal traction into formal education; (v) training in animal traction and (vi) improving public awareness. In addition, multidisciplinary programmes are recommended (Starkey et al., 1991).

Mbata (1997) declares, according to results obtained in Kenya that animal traction adoption is mainly influenced by economic factors rather than sociological and institutional factors. In particular, the number of oxen available for farmers, availability of credit and the price of maize is the major determinants of animal traction in the study area. In contrary, Mbata’s results (2001) of the study from Lesotho indicate that animal traction adoption is equally sensitive to both sociological and economic factors, the most significant being the number of work animals and farm income, respectively. In both cases, for widespread animal traction adoption, Mbata (1997, 2001) recommends increasing the economic base of the farmers, with special efforts to credit for poor farmers as a motivation towards increased animal traction adoption.

The development of an efficient and reliable system for purchasing farmers' maize, at a fair price, would probably be the most effective means of boosting animal traction in South Africa (Starkey et al., 1991). In Mozambique, Keyserlingk (1999) recommended for the post-war situation integration of cattle into the farming systems as an essential supplement to cattle restocking. In areas where there is a demand for draught animals, but few cattle available, the establishment of small-holder breeding herds should be encouraged; cattle supplied for work purposes should not be sold to farmers below their market value for meat (Starkey et al., 1991).

Animal traction spread seems to be linked to the introduction of a new cash crop, elsewhere, farmers often seemed to be slow to adopt it (Ker, 1995); adoption of animal traction is more likely on larger farms as well (Feder, 1981). The areas of possible new adoption with more chance of success are according to Starkey et al. (1991) those of high agricultural potential where draught animals are presently little used; success is likely to be the highest in areas with good infrastructure and easy access to markets for farm produce. Barrett in Reardon et al. (1997) found important cash flow problems for traction adopters: internal rates of return were positive over 10 years, but net returns for oxen-traction farms were below net returns before adoption for the first four years due to slow learning by farmers. Thus, because of high costs and learning requirements, farmers' cash sources or credit and veterinary services are crucial.

Generally, the power available for farm use can be increased by diversifying the type of work. Diversification and expansion of draught animal power can be brought, according to Sims and Kienzle (2006), in some of the following ways:

(i) widening the scope of the number of jobs that animals can do as more crop production jobs or stationary activities like milling,

(ii) using single rather than multiple animals, and providing them with appropriate (usually lighter) equipment,

(iii) using animals that have hitherto not been used for farm work as donkey or mules and

(iv) using animals for non-farm work, such as road maintenance; the greatest potential for diversification is in transport.

Diversification of the animals' work is essential in the context of sub-Saharan Africa as nowadays, animals are usually used only for few weeks per year, thus making costs of these operations very high.

Improved ploughs design forms another option in improvement of efficiency in animal traction (Fuller and Aye, 2012). Animal-drawn wheeled tool carriers, identified as a step between traditional implements and the tractor, are not recommended by Starkey et al. (1991) for small farmers as they found it too costly and even risky because breakdown could result in a loss of all processes, rather than one in the case of the traditional implements.

### 2.2.6 Tractorization and mechanical power technology adoption

Mechanical power technology share on the land cultivation has been increased in developing countries in Asia and Latin America, with the exception of sub-Saharan Africa. In Asia, adoption of mechanical technologies helped enhance agricultural productivity and lowered the unit cost of crop production. In contrary, sub-Saharan Africa continues to have very low levels of mechanization and available data indicate declining rather than increasing levels of adoption, even among the countries that were the early trendsetters, such as Kenya and Zimbabwe (Pingali, 2007).

Regarding mechanical power technology effective adaptation and use, Rušarová (2010) formulated following recommendations:

(i) significant increase of tractors; more durable tractors with higher estimated life suitable for the conditions of Angola are recommended, especially brands Massey Ferguson, New Holland, Valtra and Zetor. Long-term loyalty to chosen brands is recommended for reasons of availability of spare parts and simplifying work of technicians taking care for same tractor types. Simple models with minimum electrical parts are highly recommended due to poor service centres spread and climatic conditions different from that of the tractors origin;

(ii) increase work capacity of tractors;

(iii) increase of number of implements to achieve higher share of complex mechanized technologies in agriculture;

(iv) establishment of tractor assembly line construction that would result in increased possibility of tractor purchase and faster delivery of spare parts;

(v) organization of convenient courses for technicians and tractor drivers which should be focused on proper tractor use within specific agriculture activities in conditions of Angola, periodic tractor maintenance and basic repairs. Courses are recommended to be as the most practical as possible, as tractor drivers and technicians might have low literacy level.

## *2.3 Angola*

The area of the country is 1,246,700 $km^2$, the population was 20,609,294 in 2012 (INE, 2013). Basic administrative structure divides Angola to 18 provinces; each province is fragmented into municipalities (164 in total). Municipalities are segmented in communes (635 in total) that are formed by the villages.

### 2.3.1 Literacy and education

The literacy rate is 67 % (INE, 2013). Real literacy rate is probably lower as qualitative level of education is low and especially in rural areas, cases with pupils in the higher classes of primary schools that are not able to read and write occur. Education is considered as a priority of the services – in the last decade, all curricular school programmes were reformed, the duration of free mandatory primary education expanded to six years and large investments were put into the infrastructure of the school network. The government has expanded vocational/technical education to address massive skill shortages: between 2006 and 2009, 34 new technical schools were built and equipped throughout the country (AfDB, 2012). However, more than 75 % of teachers never received the necessary training and only 54 % of students enrolled complete primary school (AfDB, 2012).

Majority of literate population has only primary education: 55 % in Angola, 82 % particularly in rural areas; the highest rate of only primary education is in the Bié province (INE, 2013). Agricultural education in Angola is divided to basic vocational education and medium vocational education. Six courses: Livestock production, Agriculture, Management of agriculture, Forestry, Mechanization and Food processing specifically are available at seven specialized schools –*Instituto Médio Agrário*; the schools are in Tchivinguiro – Huíla province, Malanje – Malanje province, N’dalatando – Kwanza Norte province, Waco Kungo – Kwanza Sul province, Huambo – Huambo province, Andulo –

Bié province and Negage – Uíge province (Mazancová et al., 2009). *Escola das Práticas Agrícolas de Catabola* in Bié province offers only basic vocational courses.

### 2.3.2 Agriculture

69.3 % of the 8,447,000 economically active population worked in agriculture in 2010 (Faostat, 2013). In contrary, according to the Ministry of Agriculture, 9,306,260 people work in agriculture, with 52% women share, minimal age of workers is considered as 10. Table 2 shows the age structure of people concerned in an agricultural occupation. According to INE (2013), there are 1,861,252 farmer families with a mean of 5 family members in Angola.

**Table 2: Age composition of people working in agriculture**

| Age | 10-25 | 26-35 | 36-45 | 46-55 | 56-65 | 65-75 | 76 and more |
|---|---|---|---|---|---|---|---|
| Population [%] | 63 | 10 | 11 | 7 | 5 | 2 | 2 |

Source: Ministry of agriculture, 2009

The average area cultivated by farmer family in agriculture season 2007/2008 was 1.56 ha. The majority of the area is cultivated by farmer families; rate of the area is estimated at 97 %.

The size and organization of lands is variable: vast majority of Angolan farmers is substantial small-scale farmers - *camponeses*. The area of *camponeses* oscillates about 1.5 ha. Only small parts of farmers belong to the category of medium or large-scale farmers – *agricultores* (or as has been usual since the Portuguese era *fazendeiros*) – they usually live in town and their land is cultivated by external hired labour, only part of the area is commonly cultivated. The most vulnerable groups in land tenure as well as extreme poverty is often related to the status of widow; the widow’s children move out of the extreme poverty situation as they become productive and as they are given access to land through different means (Jul-Larsen and Bertelsen, 2011).

In Angola, there are three main categories of substantial agricultural land: *Ochumbo*, usually small area neighbouring to family house, is used for fruit trees, vegetables or intercropping of maize and beans cultivation. *Ongongo* or *lavra* are larger, more distant rain-fed fields used predominantly for maize, cassava and sometimes beans cultivation. *Onaka* or *naca* are small wetland fields along rivers and drainage systems used for vegetables, bananas and sugar cane cultivation. There is a fourth category of land appeared only in richer villages – *ombanda* which is fed by a well-developed system of dams and water canals and are used almost exclusively for production of cash-crops (Jul-Larsen and Bertelsen, 2011; Delgado-Matas and Pukkala, 2014). *Ombanda* and *naca* are the most valuable, according results of Delgado-Matas and Pukkala (2014).

From the legal point of view, new land law from 2004 redefined the land use and rights – all land has to be regularized and revert to state control (Nielsen, 2007). This means in fact, that Angolan state is the only legal owner over the land with the right to give concessions to farmers. Another crucial principle of the law from 2004 is that priority over the land concession should pertain to traditional land owners. Other constraints in land ownership have been raised as a result of a long civil war, mainly in the central regions where significant numbers of traditional land owners were displaced: the main conflict over a land ownership is between actual residents and internally displaced people, returnees and ex-combatants.

Agriculture in Angola is closely controlled by the Ministry of Agriculture (MINAGRI). At the provinces, MINAGRI is represented by Provincial Directory of Agriculture and Rural Development (MINADER). MINADER is represented in each municipality as a situation of Agricultural Development (EDA). Technicians at EDA have their certain area of activity as animal production, crop production, etc. with responsibility to realize these activities to improve the development of rural communes, quantity of technicians depends on municipality size (Rušarová, 2010).

In the Bié province, despite the high agricultural potential, only few crops are cultivated; the most obvious causes of the situation are low crop diversity, lack of seeds of good quality, low level of agricultural knowledge and lack of tools (Mazancová et al., 2007). Farmers of the region have traditionally produced maize and pulses for subsistence, vegetables (mainly garlic, cabbage and potatoes) and timber as cash crops (Delgado-Matas and Pukkala, 2014). The traditional Umbundu land-use system allows to meet the subsistence needs while producing economic revenue for the developing Angolan economy, although meeting the subsistence needs of daily food depends on the amount of cattle (Delgado-Matas and Pukkala, 2014). According to Delgado-Matas and Pukkala (2014), one additional livestock unit would decrease the total land expectation value as much as one additional hectare of *naca* or *ombanda* field would increase it, thus, according to him, increase of ploughing productivity or introduction of new cultivation techniques can have important impacts if the number of draught animals are reduced.

### 2.3.3 Station of agricultural development (EDA)

EDA is the basic governmental unit responsible for agricultural development in the municipality. EDA Catabola suffers from a considerable lack of skilled personnel as the others EDAs in the country as well. The main reasons of this situation are identified as follows: lack of professionals as war consequence, insufficiency of students willing to study agriculture and lack of graduates willing to work in rural areas such as Catabola municipality. Additionally, job positions in EDAs are under the responsibility of the Ministry of Agriculture and call for new positions is made only once per few years across the whole country at the same time. The technical staff in EDA in 2011 consisted of three medium technicians with achieved level of education of 12$^{th}$ class, five basic technicians with achieved level of education of 8$^{th}$ class (three of them have their job position in the communities) and one non-qualified staff. Except for these, two medium and two basic technicians were paid by the Czech Development Cooperation project, but their contracts were not prolonged after the project termination at the end of 2011. In addition, one veterinary technician is allocated to the municipality; he is responsible mainly for the vaccination of animals in the municipality.

Main activities of the EDA are: extension and material support through credits and micro-credits to assisted villages within the PEDR programme (Programme for Rural Extension and Development), distribution of inputs among selected farmers and associations, establishment and management of demonstration plots including demonstration days, support in associations and cooperatives establishment and facilitation with (micro-)credits arrangement for their members, realization of trainings for the FFS facilitators and cooperatives' members. Training topics for 2011 included the following: vegetables transplantation, composting and associations' establishment and management.

EDA is receives certain amount of fertilizers, seeds, tools and equipments from the regional IDA each year. Regarding to the actual governmental strategy, part of the received inputs is directly sold to farmer son subsidized price; other part is distributed in form of credit, and the rest remains stored in the EDA's stock for future distribution, usually according to the plan of Agricultural Campaign. Annex 5 shows type and quantity of inputs that EDA Catabola received in 2008, 2009 and 2010. The inputs distribution focuses on selected villages or neighbourhoods which are called assisted communities (in total 34 in 2011), then on medium-scale farmers, cooperatives and FFSs.

Majority of the trainings related to agriculture are conducted in the Centre of Agricultural Trainings in Wongo. The Centre serves as main agricultural training and experimental compound for the whole province as it is equipped sufficiently for long-term trainings with capacity up to one hundred participants. Thus, agricultural trainings for governmental as well as non-governmental staff are frequently taken place there. Wongo locality is close to Chipeta, basically on a half way from Kuito to Catabola.

### 2.3.4 Technologies applied in agriculture

The traditional Umbundu land-use system of Bié province is labour-intensive and uses animal traction for specific tasks; women play a pivotal role in farming (Delgado-Matas and Pukkala, 2014). Most common hand-tool implements are machetes, European hoe, traditional hoe and saws. The average farmer family owns 2 machetes, 3 European hoes and 2 traditional hoes (Ministry of Agriculture, 2009). According to Delgado-Matas and Pukkala (2014), labour needs are a major constraint in the Umbundu system; especially women labour availability is crucial.

The most common use of animal traction is for ploughing and cart drought, cattle are the most utilized animals, followed by donkeys. Cattle in Huambo are working on average 2 – 3 $h.day^{-1}$, in total 2 – 3 $day.year^{-1}$, the costs for animal traction are 717.23 $AKZ.h^{-1}$ (Chipaco, 2010).

Majority of the draught animals restocked in Huambo province (from where majority of draught animals in the neighbour Bié province have their origin) come from Huíla in the southern part of Angola, the breeds are 'Sanga' and 'Crioula', both are of more or less 400 kg ; the animals are fed extensively: cattle are usually out at the pasture between 8 a.m. and 3 p.m., secured by boys; except for this period, the animals are usually kept without any fodder and even water (Chipaco, 2010).The contribution of livestock to agricultural production is based on the use of oxen as draught animals (Delgado-Matas and Pukkala, 2014). After the war, draught animals restock started with their distribution to the ex-military forces in the framework of the World Bank project: each group of the chosen ex-combatants received one pair of draught animals (Chipaco, 2010).

The total number of tractors in operable status in Angola (April 2010) is estimated at 1,940 units, annual growth of the tractor number in operable status owned by the landholders can be about 120 units; thus, the number of tractors per 1,000 ha reached 0.473 (Rušarová, 2010), while in Huambo, there are 0.2 tractors per 1,000 ha (Dos Santos, 2009).

From the point of view of brand structure, tractors of Indian brand Mahindra are the most frequent, followed by Massey Fergusson (Dos Santos, 2009; Rušarová, 2010), New Holland, Valtra and Tafe. The structure of the machinery park has changed every year, as the assortment is very fast; rapid tractors wear in Angola is caused by many factors that are resulting from the general lack of proper tractor maintenance as the base for tractor durability (Rušarová, 2010).In rural areas of Huambo, one tractor cultivates on average 95 ha with use of 1.7 implements, one working pair of cattle work on 2.4 ha using 0.8 implements; comparing to international statistics where number of regularly used implements is 6 and 7 respectively (Dos Santos, 2009).

Mecanagro, as a specialized governmental agricultural mechanization department, is responsible, among others, for machinery distribution to its provincial departments. At the provincial level, Mecanagro manages cultivation of selected areas with use of the tractors and relevant implements (mainly disc ploughs and harrows), machinery repair and is mainly responsible for rehabilitation of unpaved roads. Majority of tractors received from the national level are further distributed among municipal administrations (which consequently spread tractors to communities). Mecanagro (and in 2008 and 2009 the contractors as well) is managing implementation of Campaigns for Soil Preparation parallel to the Agricultural Campaigns. Its implementation at the communities' level is controlled by EDAs, certain areas are chosen according to the necessities of the communes and objectives for the corresponding Agricultural Campaign. Nevertheless, medium farmers and associations are preferential. Price for specific operations varies according to the type of operation, locality and operator. Primary tillage with use of plough and secondary tillage using disc harrows oscillate from 40 to 75 USD.ha$^{-1}$ (MecaInforme, 2009). Sekualali (2007) defined main constraints of mechanization spread in the municipalities in the Bié province as follows: (i) lack of technical assistance, (ii) lack of fuel and lubricants, and (iii) problematic access to remote areas.

Energy employed in agricultural production (using man-labour, draught animals or machines) can be characterized according to the amount of energy input per ha of agricultural land (kJ.ha$^{-1}$) or the so called installed power (kW.ha$^{-1}$) which is categorized to three grades: grade I has an input of 0.1-0.3 kW.ha$^{-1}$, grade II has an input of 0.3-1.5 kW.ha$^{-1}$ and grade III has an input above 1.5 kW.ha$^{-1}$ (Havrland et al., 2003). The installed power in Angola, according to Rušarová (2010) is represented in Table 3. The remaining 3.2 % of arable land corresponds to commercial agricultural companies whose technologies structure is not known.

**Table 3: Installed power by technologies used in Angola in 2008**

| Technology | total area cultivated [ha] | area cultivated [%] | total power [kW] | installed power [$kW.ha^{-1}$] | grade |
|---|---|---|---|---|---|
| mechanical power | 25,380.0 | 0.8 | 18,409.5 | 0.75 | II |
| animal draught | 768,701.5 | 25.0 | 168,000.0 | 0.22 | I |
| hand-tool | 2,183,112.0 | 71.0 | 413,227.7 | 0.19 | I |
| **Total** | **2,977,193.5** | **96.8** | **599,637.2** | **0.2** | **I** |

Source: Rusarova, 2010

Dos Santos (2009) defined installed power of tractors in rural areas of Huambo at 0.19 $kW.ha^{-1}$. The significant difference from data of Rušarová (2010) could be explained by relative high area cultivated per one tractor in the area surveyed by Dos Santos in comparison with total area in Angola.

# 3 Hypotheses

This study is based on the overall hypothesis that hand-tool technology use is prevailing among farmers in Catabola municipality; use of draught animals is known but rare, as well as mechanical power technology. The specific hypotheses of the study are summarized in Table 4.

**Table 4: Hypotheses of the study**

| **Hypothesis number** | **Summary** |
|---|---|
| H1 | Use of animal traction and/or mechanization is highly affected by farmer family income, education level of family members, field size and structure of family members involved in field operations. |
| H2 | There is a difference in labour utilization and adoption capacities between two categories of farmers using only hand-tool technology: (i) farmers using only human power of their own family members and (ii) farmers using also human power of hired external workers. |
| H3 | Child labour prevails within poorer, less educated farmer families where it forms an important part of the total power of the farmer family. |

# 4 Objectives

## 4.1 The main objective

The overall objective is to formulate an agricultural strategy for Catabola municipality related to the use of technologies. The strategy could serve as a source of data for the Government of Angola (or more specifically, for the Ministry of Agriculture) in the formulation of the agricultural technologies' development strategy to be implemented in the particular provinces and municipalities consequently, with regard to their specific conditions.

## 4.2 Specific objectives

(i) To analyze the present situation of technologies (hand-tool, draught animal, mechanical power) use in the Catabola municipality and prognosis of its probable progress.

(ii) To identify independent variables affecting technologies use (as a dependent variable) in agricultural practice in Angola (Catabola municipality).

(iii) To propose the most suitable strategy of agricultural development in the Catabola municipality.

# 5 Methodology

## 5.1 Catabola municipality

Catabola is one of the nine municipalities in the Bié province. The municipality covers an area of 3,028 $km^2$. Number of its population is 182,429 (7 % of the Bié population) with half of its population living in Sede community (MINADER, 2011). Catabola is divided in five communities and one settlement: Catabola (for easier distinction from the whole municipality is often called Sede), Chiuca, Chipeta, Sande and Cayuera and settlement (*povoação*) Muquinda. Administrative division of the Bié province to municipalities and communities is designed in Annex 1. Structure of the municipality relevant to the administrative and population division is represented in Table 5.Villages (*aldeias*) or town neighbourhoods (*bairros*) lie in the authority of *embalas* which are larger villages in fact; one embala usually administrates up to ten villages or neighbourhoods. From the point of view of way of life in the municipality, neighbourhoods do not differ notably from villages.

**Table 5: Administrative and population division of the Catabola municipality**

| Community | Number of villages | Number of neighbourhoods | Number of population | Number of families |
|---|---|---|---|---|
| Sede | 63 | 17 | 96,066 | 20,180 |
| Chipeta | 45 | 7 | 20,138 | 4,119 |
| Sande | 35 | 3 | 18,092 | 3,433 |
| Chiuca | 61 | 1 | 18,964 | 3,274 |
| Cayuera | 37 | 1 | 17,782 | 3,202 |
| settlement Muquinda | 32 | 1 | 11,387 | 2,157 |
| **Total** | **273** | **30** | **182,429** | **36,365** |

Source: Administration of Catabola municipality, 2010

The altitude of the municipality is quite high – above 1,500 m.a.s.l. Soils are quite favourable for agricultural activities with prevailing clayish type. Annual precipitations oscillate about 1,500 mm. In comparison with other municipalities, Catabola is of convenient hydro conditions with relative water sufficiency because of rivers Cunje, Konjo, Kuquema and Kuito. The river basin comprises significant potential for fishing and fish breeding. 16 simple barriers are constructed on the rivers and their tributaries in the municipality for the purposes of milling – traditional mills consist of two stone wheels, one of them is moved by the water flow.

Catabola municipality belongs to the Agricultural region III defined by Diniz (1998) which is considered as the most suitable for agriculture; traditional crops are cereals, beans, potatoes and vegetables; interior fishery is common due to sufficient rivers. Agricultural production in the municipality is based on rain-fed growing season from September to April with planting realized from September to February. There are two traditional harvest periods in agricultural season: first is from beginning of February till half of March, the second is from the end of May do beginning of July. Maize is produced only in the first season, beans in both of the seasons.

The main ethnic group in the area is Umbundu. Although Portuguese is the official language of Angola, the majority of the population in the municipality speaks only Umbundu; Portuguese is used only occasionally, mainly in the formal situations. For customary reasons, tribes prefer to produce different crops, although general conditions for agricultural production is almost identical in some cases, tribal boundaries can be thus easily distinguished regarding crops growing in fields. In the municipality, maize and beans prevail on fields of ethnic Umbundu, while cassava is a main crop produced by neighbour Thokwe.

Education in the municipality mainly focuses on the schools of basic level; in 2008, there were 203 basic schools, 7 basic secondary schools referring to classes from $7^{th}$ till $9^{th}$ and 1 medium secondary school from $10^{th}$ till $12^{th}$ class. One of the basic secondary schools is EPAC (*Escola de Práticas Agrícolas de Catabola*), agricultural vocational school established in 2010 in the framework of Czech Development Cooperation. The school is the only one basic agricultural school in the region, its exceptionality at even national level is based on its advanced facilities which should serve for purposes of agricultural technicians and farmers of wider area than the municipality as well: agricultural library, pedological laboratory, parasitological laboratory, computer laboratory, meteorological station, processing centre of agricultural products, smith workroom and school farm of seven hectares.

The main road from Bié capital Kuito to Moxico province and further to Zambia crosses Chipeta and Sede community; Catabola town distances from Kuito by 57 km. The most distinct community in the municipality is Sande with 35 km far from the Catabola town. Although Catabola municipality with the Catabola town itself is crossed by the main road to Zambia, the traffic remains limited as the road is unpaved, as well as all other roads in the municipality. The quality of the road surface is rapidly degraded by the strong rains.

As a result, the majority of the roads in the municipality connecting other communities can be accessible only with the use of jeeps; roads are only partially or absolutely not passable in the raining season. Catabola municipality suffers from lack of access to electricity as well. There are only five public generators in each of the community capital. The generators are working for average three hours per day with common blackouts for longer periods. Additionally, cover of the public electricity remains limited to a few buildings in the centres.

## 5.2 Data collection

Primary data collection was conducted at three levels: national, provincial (Bié province) and municipal (Catabola municipality) in the following periods: (I) July - December 2010 and (II) July - August 2011.

The main limitations of the survey are based on poor literacy level of the farmers which created complications in the farmers' definitions of numbers and amounts; for an example of the area cultivated and income. Generally, there could be some data loss in the process of translation from Portuguese to Umbundu and back.

### 5.2.1 Methods in primary data collection

Methods used for the data collection varied according to the target groups, semi-structured personal interviews, focus group discussions and analysis of internal documents were the most frequent. The majority of the personal interviews at the provincial and municipal level were refilled as other questions have been raised during the data collection.

The interviews were conducted in a broad range of settings, including the respondents 'offices, households, fields and village meeting points. Most beginnings and termination parts of the interviews were informal, and many insights were obtained during casual conversations. Questions in all interviews were prepared in advance, but usually, during the interview, further information was detected as well. For the target group of small farmers, a questionnaire was designed (detailed Questionnaire is attached as Annex 2). Within this study, a responsibility towards the indigenous people was observed. First, the surveyor explained the premise for the study, including the aims. All interviews were carried out by people willing to participate in this survey.

The whole survey was conducted in Portuguese language, although questionnaires in the villages were translated in Umbundu language. The survey was conducted with the help of the EDA Catabola agricultural technicians: Alfredo Sapalo, Luís Cavicolo and Salomão Cangombe Wimbuando Henda.

Other valuable findings for the thesis included documents from Provincial Directory of Agriculture (MINADER), EDA Catabola and Catabola Administration. Some of the documents were rather internal; their obtaining was conditioned by long-term cooperation on developing projects in the Bié province.

Participant observation was one of the most important qualitative data collection methods used within the survey. According to DeWalt and DeWalt (2002), living in the survey context for an extended period of time is one of the key elements of the participant observation method. The experience of the almost two years long work on the agricultural development project in the area played an important role in the survey approach and collected data elaboration.

### 5.2.2 Organizations and individuals involved in the primary data collection

The structure of the organizations and individual involved in the primary data collection are defined in Annex 3.

Regarding small farmers, from five communities in the Catabola municipality, only two were selected for the survey: Sede and Sande in order to obtain a representative sample of small farmers in the municipality. According to the extension workers and administrator of the Catabola municipality, more advanced agriculture could be found in the Sede community whereas agriculture of small farmers in the Sande community is the least developed in the municipality. In the Sede community, of total 63 villages six were chosen: Liunde, Sashonde, Cavinda, Canjoio, Embala Gonde and Bimbi. In the Sande community, of total 38 villages three were selected: Dembi-1, Ongué and Bairro Santinho.

Contacts with the villages were conducted by the technicians Alfredo Sapalo (villages Liunde, Cavinda, Canjoio, Embala Gonde and Bimbi), Luís Cavicolo (villages Dembi-1 and Ongué) and Salomão Cangombe Wimbuando Henda (village Sashonde).

A survey in the villages started with semi-structured questionnaire with an authority of the village: village leader or other respected village inhabitant, such as teacher. Later, semi-structured questionnaires with farmers (usually family heads) were conducted. As a survey was conducted in the villages, direct observation was the other approach used as well. All of the village surveys began latest at six a.m. to meet farmers before they leave for their distant fields. The village survey took usually five hours.

## 5.3 Data analysis

The basic research output for further analysis is a typological classification of small farmers into categories based on technology use in combination with the hiring of extra labour:

(i) farmers using only hand-tool technology with no record of extra labour hire – farmers using the power of the farmer family members only (HT farmers),

(ii) farmers using only hand-tool technology with the employment of hired labour (HTH farmers), and

(iii) farmers using animal draught and/or mechanical power technology with/without some/any record of hiring extra labour (AM farmers).

Further division of AM farmers was found to be disadvantageous as the sample of AM farmers in comparison with HT and HTH farmers was considerably smaller. The key assumption for the typological classification is hypothesis H2 that HTH farmers are supposed to be transitional farmers, moving on to apply innovation in the form of draught-animal or mechanical-power technology.

MS Office Excel was used for descriptive statistics of agriculture and technologies used in the Catabola municipality, as well as for sociological analysis of small farmers. Furthermore, factors influencing level of technology used by farmers were determined. In addition, strategy for agricultural development focused on technologies use was designed. The strategy is based on quantified SWOT analysis.

### 5.3.1 Determination of factors influencing level of technology used by farmers

Ten factors that might influence the dependent variable – *level of technology used by farmers in combination with hiring of labour* – were defined. All factors, except for a few specific ones, take into consideration all farmer family members, not simply the head of the family. The factors are described in Table 6. There were two main sources for the factors definition: Coelli and Batesse (1996) and extension workers of EDA Catabola. Some of the factors defined before the primary data collection could not be applied as their validity was low. For example, factor *labour-days* was defined by the respondents as the family members working on field are working every day. Other useful variable, access to credits, was not included as the access to credits for Catabola municipality farmers was yet at the very beginning in the form of a governmental programme and the respondent farmers did not have the possibility to use them yet.

The data were analyzed using MS Office Excel for basic calculations and simple descriptive statistics as well as for the calculation of ANOVA. ANOVA (with $\alpha = 0.05$ %) was used to analyze ten variables defined in the Table 6 and to test the difference between small farmers' income in relation to citrus production as well.

**Table 6: Factors influencing type of farmer regarding technology used on field in combination with hiring of extra in the Catabola municipality**

| No. | Factors | Unit | Definition | Source |
|---|---|---|---|---|
| 1 | Total cultivated area | hectares | Size of land (*lavra* and *naca* field) * | Coelli, Batesse (1996), extension workers |
| 2 | Area cultivated per farmer family members | $ha.person^{-1}$ | Share of total area per each member of farmer family | extension workers |
| 3 | Annual income | .000 of AOA | Total annual income of the farmer family | extension workers |
| 4 | Power of farmer family | kiloWatt | Total power of farmer family members working on field | extension workers |
| 5 | Share of family members working on field | percent | Share of farmer family members working on field, including children | extension workers |
| 6 | Share of children age 5-14 working on field | percent | Share of children age 5-14 (both males and females) working on field** | extension workers |
| 7 | Share of children age 15-17 working on field | percent | Share of children age 15-17 (both males and females) working on field** | extension workers |
| 8 | Annual labour-days of hired workers | $day.year^{-1}$ | Number of extra workers multiplied by number of days they are working on the field of the farmer per year*** | extension workers |
| 9 | Education level of farmer family - parents | / | Proxy variable defining education level of head of farmer family and his wife**** | Coelli, Batesse (1996) |
| 10 | Highest education level reached by children of farmer family | / | Proxy variable specifying only the highest education level achieved among the children in the farmer family***** | Coelli, Batesse (1996), extension workers |

Notes: **Lavra* correspond to larger, more distant rain-fed fields used predominantly for maize, cassava and beans cultivation and *naca* are predominantly small wetland fields along rivers and drainage systems used for cultivation of vegetables, bananas and sugar cane.

** Families without children (not yet born or already out of the farmer house) and families with children younger than 5 years were excluded. Thus, data of 118 families in case of factor 6 (24 families in the case of factor 7) out of total 151 were applied.
*** The variable was used only for the comparison of the farmer groups HTH and AM; comparison with the HT farmer group is irrelevant as the farmers of the HT groups use only power of the farmer family members.
**** The scale from 1 to 15 has been broken into levels according to the Angolan education system: 1st-4th class, 5th-6th class, 7th-9th class, 10th-12th class (where 12th class is the graduation year of high school). The scale starts with the most frequent illiteracy of both the parents (and widow/widower). The highest level (15) corresponds to the 10th-12th class of one of the parents and the 7th-9th class of the other one. There was no higher education level achieved by the farmers. In the case of widows and widowers, only levels from 1 to 5 of the scale were used.
***** The scale ranges from level 1 to level 6 where level 1 corresponds to illiteracy of all children, level 2 to 6 is divided into levels according to the Angolan education system: 1st-4th class, 5 th-6 th class, 7 th-9 thclass, 10 th-12 th class, university
(1 USD equals is about 105.8 AOA – March 2015; Banco Nacional de Angola 2015)

## 5.3.2 Calculation of power applied by small farmers in the field

The man power depends on the individual characteristics such as follows: physical conditions, age and gender. An adult man in good health and well fed has a power capability of about 0.07 to 0.10 kW (Crossley, 1983). When working continuously, he produces about 0.08 kW, for shorter periods he can develop up to 0.30 kW (Havrland et al., 2003). Peak power output for a fit and healthy adult (but for only a few seconds) is about 0.90 kW (Parker in Fuller, Aye, 2012). But for a long duration, 0.06 kW is believed as reasonable (Tiwari et al., 2011).For calculation of human power, calculation of total energy expenditure TEE ($kJ.day^{-1}$) (Eq. 1) regarding gender, age and body weight was used as the derivation basin. TEE was calculated as:

$$TEE = PAL * BMR * 4.187 \qquad (1)$$

where PAL is a physical activity level that corresponds to heavy physical activity or vigorously active lifestyle divided according to gender and age (FAO, 2001), BMR is a basal metabolic rate and 4.187 is used for conversion of BMR from kcal to kJ. For the definition of BMR ($kcal.day^{-1}$), Schofield equation (Schofield, 1985) was used. Finally, data of body weight complied with gender, age and Angolan nationality (The United Nations University Press, 1995) were used for the calculation of BMR.

Subsequently, working energy WE (kJ)(Eq. 2) was calculated as a difference of total energy expenditure and basal metabolic rate where 16/24 rate corresponds to 16 working hours:

$$WE = (TEE – BMR) *16/24 \qquad (2)$$

Finally, human power HP (W) (Eq. 3) was calculated as working energy divided by time D (in fact 86,400 seconds corresponding to 24 hours):

$$HP = WE/D * 1{,}000 \qquad (3)$$

Age categories of farmer family members were defined according to Havrland et al. (2003). Data of farmer families 'human power were used for determination of hired labour power as well. For calculation of animal power, data of Chipaco (2010) related to the breed "Crioula" were used. Data of tractors' power are based on the tractors' brand and type defined directly together with the tractor owners as the respondents were able to describe the solely color of the tractor that they hired and its owner.

Installed power IP ($kW.ha^{-1}$) per farm was calculated as summary of human power of farmer family members working on field, human power of hired workers, power of draught animals and tractors owned or rent by the family. These components are considered as primarily available to be used for field operations. The installed power is categorized into three grades: grade I has an input of 0.1-0.3 $kW.ha^{-1}$, grade II has an input of 0.3-1.5 $kW.ha^{-1}$ and grade III has an input above 1.5 $kW.ha^{-1}$ (Havrland et al., 2003).

### 5.3.3 SWOT analysis

For the survey purposes, simplified quantified SWOT analysis according to Chang and Huang (2006), Ackermann Blazkova (2015) and Svatoňová (2015) was implemented.

Categories S and O are considered as positive factors, whereas W and T are negative factors. For each S, W, O and T category, comparable criteria were defined. The criteria for the S, W, O and T category were chosen based on: (i) suggestions stated by the respondents during the interviews at national, provincial and municipal level and (ii) author' knowledge of the situation in the municipality.

Each of the criteria has three types of parameters:

$Q_{(i)}$ – identifies the volume of the impact of a criterion; with values from the closed interval <1;9>

$P_{(i)}$ – probability of the criterion occurring at full strength; with values from the closed interval <0.1;0.9>

$W_{(i)}$ – weight (degree of gravity) of the criterion; with values from the closed interval <1;9>

$K_{(fi)}$ – overall criteria effect of the i-criterion.

The parameters' values were defined empirically on the basis of the author estimate. The product of the separate parameters is the criteria factor SWOT analysis coefficient $K_{(fi)}$. In each S, W, O and T category, five separate criteria were calculated. After adding together the separate items, the overall coefficient for each category was calculated (four in total). The maximum value of $K_{(fi)}$ is given by the product of the maximum values of separate parameters which a criterion can acquire (72.9 points). By summarizing the results of each category, maximum value of the criterion effect coefficient $K_{(fi)}^G$ is gained. When using five criteria per each category, the maximum value $K_{(fi)}^G$ equals 364.5 points. The maximum value of the S-O category equals double the maximum $K_{(fi)}^G$ (729 points); the maximum value of the W-T category is negative (- 729 points).

# 6 Results and discussion

The thesis results should primarily serve for the respective governmental bodies as a guideline for what to consider in the strategy for agricultural technologies development at the most. From the scientific point of view, the thesis contributes with detailed data related to technologies use in southern Africa and thus could serve as basin for further designs of agricultural technologies adoption models. In addition, due to scarcity of scientific data from Angola, the thesis contributes to deeper research relevant to agriculture in Angola.

## *6.1 Agricultural and socio-economic analysis of small farmers in the Catabola municipality*

The chapter is focused on description of actual situation regarding agricultural development primarily of small farmers in the municipality. Special regard is given to the role of EDA and agricultural associations. Socio-economic analysis is related to the agricultural development, education level of both parents and children and household income are mainly considered.

### 6.1.1 Agriculture in the Catabola municipality

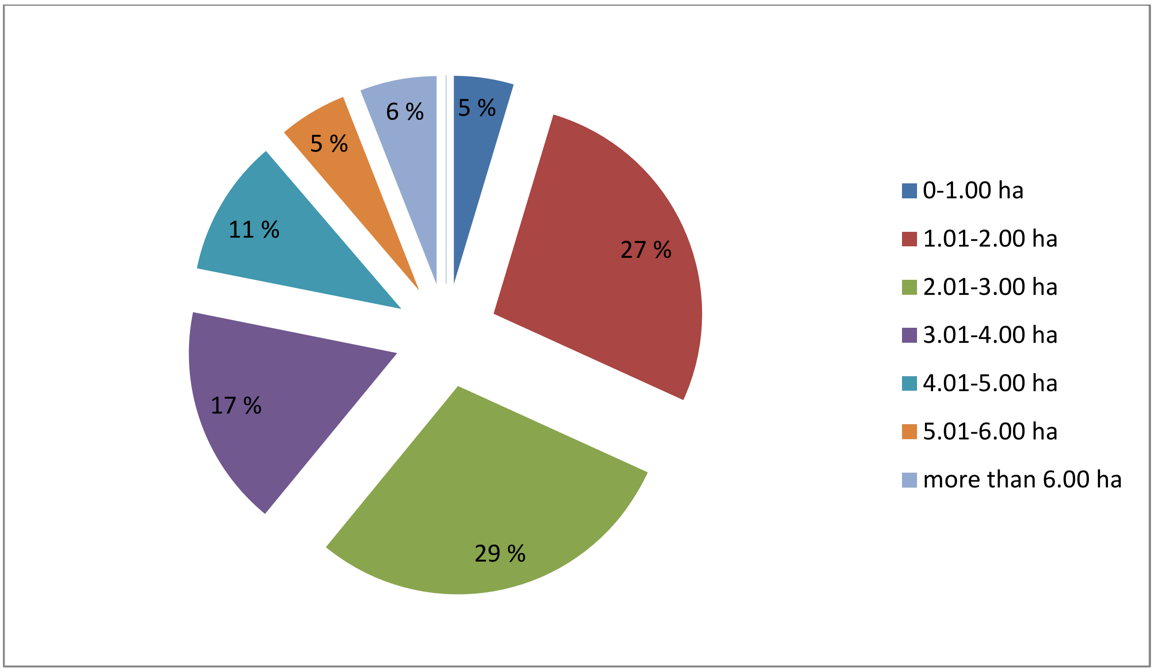
As it is evident from the interviews and questionnaires, fields cultivated by small farmers in the municipality can be divided into two main types – *lavra* and *naca*. The rain fed *lavra* field is used for cultivation of maize, beans and cassava as it is typical for the Umbundu cultivation system. *Lavra* fields can distance from the village, thus, in the periods of work on *lavra*, at least part of the family members working on field is moving to the field area. Regarding size, *lavra* forms majority of the field area that is cultivated by the small farmers. Crops produced on *lavra* take the highest share in the household consumption – majority of the cash crops (vegetables, citruses, sugar cane and pineapple) are produced on irrigated *naca* fields, in conformity with the results of Delgado-Matas and Pukkala (2014). Irrigation is simple, usually consisting of a network of small, unsophisticated canals leading from the neighbouring stream or river. Mean area of *lavra* is 2.77 ha (with standard deviation of 1.99 ha), contrary to mean area of *naca* – 0.15 ha (with standard deviation of 0.30 ha). The difference in size of *naca* field is significantly higher than in case of *lavra*, 76 % of the small farmers have *naca* field smaller than 0.10 ha.

Among small farmers in the Catabola municipality, there is no report of *ombanda* field reported by Delgado-Matas and Pukkala (2014) for the Bié province.

The mean total area of the small farmers' field in the Catabola municipality is 2.92 ha with standard deviation of 2.05 ha, contrary to the data of the Ministry of agriculture (2009) with the average area cultivated by a farmer family in Angola is 1.56 ha. Structure of the area cultivated size in the municipality is presented in the Figure 1. Farm families using only hand-tool technology cultivate field of the mean 2.65 ha (with standard deviation of 1.48 ha). 92 % of the farmers using animal traction have area 2.5 ha or larger, contrary to the results of Bawa from Nigeria, where 93 % of farmers applying animal power have size of fields smaller than 2 ha. On the other hand, data of Toro and Nhantumbo (1999) from Mozambique are similar as the mean area cultivated by farmers using animal traction is 3.0 ha.

Regarding the relation of cultivated area size to the number of small farmer family members, there is mean of 1.12 ha per a working family member in the municipality, with the standard deviation of 0.99 ha. When all family members included, there is mean of 0.71 ha per a family member with the standard deviation of 0.62 ha.

**Figure 1: Structure of field size – area cultivated by small farmers (N = 151)**




The relatively large areas cultivated by small farmers could be explained by planting larger areas than necessary in order to ensure a sufficient amount of food and reduce uncertainty, corresponding to the results of Hildebrand et al. (2003). Farmers in the Catabola municipality could gain permission to use more hectares of bushy virgin land (or land cultivated decades ago) as the population density is low and the majority of the non-cultivated areas are without any significant potential for extracting natural resources. These findings, in combination with prevailing use of the hand-tool technology, are in line with results of Boserup (1965) that farmers intensify their production only when land becomes limited due to population pressure, and even then they continue to use techniques adapted to more extensive systems as long as possible, until forced by starvation to adopt or invent labour-saving technologies such as ploughs. However, the most profitable crops (garlic, potatoes and cabbage) can grow well only on sites that are among the least abundant in the region, which could create conflicts related to the ownership of these sites (Delgado-Matas and Pukkala, 2014).

Specifically for the Catabola municipality, staple crops are maize (*Zea mays*), cassava (*Manihot esculenta*) and beans (*Phaseolus sp.*, *Vigna sp.*), similarly to Delgado-Matas and Pukkala (2014). Majority of maize seeds is local, although improved maize varieties ZM-521 and SAM3 experimentally cultivated in Wongo centre are available. Nevertheless, farmers are increasingly acquired seeds of good quality through micro-credits, usually in the form of 50 kg bags. In case of beans, local varieties prevail. Cassava in the municipality is represented by local long-term maturity variety of 18 months with low content of hydrogen cyanide. Additionally, cooked cassava leaves (*kizaka*) represent local welcomed food supplement. Some farmers are producing improved seeds in small scale as well; MINADER (2010) recorded 8 such producers in Catabola municipality, total area of the seed production is estimated as 25 ha. Annex 4 represents data about main staple crops in the Catabola municipality: area cultivated and yields, divided according to the communities; for cassava, data from the communities are not available.

Complementary food for the farmers consists of vegetable, fruits, and fish. Meat is consumed rarely, usually on the occasion of celebrations. The most commonly consumed meat is of old hens which cannot produce eggs any more or young goats.

Contrary to the results of Delgado-Matas and Pukkala (2014) that farmers in Bié province have produced vegetable (mainly garlic, cabbage and potatoes) and timber as a cash crop, following crops are considered by small farmers in the Catabola municipality as cash crops (in descending order): citruses (*Citrus sp.*), vegetables (onion (*Allium cepa*), garlic (*Allium sativum*), tomato (*Lycopersicon esculentum*), cabbage (*Brassica oleracea* *convar. capitata var. alba*), lettuce (*Lactuca sativa*), carrot (*Daucus carota*)), soya (*Glycine max*), peanut (*Arachis hypogaea*), sugar cane (*Saccharum sp.*), beans, mango *(Mangifera indicia*) and avocado (*Persea americana*). The majority of these crops is sold at markets, only a minor part of the yields is used for own consumption, mainly in the case of fruits. According to the survey of Mazancová et al. (2007) from Bié province covering 100 respondents, 25.0 % of the respondents keep the complete agricultural products for their own consumption, while 34.1 % of the respondents (N= 100) sell smaller part of their products and bigger keep for themselves.

Most common livestock in the municipality include poultry (mainly hens for meat and eggs; production of ducks is limited) and goats. Pigs are owned only by relatively rich farmers; a cattle breeding is rare. According to MINADER (2009, 2010, 2011), one of the limiting factors for cattle breeding spread in the municipality is frequent disease infections and parasites transmissions. Table 7 and 8 the present structure of fruit trees/plants and of animals produced and owned by the farmers.

According to the old farmers and extension workers involved in the survey, citruses production used to be the most profitable strategy of agriculture for Catabola farmers during the Portuguese colonial era as the municipality has the most favourable climatic and soil conditions for the citrus production (Diniz, 1998). Still, few shabby citrus plantations could be found. Nowadays, farmers tend to produce avocado, mango and banana (*Musa sp.*) rather than citruses, although production in small scale is present in some villages (usually on the southern side of the main road: in Chiuca community and partially in Sede community). Small farmers' preference of fruit production could be explained by more complicated system of economic effective citruses' production in comparison with avocado, mango and banana. In addition, new disease in the municipality – citrus bacterial canker disease caused by the bacterium *Xanthomonas axonopodis pv. citri* – has been partially endangered some of the citrus orchards in the municipality.

In the communities of Chipeta and Chiuca, rice (*Oryza sativa*) is produced in limited quantity, although Catabola municipality was one of the main rice producers in the country till the war beginning, as ruins of a factory processing rice near to the town access road remind. Similarly, almost distinct coffee (*Cofea Arabica*) production is present in small scale in the communities of Sande and Cayuera. Very popular culinary spice in dried or soused form origins from local chilli peppers *jindungo* (*Capsicum sp.*).

**Table 7: Structure of fruit trees/plants at the small farmers' farms (N = 151)**

| | Farms with 0 trees/ plants (%) | Farms with 1-5 trees/ plants (%) | Farms with 6-10 trees/ plants (%) | Farms with 11-20 trees/ plants (%) | Farms with 21-50 trees/ plants (%) | Farms with 51-100 trees/ plants (%) | Farms with more than 100 trees/ plants (%) |
|---|---|---|---|---|---|---|---|
| Tangerine | 68.9 | 15.9 | 2.6 | 5.3 | 4.0 | 2.6 | 0.7 |
| Lemon | 71.5 | 15.2 | 7.3 | 0.0 | 4.0 | 2.0 | 0.0 |
| Orange | 71.5 | 15.9 | 4.0 | 2.0 | 3.3 | 2.0 | 1.3 |
| Mango | 41.7 | 34.4 | 13.9 | 8.6 | 1.3 | 0.0 | 0.0 |
| Avocado | 27.2 | 43.0 | 19.2 | 9.3 | 0.7 | 0.7 | 0.0 |
| Banana | 44.4 | 42.4 | 7.9 | 5.3 | 0.0 | 0.0 | 0.0 |
| Papaya | 84.8 | 13.9 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 8: Structure of animals at the small farmers' farms (N = 151)**

| | Farms with 0 head (%) | Farms with 1 head (%) | Farms with 2 heads (%) | Farms with 3 heads (%) | Farms with 4-5 heads (%) | Farms with 6-10 heads (%) | Farms with 11-20 heads (%) | Farms with more than 20 heads (%) |
|---|---|---|---|---|---|---|---|---|
| Hens | 5.3 | 4.0 | 6.0 | 11.9 | 17.2 | 35.8 | 19.2 | 0.7 |
| Goats | 31.1 | 12.6 | 14.6 | 15.2 | 16.6 | 8.6 | 1.3 | 0.0 |
| Pigs | 72.8 | 10.6 | 7.3 | 1.3 | 4.0 | 4.0 | 0.0 | 0.0 |

Interestingly, farmers that produce citruses are still considered as the richest farmers among the small farmers. Nevertheless, the income of the small farmers that produce citruses is not significantly different from the other farmers, resulting from the ANOVA test (F = 0.13, F crit. = 4.54 and p = 0.72).

The majority of the inhabitants in the municipality can be considered as small scale or subsidiary farmers – 90 % more accurately according to the data of EDA Catabola. In 2011, from the total of 36,365 households in the municipality, there were 79 medium scale and one large scale farmer concentrating his business mainly on laying hens breeding and egg production with perspective of production of 120,000 eggs per year in 2010.

As majority of Catabola municipality population is subsidiary farmers, most common off-farm activities are fuel wood collection or charcoal production, fishing and hunting. According to MINADER, in total 7,784 kg of fresh fish were pulled out of water in the municipality in 2010, most common fish were *bagre* (*Clarias sp.*), *cacusso* (*Tilapia sp.*), *sardinha* (*Sardina sp.*) and *barbo* (*Barbus sp.*). Fish breeding is quite potential in the municipality, but still remains infrequent as it is more labour intensive and local farmers were not traditionally used for fish breeding. MINADER is promoting fish breeding in combination with duck breeding; nevertheless the facilitation in the fish breeding which the responsible MINADER workers should provide primarily to farmers' cooperatives and associations is minimal. Hunting, although already forbidden by law, is done occasionally; the most popular catch is small deer *kambambi* (*Sylvicapra grimmia*).

Post-harvest processing is limited only to open air solar drying and milling of maize and cassava, mainly at the traditional mills. There are two modern mills powered by diesel engine as well in the municipality, both of them are situated in the Catabola town. Less sophisticated traditional processing ways comprise of maize and dried cassava grinding in wooden mortars or using stones at rocks and of drying in direct sun which is used especially in the cases of *jindungo*. In the framework of the Czech Development Cooperation project *"Support of the Agricultural Vocational School in Catabola"*, a processing centre was established and equipped with a juice extractor, a sugar cane extractor, an oil presser, a solar dryer and a rice peeler, although their use by small farmers was not recorded, according to the responsible technician at the centre.

The average small farmer that is using animal traction and/or tractors in the Catabola municipality is breeding 13 hens, 5 goats and 1 pig; in addition to crop production, the average farmer has an orchard of 145 citrus trees and 13 avocado trees.

### 6.1.2 Agricultural associations in the municipality

Considering EDA reports from 2011, there are 58 farmers' associations and 9 cooperatives in the municipality. Seven cooperatives are of Sede community, one is in Sande and the last one in Chipeta community. There were 537 members in the cooperatives in total, 23% of them are women. The majority of the associations can be found in the Sede community, 45 specifically. In total, 3,486 people were members of associations in 2011 with 32% share of women. Number of the members per association or cooperative oscillates from 19 to 139.All associations related to agricultural and similar activities are united in the Union of Farmers' Associations and Agriculture Cooperatives (UNACA) which has its branch in Catabola municipality as well. The union objective is to create information network and to mediate communication and experiences sharing among associations and their members.

One of the main advantages of cooperative membership is significantly increased probability of obtaining credit and higher amount of the received sum as well. In 2011, associations solicited micro-credits of 25,021,875 AKZ (equivalent to 236,502 USD

(Banco Nacional de Angola, March 2015)) in total. The applicants – members of associations or cooperatives – should fill the form with desired amount of units which are available in the list: 50 kg bags of fertilizers (NPK 12-24-12, ammonium and urea), seeds (potato, onion, carrot, cabbage and beans), a pair of animals for traction, pump and implements (European hoe, machete and axe). According to the EDA Catabola head, the most popular item in the credit request among associations and cooperatives are draught animals. After the request approval, applicants will pick the items from the list at shop(s) indicated in advance. Repayment period differs for each item, but does not exceed one and half year. The short period could endanger significantly the capability of farmers' repayment, especially in the case draught animals and/or pump. With regard to the small farmers' annual income, the majority of the farmers with these items on the list will probably not repay on time. Thus, as extension workers are offering and discussing the credits with the farmers, the extension workers should improve their explanations in term of financial balance.

Although there were almost 70 associations and cooperatives in the Catabola municipality at the time of data collection, except for future benefits (or currently received material within the credit described above) there were no data relevant to the profit from the cooperative membership available. The reason is that the vast majority of the associations and cooperatives were founded only recently, usually 1 – 3 years ago. For example, there is a cooperative in Liunde village established in 2009. After two years, the members only prepared field of 4 hectares and started cultivation of beans and peanuts; in addition, members were still waiting for the material approval within the governmental credit programme as the delivery period oscillates around 1 year. The longer waiting period is predominantly caused by a slow bureaucratic process of required material preparation.

Interestingly, according to information from the Catabola administration, the associations that already received cattle for animal traction consist only from ex-military members. The cattle were distributed among the members in the following way: three members received together two heads – male and female. Although the associations received the animals in 2010, their use for the animal traction remains still limited.

### 6.1.3 Structure of the family, household total income

The majority of the small farmer households included in the survey is male-headed, only 9 % of households are female-headed, typically by widows as the traditional structure of the Umbundu society is highly patriarchal. Access of land, as well as innovation is more limited for widows, they could be considered as late adopters from the point of view of modern approaches in technologies

The mean number of family members is 5 with a standard deviation of 2, which corresponds to statistics of INE (2013) remarking mean number of farmer family members as 5. Table 10 in the chapter 6.2.1 shows age structure of the small farmer family according to the age category and sex.

The mean average annual income is 71,146 AKZ corresponding to 672 USD (Banco Nacional de Angola, March 2015), with a standard deviation of 97,510 AKZ. Nevertheless, more than half of the small farmers (56 %) have total household income 10,000-50,000 AKZ (95-473 USD (Banco Nacional de Angola, March 2015)); detailed differentiation of the small farmers' average annual income is presented in Figure 2. Vast majority of the farmers (93%) determined dried seeds of beans as a source of income. The other most common income sources are dried seeds of maize, dried cassava (*bombo*) and fresh vegetable as all these products are sold by 60 or more % of the farmers (as it is shown in Figure 3). Cash crops contribution to the annual income of small farmers is usually limited to vegetables, which is in conformity with the results of Delgado-Matas and Pukkala (2014) that garlic, potatoes and cabbage are the most profitable crops in the Bié province. Salary – originated from a governmental or private job, usual professions are a teacher, carpenter and bricklayer – is a source of income only for 1 % of the farmers. Thus, agricultural production in the Catabola municipality can be defined as typically subsistence.

**Figure 2: Average annual income of small farmer families (N = 151)**

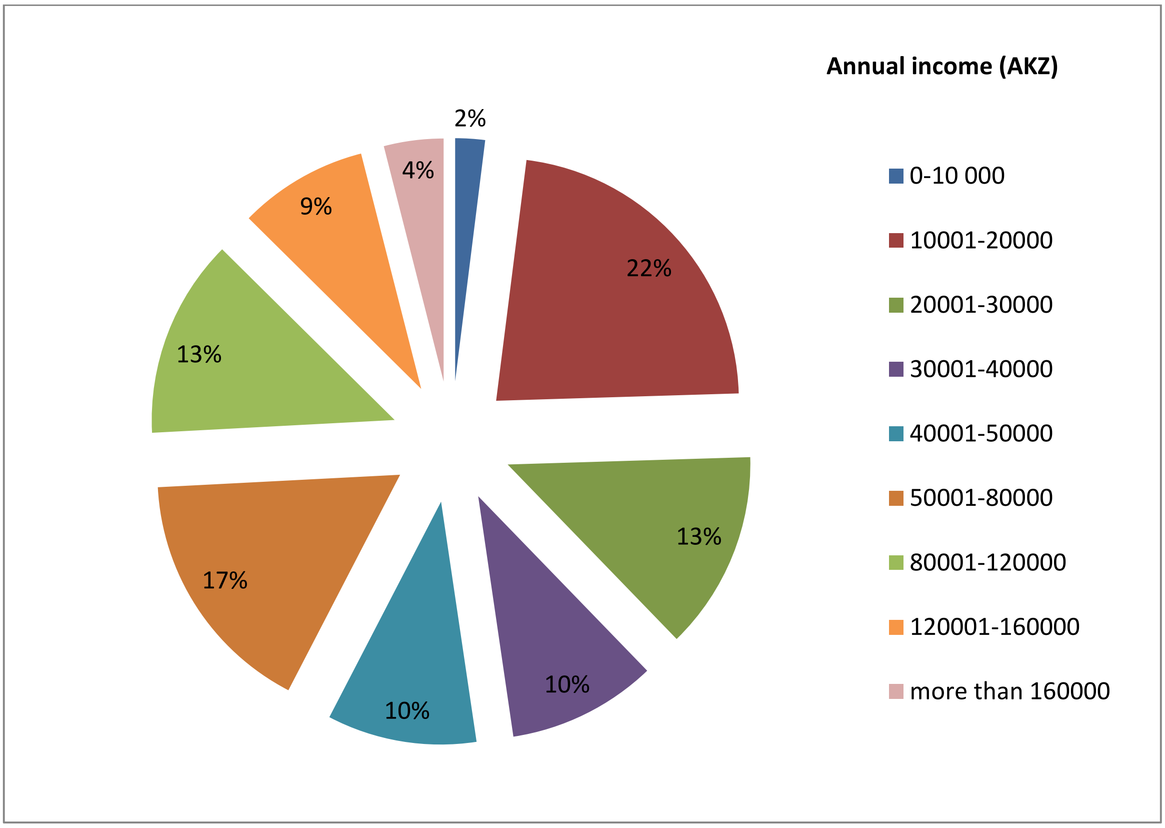
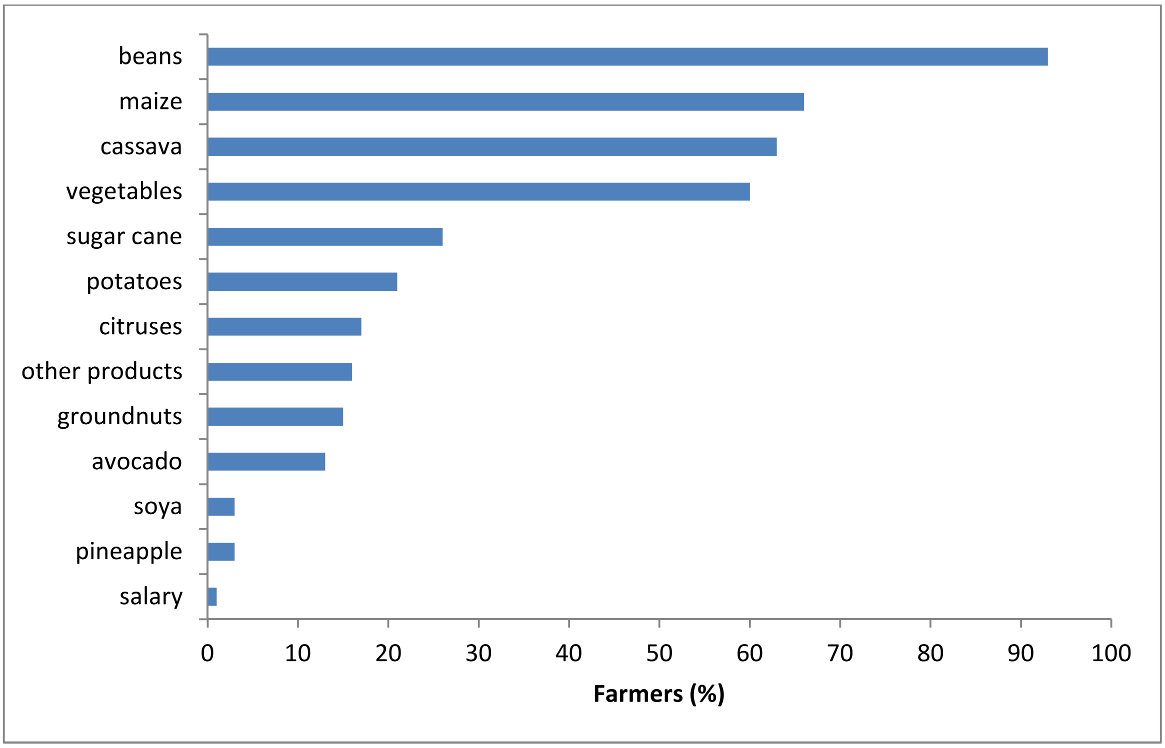



**Figure 3: Sources of small farmer families' income (N = 151)**



According to the EDA Catabola head, there is no company connected with agribusiness operating in the municipality. At the harvesting time, middlemen occasionally appear with aim to buy beans only. The majority of the small farmers (73 %) sell their production in the Catabola municipality – at the main city market and/or small local markets in the villages and on the main road heading to Zambia. Other small farmers sell their product in Kuito from time to time. Typically, women (usually the wives of the farmers as daughters marry generally until they are 18, then, they are responsible for the marketing of the products of their own family) are responsible for selling of the products. 27 % of the households partially involve men, mainly when products are sold at the more distant market. Common means of transport to the markets is by foot – this way is used by 81 % of small farmers. 15 % of the farmer families use bike sometimes, always by men. 4 % of the small farmers transport the production by motorbike; again, only men are driving it. Similarly, according to Fuller and Aye (2012), walking, bicycles and animals are the most common means of transport in the remote rural areas.

Except for usual product commercialization, barter exchange (although it is rare) still exists, typically in the form of vegetables for maize exchange. To market opportunities, Mazancová et al. (2007) identified the main constraint as very weak transport infrastructure as poor conditions of the roads cause high transition costs at market. There is railway connecting Kuito and Luena with station in Catabola that has been working regularly since 2012 – nevertheless the results do not reflect this change as the data were collected before opening of the railway.

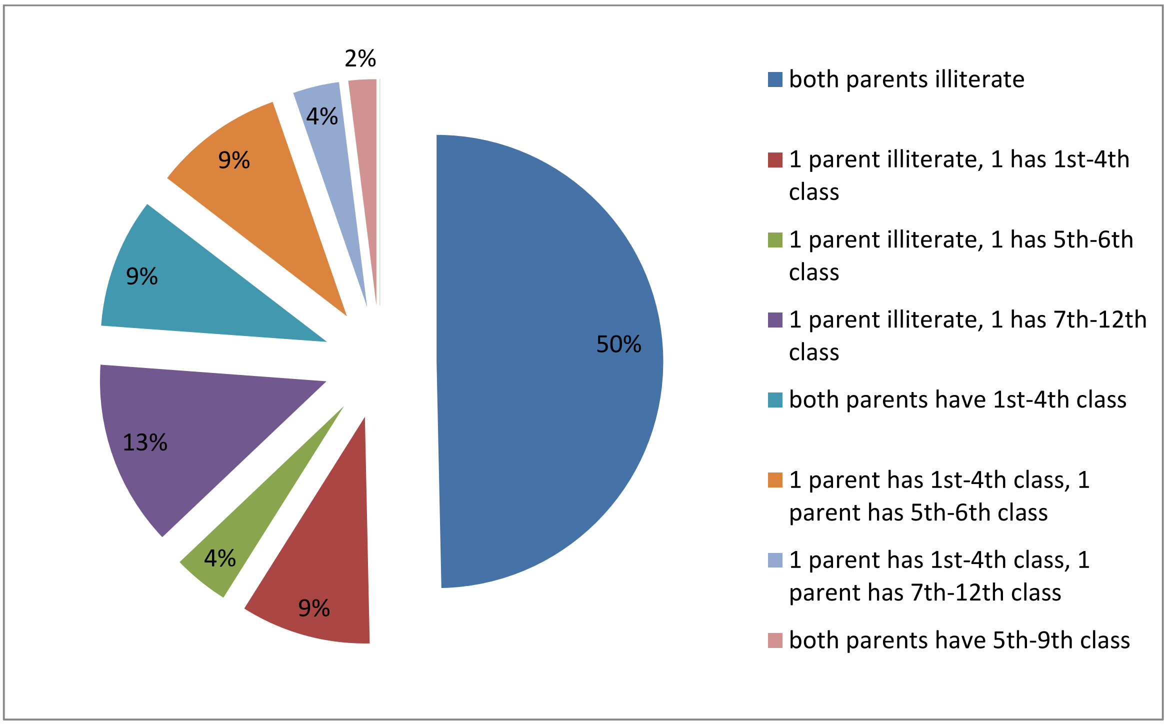
Medium farmers focus on markets in Kuito or outside Bié province. Usually, the farmer himself takes care of the products sell; or intermediary is involved. The means of transport to markets is always a car.

EDA Catabola is investigating prices at local market regularly; price list of chosen products from 2011 is represented in Annex 6 where prices of markets and supermarkets in Luanda monitored by IDA Luanda are presented as well in order to show comparison of products prices. Minimal and maximal prices were chosen according to the price bottom/peak in the monitored markets and supermarkets. Differences in the prices reflect high transportation costs, some products are even preferably imported to Luanda from abroad. Insufficient quantity of products in demanded quality could reach Luanda because of lack convenient means of transport (with cooling facility) in combination with poor roads' quality. In addition, in some products' cases the Angolan production could not cover the demand, especially in the cases of meat, eggs and dairy products.

### 6.1.4 Education level of the small farmer families

As a result of the civil war, majority of the rural adult population in the Catabola municipality remains illiterate. Evening courses for adults that serve for education completion, commonly organized in Kuito, are limited in the municipality. Reflecting Figure 4, illiteracy level among the small farmers (both head of the family and his wife or the widow/widower) reaches 50 %. Only 15 % of the small farmer households have at least one parent with secondary school education ($10^{th}$ – $12^{th}$ class). Regarding non-formal education, farmers participate mainly in farmer field schools that are organized by government through EDA and/or non-governmental organizations (FAO, ADAC and CULS).

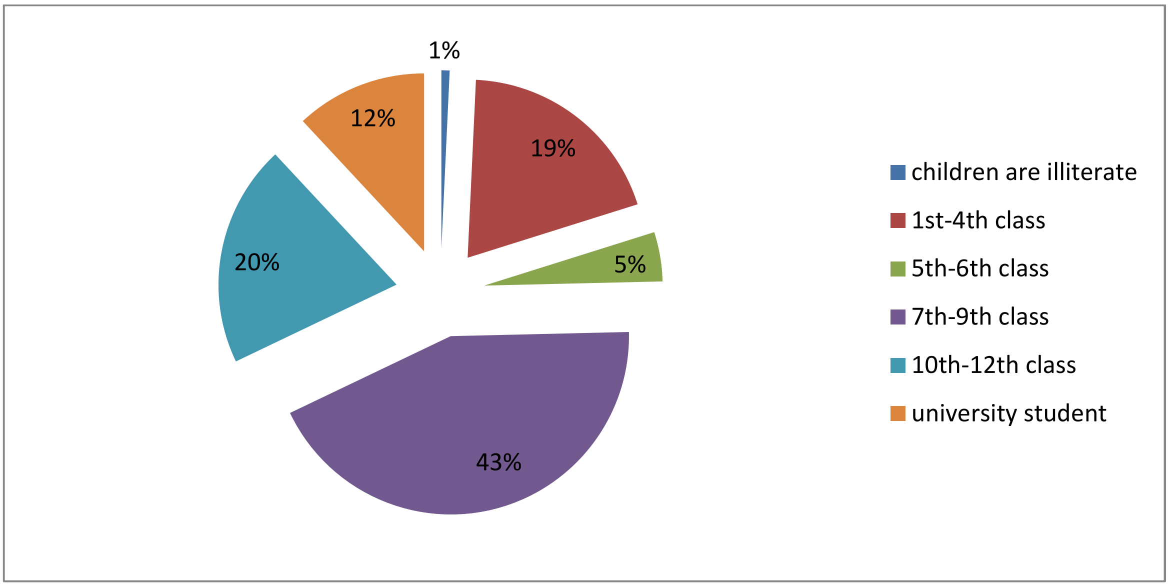
**Figure 4: Education level of the small farmer family – parents (N = 151)**




Contrary to the education of parents, children are regularly going to school. The most frequent highest education level reached by children in the farmer family household is $7^{th}$-$9^{th}$ class (as it is shown in Figure 5), illiteracy among children older than 6 years occurs only in 1 % of the households. Although this data could be presented as success of education strategy in Angola, the reality in literacy is different: students are frequently receiving certificates that prove successful termination of the year based on solely minor progress in their education level. In addition, education level of the teachers themselves is unsatisfactory. As a result, the majority of students with officially gained education level of 6$^{th}$ class in the Catabola municipality have only limited capability in writing and reading as it was obvious during the admissions of new students at EPAC in 2010.

Children attend secondary school in Catabola or in Kuito; university in Kuito or Huambo. Although there is one secondary school in Catabola town available, farmers usually prefer their children going to secondary school in Kuito as they believe that the quality of education there is higher than in the municipality. Actually, this argument of farmers could be considered as real as graduates of pedagogical programmes try to avoid working in the countryside. In addition to the fact that only the best teachers work in Kuito, the rest of the teachers tend to stay in the provincial capital as long as possible and are usually late or even absent during the teaching time. Generally, more distant area gain worse teachers and total number of real taught hours per school year is lower.

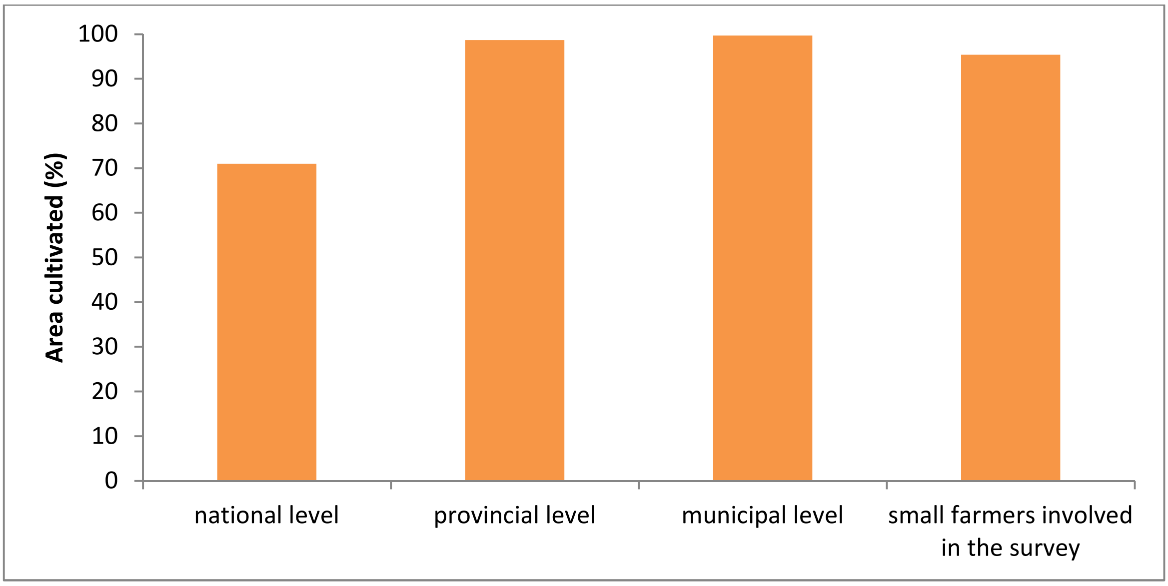
**Figure 5: Highest education level reached by children of the small farmer families (N = 131)**



## 6.2 Structure of technologies applied in field operations in the Catabola municipality

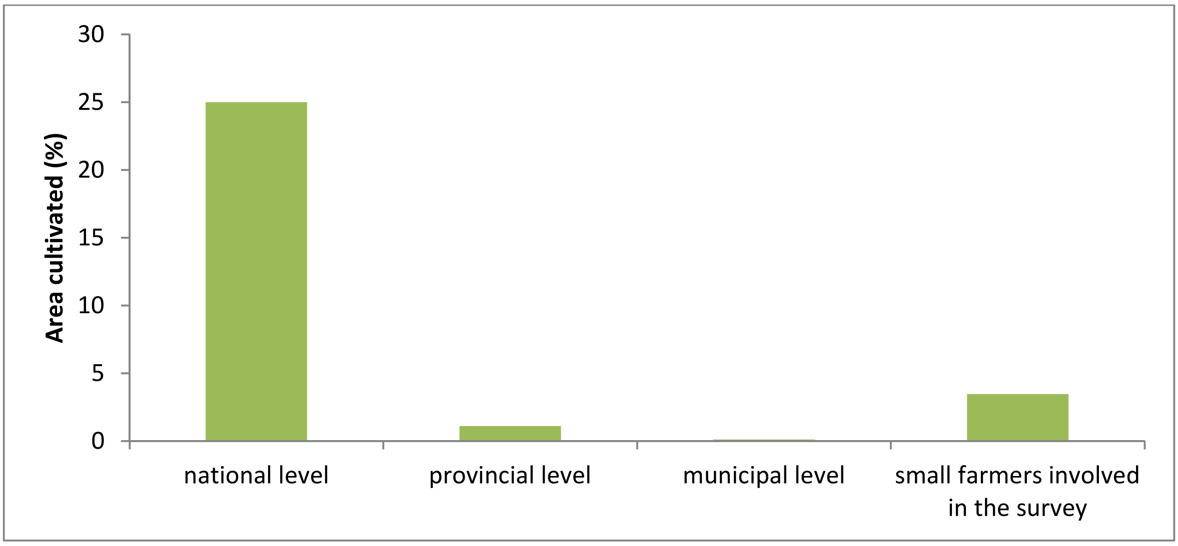
In the municipality, hand-tool technology use prevails as it is employed in 95.38 % of the cultivated land of small farmers (compared to 99.70 % of the municipality official data (EDA Catabola, 2009), 98.70 % at the provincial level (MINADER, 2010) and 71.00 % at the national level (Ministry of Agriculture, 2009)), as against only 65.00 % determined by Sims and Kienzle (2006) for Sub-Saharan Africa. The comparison of three levels (national, provincial and municipal) data and data of small farmers involved in the survey are presented in the Figures 6, 7 and 8. Structure of the technologies used in the Catabola municipality is similar to the data of Toro and Nhantumbo (1999) for Mozambique, where there is a slightly higher share of animal traction and tractor mechanization; the conformity could be explained by analogous history, including Portuguese colonialism and civil war that was terminated in Mozambique by a decade before it happened in Angola.

**Figure 6: Comparison of hand-tool technology use in relation to area cultivated**



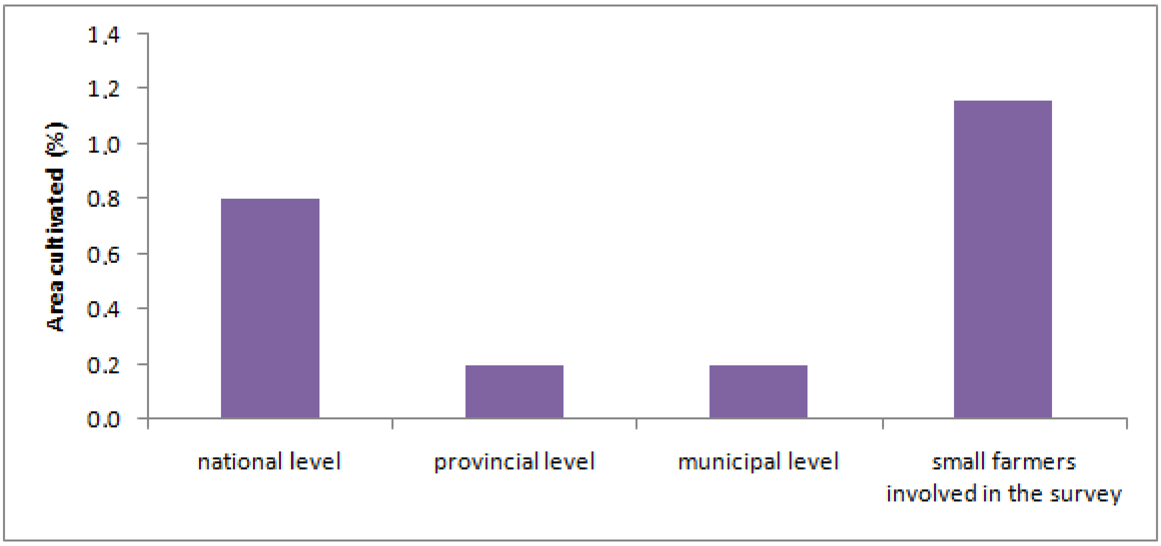

Sources: MINADER 2010, Ministry of Agriculture 2009, EDA Catabola 2009

**Figure 7: Comparison of animal-draught technology use in relation to area cultivated**




Sources: MINADER 2010, Ministry of Agriculture 2009, EDA Catabola 2009

**Figure 8: Comparison of mechanical-power technology use in relation to area cultivated**

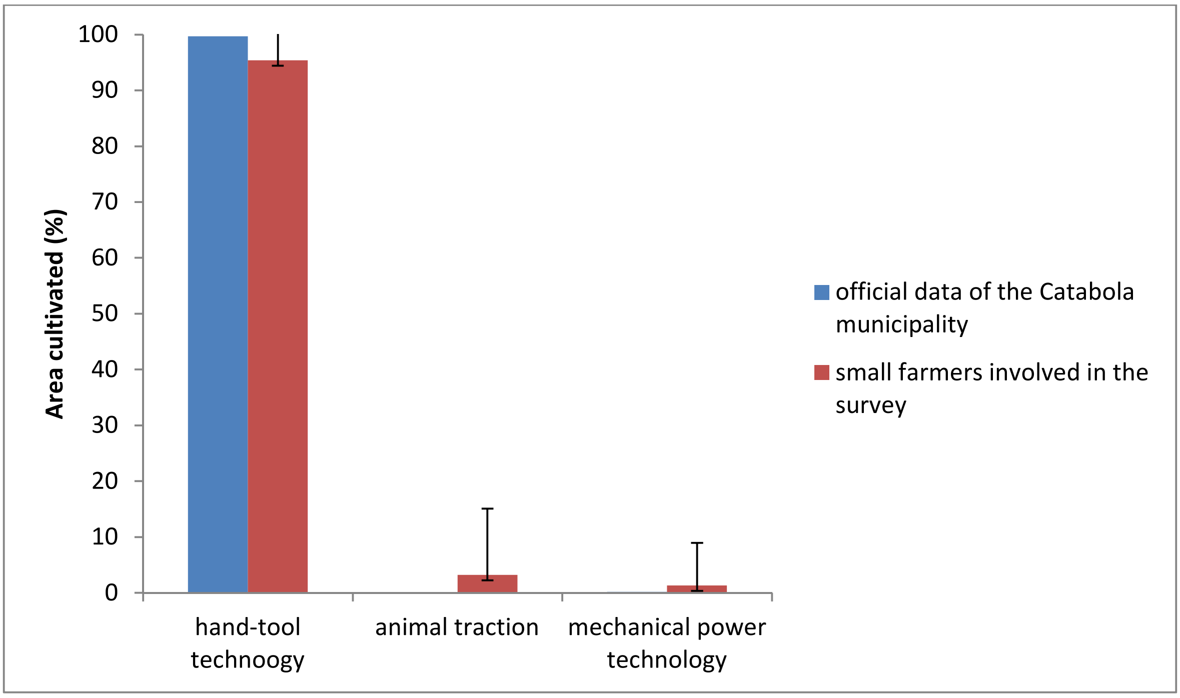



Sources: MINADER 2010, Ministry of Agriculture 2009, EDA Catabola 2009

The measured data are consistent with the official data of EDA Catabola, regarding to Annex 7 which refers to areas division regarding to technologies use in the period from 2008 to 2010. Real use of mechanical power technology differs significantly from the schedules of MINADER which plans usually to realize tillage on 500 or 600 ha. In 2010, data for private tractor owners/contractors were available for the first time – 412 ha of total 442 were ploughed by them.

Figure 9 shows a comparison of the technologies structure data: of EDA Catabola (2009) and the data relevant to small farmers in the Catabola municipality involved in the survey, based on mean of technologies use regarding to area cultivated and its standard deviation.

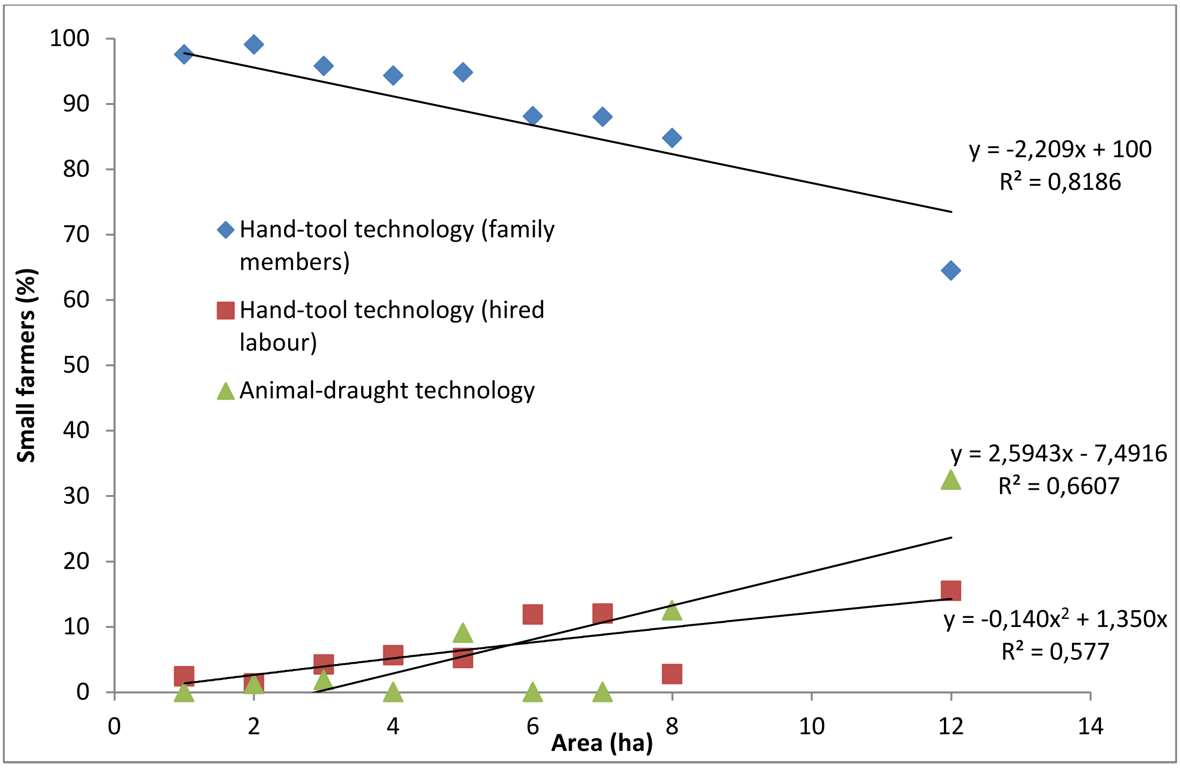
**Figure 9: Comparison of technologies structure – EDA Catabola and small farmers in the Catabola municipality involved in the survey (mean, standard deviation)**




Source of official data: EDA Catabola 2009

The mean power (regularly used) of small farmer families is 1.80 kW (with standard deviation of 2.37 kW), the installed power is 0.50 kW.ha$^{-1}$ (with standard deviation of 2.37 kW.ha$^{-1}$). Nevertheless, these results are highly misrepresented by only four farmers renting the tractor and three farmers with more than 20 hired external workers. With exclusion of them, the mean power of small farmers in the Catabola municipality is 0.27 kW, (with standard deviation of 0.18 kW), the installed power is 0.11 kW.ha$^{-1}$ (with standard deviation of 0.08 kW.ha$^{-1}$) which is significantly less than installed power for hand-tool and animal-draught technologies calculated for Angola, year 2008 – as it is shown in Table 3 by Rušarová (2010). Still, the high standard deviations are caused by diverse structure of human power (of family members as well as external labour) and animal-draught power at the farm. Annex 8 shows a complex table that represents data related to the power use of all farmers (small, medium and large). Figure 10 presents share of the technology use in relation to the area cultivated with exclusion of mechanical-power technology as data were not significant for this cathegory. The data correspond to the percentage mean within the field size cathegory (different from each other by1 ha) with the exception of the last size cathegory (12 ha) which corresponds to the mean field size of 4 farmers with field larger than 8 ha. The data were fitted by curves that were defined by Havrland (2003). Hand-tool technology (only family members as hired labour in relation to area cultivated has different specifications) has a linear decreasing tendency with increasing size of cultivated field. Use of hired labour has polygonal trend. Animal traction use has linear increasing tendency corresponding to increase of cultivated field size.

**Figure 10: Technologies use in relation to the size of the cultivated area (N = 151)**




## 6.2.1 Human power

Farmer family members form the basic power source used in the fields of small farmers in the Catabola municipality – 94.8 % of the small farmers' total area is cultivated only with the use of power of family members. The mean power of small farmer family is 171.56 W with a standard deviation of 79.68 W. Table 9 presents baseline and further calculation of human power. Human power was calculated for age 5 and older as the youngest age of working children was 5 years old.  Men are of the highest power

(63.16 W) in the age category 18-30, women in the age category 31-60 with 50.59 W. Accordingly, power of hired labour was calculated as mean of power of male and female age 18-30 which is 56.40 W as the small farmers hire both males and females, typically in this age interval.

**Table 9: Calculation of human power regarding age and sex (Angola)**

| Age (year) | Average weight (kg) | | BMR ($kJ.day^{-1}$) | | PAL (-) | | TEE ($kJ.day^{-1}$) | | WE (kJ) | | Human power (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | M | F | M | F |
| 5 | 16.0 | 15.9 | 3632.6 | 3386.9 | 1.80 | 1.80 | 6538.7 | 6096.4 | 1937.4 | 1806.3 | **22.42** | **20.91** |
| 6 | 17.7 | 17.5 | 3794.2 | 3523.0 | 1.80 | 1.80 | 6829.6 | 6341.4 | 2023.6 | 1878.9 | **23.42** | **21.75** |
| 7 | 19.5 | 19.3 | 3965.4 | 3676.1 | 1.85 | 1.85 | 7335.9 | 6800.8 | 2247.0 | 2083.1 | **26.01** | **24.11** |
| 8 | 21.4 | 21.7 | 4146.0 | 3880.2 | 1.90 | 1.90 | 7877.4 | 7372.5 | 2487.6 | 2328.1 | **28.79** | **26.95** |
| 9 | 23.3 | 24.5 | 4326.6 | 4118.4 | 1.90 | 1.90 | 8220.6 | 7825.0 | 2596.0 | 2471.0 | **30.05** | **28.60** |
| 10 | 25.5 | 27.7 | 4644.2 | 4452.2 | 1.95 | 1.95 | 9056.2 | 8681.8 | 2941.3 | 2819.7 | **34.04** | **32.64** |
| 11 | 28.2 | 31.3 | 4844.1 | 4653.9 | 2.00 | 2.00 | 9688.3 | 9307.9 | 3229.4 | 3102.6 | **37.38** | **35.91** |
| 12 | 31.5 | 35.2 | 5088.5 | 4872.5 | 2.05 | 2.00 | 10431.4 | 9745.0 | 3561.9 | 3248.3 | **41.23** | **37.60** |
| 13 | 35.6 | 39.2 | 5392.1 | 5096.6 | 2.05 | 2.00 | 11053.8 | 10193.3 | 3774.5 | 3397.8 | **43.69** | **39.33** |
| 14 | 40.6 | 43.1 | 5762.4 | 5315.2 | 2.15 | 2.00 | 12389.1 | 10630.4 | 4417.8 | 3543.5 | **51.13** | **41.01** |
| 15 | 46.1 | 46.3 | 6169.6 | 5494.5 | 2.15 | 2.00 | 13264.7 | 10989.0 | 4730.1 | 3663.0 | **54.75** | **42.40** |
| 16 | 51.2 | 48.7 | 6547.3 | 5629.0 | 2.15 | 2.00 | 14076.7 | 11258.0 | 5019.6 | 3752.7 | **58.10** | **43.43** |
| 17 | 55.3 | 49.8 | 6850.9 | 5690.6 | 2.15 | 1.95 | 14729.5 | 11381.3 | 5252.4 | 3793.8 | **60.79** | **43.91** |
| 18-30 | 57.9 | 50.1 | 6548.5 | 5145.7 | 2.25 | 2.25 | 14734.1 | 11577.9 | 5457.1 | 4288.1 | **63.16** | **49.63** |
| 31-60 | 57.9 | 50.1 | 6436.8 | 5245.1 | 2.25 | 2.25 | 14482.8 | 11801.5 | 5364.0 | 4370.9 | **62.08** | **50.59** |
| 60+ | 57.9 | 50.1 | 5299.8 | 4662.3 | 2.25 | 2.25 | 11924.5 | 10490.1 | 4416.5 | 3885.2 | **51.12** | **44.97** |

Note: PAL is not defined for age 4 and less; M = male; F = female

The calculated power is similar to human power defined by Tiwari et al. (2011) for a long duration (60 W) but slightly lower than human power defined by Crossley (1983) and Havrland et al. (2003): 70-100 W and 80 W respectively; nevertheless, all these sources defined power for developing countries generally, contrary to data in Table 9 based on FAO data for Angola.

Table 10 shows age structure of the small farmer family in relation to participation in field operations. Child labour will be analysed and discussed in the chapter 6.2.3. Adult females are involved in the field operation slightly more than men, in accordance with Delgado-Matas and Pukkala (2014), as men have more often primary occupation different from agriculture. In these cases, the most common occupations in the Catabola municipality are teacher, carpenter and bricklayer. Interestingly, all family members older than 60 years are working on field. Thus, no retirement age could be assumed to be part of the traditional farmer life in the municipality. Nevertheless, the majority of the human power forces (59.11 %) consist of males and females age 18-60. Usually, men and women work on same plots, similarly to Nielsen (2008) data for Angola.

**Table 10: Age and sex structure of farmer family – involvement in field operations (N = 151)**

| Sex and age | Age structure - all family members (No.) | Age structure - all family members (%) | Age structure - family members working on field (No.) | Age structure - family members working on field (%) | Share of family members working on field within the age category (%) |
|---|---|---|---|---|---|
| M age 0 - 14 | 187 | 24.32 | 80 | 15.36 | 42.78 |
| M age 15 - 17 | 29 | 3.77 | 25 | 4.80 | 86.21 |
| M age 18 - 60 | 160 | 20.81 | 151 | 28.98 | 94.38 |
| M age 61 or older | 20 | 2.60 | 20 | 3.84 | 100.00 |
| F age 0 - 14 | 189 | 24.58 | 65 | 12.48 | 34.39 |
| F age 15 - 17 | 22 | 2.86 | 20 | 3.84 | 90.91 |
| F age 18 - 60 | 159 | 20.68 | 157 | 30.13 | 98.74 |
| F age 61 or older | 3 | 0.39 | 3 | 0.58 | 100.00 |
| Total | 769 | 100 | 521 | 67.75 | - |

In comparison with the official data for the age composition of people working in agriculture in Angola (Table 2), there is lower share of older people in the Catabola municipality. This difference could be explained with the civil war consequences which affected strongly older generation as during the war, there was a high food scarcity in the municipality and front line used to cross the municipality as well. In addition, Ministry of agriculture (2009) recognizes the lowest age for labour on fields as 10 years, contrary to 5 years found out in the municipality.

The findings of Ker (1995) and Sims and Kienzle (2006) that hand tools are the most important implements for small farmers in sub-Saharan Africa are valid for the Catabola municipality as well. The most common implement used for field operations is European hoe; typically, each working family member has his/her own hoe (Figure 11). Other implements are owned only by some of the small farmer families. Mean and standard deviation of European hoe, machete, axe and shovel per a small farmer family are presented in Table 11. Mean number of European hoes per farmer family is in conformity with data of Ministry of Agriculture (2009), contrary to the number of other implements:

2 machetes and 2 traditional hoes. Interestingly, use of traditional hoes in the Catabola municipality almost disappeared, although it is still known. Nevertheless, none of the interviewed farmers is ever using it.

**Figure 11: Number of European hoes per farmer family (N = 151)**

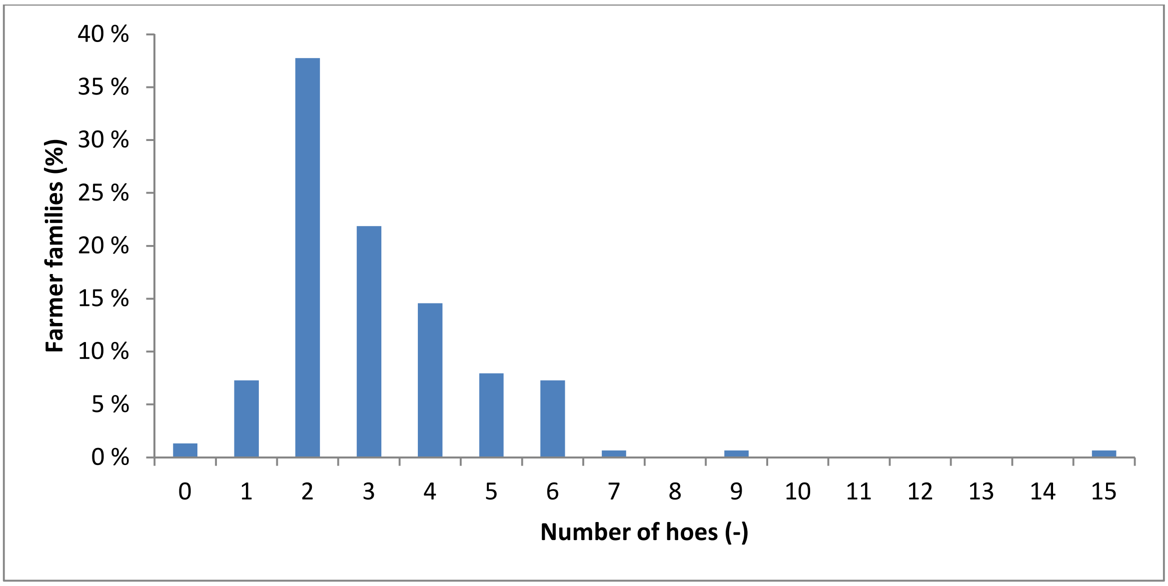



**Table 11: Ownership of the implements by the small farmer families (N = 151)**

| | European hoe (-) | Machete (-) | Shovel (-) | Axe (-) |
|---|---|---|---|---|
| Mean | 3.1 | 0.7 | 0.2 | 0.6 |
| Standard deviation | 1.8 | 1.6 | 0.6 | 1.5 |

In accordance with the results of Crossley (1983), hoe and machete are the most common implements owned by small farmers. More sophisticated implements, such as sprayer, star-wheel weeder or planter are owned by none of the interviewed farmers, with one exception: the farmer owns one hand-planter (the farmer is using animal traction as well as occasionally mechanization). Although more sophisticated manual implements are available in Kuito, farmers can’t afford them due to their high price. In addition, they are not available in the governmental list of material and equipment offered for the farmers’ credit.

The mean durability of European hoe is 2.21 years (with standard deviation of 0.61 years), similarly to IFAD (1998) data. 72 % of the farmers purchase the hoes at local markets; the rest obtained them from EDA Catabola or shops in Kuito. Although EDA is receiving a certain quantity of manual implements almost every year, their distribution remains limited; for example, according to a MINADER report from 2011, the 30 manual seeders which EDA received in 2008 were still left in the EDA stock.

The price of the hoe (only the metal part, the handle is manufactured by the farmer himself) ranges from 250 AKZ.pc$^{-1}$ to 500 AKZ.pc$^{-1}$. Typically, farmers from the particular village use the same channels for the implements purchase, thus the price recorded in the villages was the same. The purchase price of machete remains relatively stable: 170 AKZ.pc$^{-1}$. All the implements available in the Catabola municipality are imported as there is no local blacksmith.

### 6.2.2 Hired labour

Hired labour is used by 38.0 % of small farmers, usually during the harvest peak season; with mean 24 labour-days.year$^{-1}$ and standard deviation of 87 labour-days.year$^{-1}$; the detailed data are shown in Annex 8. The high standard deviation are caused by various number of workers and days per external worker used by small farmers in the Catabola municipality, independly on field size or power of the farmer family nor total power. Few labour-days of hired workers are in accordance with results of Jul-Larsen and Bertelsen (2011). Interestingly in Mozambique, hired labour is used by only 19 % (Toro and Nhantumbo, 1999) or 16 % (Worldbank, 2006) of the farmer households with 23.8 labour-days and standard deviation of 49.0 labour-days. A possible explanation of the difference might be larger area of the farmers to be cultivated in the Catabola municipality in the comparison with Mozambique.

Typically, males of age 18-30 are preferred as hired workers, although women of the same age are hired as well. The most common form of payment for hired labour is wage (250 AKZ.labour-day$^{-1}$), although 22 % of small farmers prefer to pay with production (1 labour-day is equivalent to 3 kg of beans or 10 kg of maize or small bag – for 20 kg of maize – of processed cassava called *bombo*). Reciprocal help is rare, used by only 5 % of small farmers. The workers are always using their own implements, not the ones owned by the farmer family members. Interestingly, according to the extension workers of EDA, hired labour is used regularly in some villages, whereas in other villages it is rare. The sample of the villages confirms this as hired labour is used by more than 50 % of small farmers in 5 villages. On the other hand, in 4 villages (out of total 9 selected) less than 11 % of small farmers hire external labour.

Medium farmers are using hired labour more often, with mean of 438 labour-days (and standard deviation of 340 labour-days), form of payment is wage.

### 6.2.3 Child labour

Child labour is very frequent in the Catabola municipality within the small farmers as 63.88 % of the children age 5-14 are involved in the field operations; 42 % of the not-working children are younger than 5 years. In addition, children older than 4 years and not working on field are studying in Kuito quite often. Child labour in relation to the village origin is shown in the Table 12. According to Delgado-Matas and Pukkala (2014), children in the traditional Umbundu system of Angolan highlands are participating in the farming activities mainly in harvest seasons.

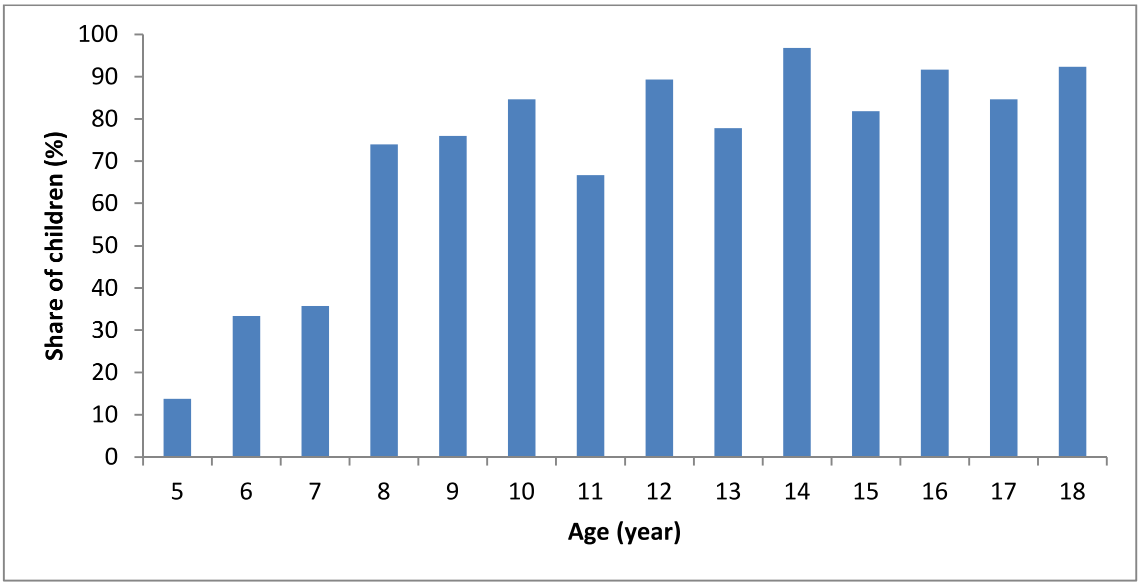
**Table 12: Child labour in the Catabola municipality – villages (N = 126)**

| Village | Children age 5-14 total (No.) | Children age 5-14 working on field (No.) | Children age 5-14 working on field (%) | Children age 5-17 total (No.) | Children age 5-17 working on field (No.) | Children age 5-17 working on field (%) |
|---|---|---|---|---|---|---|
| Liunde | 20 | 13 | 65.00 | 23 | 16 | 69.57 |
| Sashonde | 39 | 16 | 41.03 | 46 | 22 | 47.83 |
| Cavinda | 7 | 6 | 85.71 | 9 | 7 | 77.78 |
| Canjoio | 34 | 29 | 85.29 | 41 | 36 | 87.80 |
| Embala Gonde | 34 | 23 | 67.65 | 43 | 31 | 72.09 |
| Bimbi | 25 | 16 | 64.00 | 38 | 26 | 68.42 |
| Bairro Santinho | 44 | 29 | 65.91 | 46 | 31 | 67.39 |
| Dembi-1 | 13 | 6 | 46.15 | 15 | 8 | 53.33 |
| Ongué | 11 | 7 | 63.64 | 17 | 13 | 76.47 |
| Total | 227 | 145 | 63.88 | 278 | 190 | 68.35 |

The lowest age of children working on field found in the survey is 5 years, although the majority of the 5 years old children is not involved in the work yet. The importance of child labour is higher in the female headed households as it forms a significant share of the human power of the farmer family, in conformity with findings of Badmus (2011) that households headed by females have a higher dependency ratio which increases the probability of a child involvement to work.

The percentage share of children involved in field operations is demonstrated in the Figure 12. Since age 8, the involvement of children in field work does not fall under 67 %. Child labour incidence increases as the age of the child increases, in line with findings of Cockburn (1999), Grootaert and Patrinos (1999) and Badmus (2011).

**Figure 12: Involvement of children to field operations in relation to age (N = 129)**




With the exclusion of childless families, 62.7 % of small farmer families are regularly using children of ages 0-14 for operations on fields (67.7 % families in the age category of 0-17). The significantly high rate of child labour employment found in the research is consistent with the findings of Dwibedi and Chaudhuti (2014) that child labour is used in backward agriculture where primitive techniques of cultivation are applied. Similarly, International Labour Organization (ILO, 2002) defines that the highest child labour rate is in Sub-Saharan Africa where majority of the working children are unpaid family workers involved in agriculture.

From a gender point of view, in the age category 0-14 years, there is higher involvement of boys in field operations (42.8% of boys, contrary to 34.4% of girls), in conformity with results of Psacharupoulos and Arriagada (1989) and Grootaert and Patrinos (1998) and contrary to data of ILO (2002) and Badmus (2011). Figure 13 and 14 present structures of boys and girls respectively, age 5 – 18, in relation to involvement in field operations. Higher share of boys in field work in the Catabola municipality is caused mainly by their higher power in comparison with girls, in combination with a family head preference for involvement of girls in household activities, such as cooking and water collection.

**Figure 13: Involvement of boys age 5 – 18 in field operations (N = 125)**

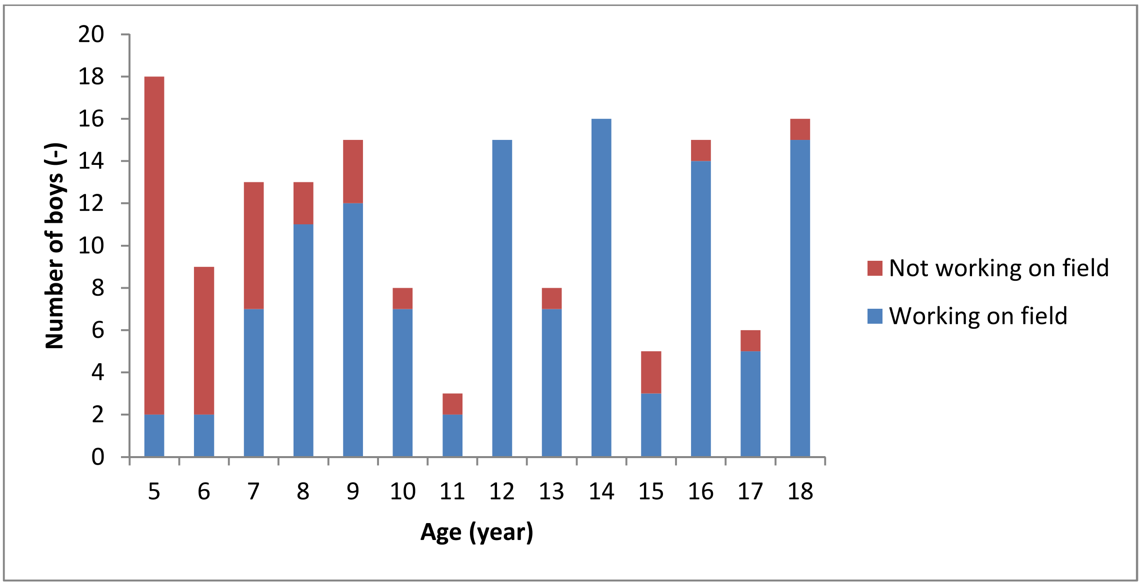
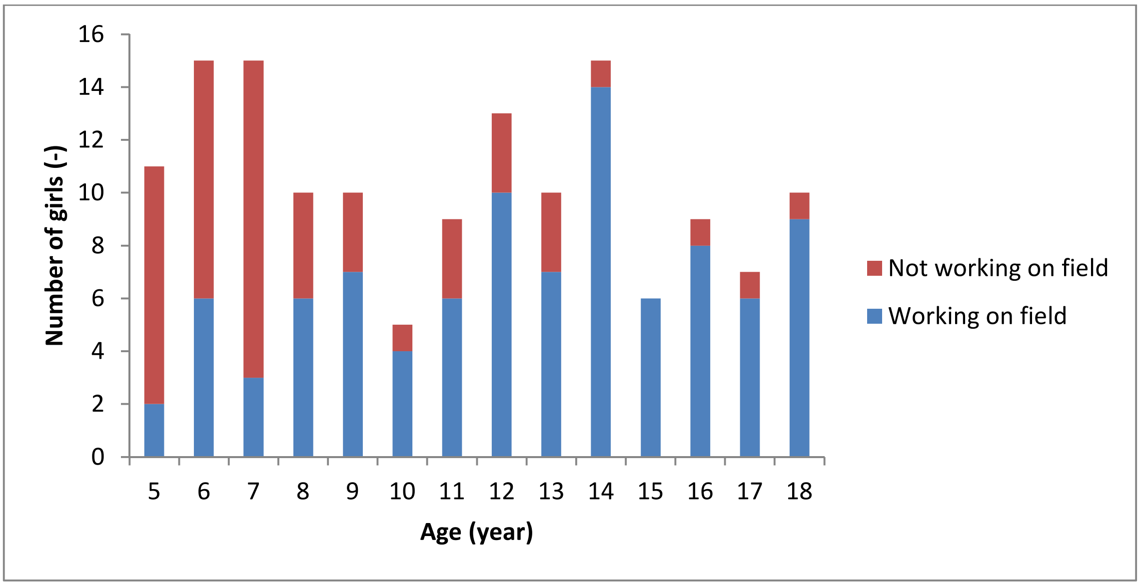



**Figure 14: Involvement of girls age 5 – 18 in field operations (N = 112)**




High involvement of children in field operations might indicate either lack of adults staying on farms caused by migration to urban areas (usually of men) and the persisting consequences of civil war or traditionally high rates of child participation in field work. Both of these possibilities are in conformity with the findings of Delgado-Matas and Pukkala (2014). A compatible explanation might be the high illiteracy rate of the farmers in the Catabola municipality, in accordance with the findings of Psacharopoulos and Arriagada (1989) that the level of education negatively affects the likelihood of child work.

### 6.2.4 Animal traction use

Animal traction is partially used by 6.6 % small farmers for specific tasks, in accordance with the results of Delgado-Matas and Pukkala (2014). The majority of the farmers using animal traction is hiring the animals, only 30 % of the farmers applicating animal-draught technology own the animals. Low rate of animal traction use is predominantly caused by the continuing civil war consequences. Knowledge of animal traction use became extinct as all draught animals were eaten or killed by land mines. As a result, some of the villages that received draught animals by the government in the period 2008-2010 slaughtered the animals and consumed them; and majority of the rest animals died, according to the information of EDA Catabola extension workers.

Usually, a farmer owns two heads of draught animals, a pair of male and female with intention of future breeding, contrary to Strakey et al. (1991, 1995), Ker (1995) and Delgado-Matas and Pukkala (2014) recognition of oxen as prevailing draught animals. The most common breed is “Crioula”, originated from Huambo, Lubango or Kunene province. The local breed has a power of 0.35 kW (Chipaco, 2010). In case of one owned animal, farmers prefer male. All respondents agreed on average 0.5 ha cultivated with use of draught animals per one day. Typically, a farmer owning draught animals is using one animal for cultivation of about 4 ha of own fields per year. Furthermore, the animal is rented for mean 25 days (with standard deviation of 10 days). Thus, the animal is used for mean 33 days for work per year, which can be considered as quite ineffective use of the animals’ working capacity, in comparison with 70 working-days defined by Goe and McDowell (1980) for cattle of 300 kg. Still, it is considerably more days than reported by Chipaco (2010) for Huambo province: 2 – 3 days.year$^{-1}$.

One of the interviewed medium scale farmers owns 69 heads of “Crioula” breed, declaring that 25 of them are used for animal traction through regular rent. Nevertheless, the statement about renting of all of 25 heads is considered implausible after cross verification with EDA extension workers and small farmers from the same village. Except for this herd, there is one cattle breeder in the municipality with 95 heads of mainly “Crioula” breed, the main orientation is meat production, although sell of the males as animal traction is admitted by the owner. Anyway, the breeding herd is of quite good potential source of draught animals for the farmers of the Catabola municipality.

The farmers hire an animal from the owner generally for 2-3 days, corresponding to 1.0-1.5 ha. Similar results were obtained by Toro and Nhantumbo (1999) for Mozambique with 2 ha on average. The fee for hiring a draught animal is ranging from 1,000 to 2,000 AKZ.day$^{-1}$, similarly as according to Chipaco (2010). The price includes wage for the animal operator, usually the owner himself. With regard to cost of draught animal (male) of 50,000 AKZ, renting of the animals could become an important source of money for the owners. On the other hand, the renting price is unaffordable for the majority of the farmers as 57 % of the farmers have annual income lower than 30,000 AKZ. In addition, other benefits of draught animals, like manure application, are rarely recognized by the farmers as well. Although manure use as organic fertilizer is used by the farmers owning draught animals in sub-Saharan Africa (Starkey et al., 1995; FAO, 2010), in the Catabola municipality, manure use by the small farmers was still unusual in 2011. Application of manure has started to be promoted through FFSs organized by CULS, FAO and ADAC, nevertheless, more actions related to the manure use promotion should be provided by EDA.

To improve economic efficiency of draught animals in the Catabola municipality, diversification of animal power could be recommended. This can be realized through widening the scope of the number of jobs that animals can do like involvement in more crop production jobs, stationary activities like milling or in non-farm work, such as road maintenance; the greatest potential for diversification is in transport (Sims and Kienzle, 2006). Diversification of livestock production is part of the National Strategy of Food and Nutrition Security (ENSAN) developed by the Angolan Ministry of Agriculture for the period 2009-2013. Nevertheless, no systematic approach relevant to livestock has been recorded in the Catabola municipality in the period 2009-2011.

Regarding the results of Delgado-Matas and Pukkala (2014) that one additional livestock unit would decrease the total land expectation value as much as one additional hectare of *naca* or *ombanda* field would increase it, hiring of draught animals can be considered as more advantageous than owning them. This consideration is supported with ineffective use of the animals’ working opacity described above. Nevertheless, the reduction of draught animals as Delgado-Matas and Pukkala (2014) suggested is not applicable to the conditions of Catabola municipality where the number of animals is limited. On the other hand, increase of ploughing productivity is essential for effective animal-draught technology adoption. Low effectiveness of animal traction could be explained by prevailing subsistence farming system as Ker (1995) and Reardon et al. (1997) argue that economics of animal traction is more favourable and adopted faster in cash-cropping areas or simultaneous within the new cash crop introduction. Moreover according to Woodhouse (2010), the key factor determining the viability of the cattle-draught system for small farmers is access to off-farm (especially wage) income with which to finance the purchase of cattle and equipment and to hire additional labour.

Regarding implements for animal traction, only ploughs are used. Usually, farmer with draught animals owns 1 plough. Mean durability of the plough is 2.6 years. 70 % of the farmers obtained the ploughs from EDA (with price of 6,000 $AKZ.pc^{-1}$); rest of them purchased the ploughs in shop in Kuito (with price of 9,000 $AKZ.pc^{-1}$). Use of carts for transport is rare – only 2 of the interviewed farmers own cart, both of them in poor operational state. Starkey et al. (1991) found out that majority of the households own and use cart in Zimbabwe and Malawi, whether in Zambia, ownership of cart is limited. EDA Catabola received few ploughs and seeders for animal traction, as well as manual seeders. Nevertheless, the received quantity remains limited, as well as the number of implements distributed or propagated among farmers. Wider spread of implements for animal traction is constrained with absence of local blacksmiths (same as in the case of hand tools) as well as steel scarcity, in accordance with Starkey et al. (1991, 1995) and Ramaswamy (1994).

### 6.2.5 Mechanization

Tractors are rarely used by the small farmers (by only 2.6 % of them), usually for the first tillage of the virgin/long-abandoned land. Regarding implements, only disc ploughs are really used.

Except for Mecanagro services, farmers can hire private tractor owners. In 2009, Safri contractor was operating in the Catabola municipality. Mr. Chiteculo has started the tractor renting service in the Catabola municipality in 2010.A tractor owned by the EPAC school was hired in 2011 as well. According to Mr. Cassoma, owner of Safri, costs of contractors could vary up to 15,000 $AKZ.ha^{-1}$ but usual price oscillates between 6,000 and 8,000 $AKZ.ha^{-1}$ (Rušarová, 2010). According to information from the Catabola administration, each community should have its own tractor but in reality, only four communities own a tractor. Mahindra 705 DI tractors with disc ploughs were distributed to Sede, Sande, Cayuera and Chiuca community; in addition, Sede community owns tractor Dong Feng 6000 since 2004 (nevertheless, the tractor is in serious disrepair). These tractors are working rarely, mainly for the purposes of the administrations with use of carriage. Although number of tractors in the municipality is limited, there are two tractor drivers paid in each community. According to the vice administrator of Sande community, tractors are not in the available for work for the majority of year due to lack of fuel, spare parts or services.

The interviewed small farmers are renting the tractors not every year, usually once per 2-3 years to cultivate up to only 2 ha. Price of the tractor rent depends on the owner: administration of community Chiuca is renting the Mahindra 705 DI tractor (with power of 52.2 kW) for 5,000 – 7,000 AKZ.ha$^{-1}$, similarly with prices defined by Mecanagro (MecaInforme, 2009). The same type of tractor is owned by the administration of community Catabola and Sande; the Catabola tractor is used only for the purposes of the municipality administration, the Sande tractor has been broken for almost 2 years. One of the farmer rented tractor New Holland T4050 (with power of 67.1 kW) owned by Mr. Chiteculo for 16,000 AKZ.ha$^{-1}$. The different price can be explained by not officially allowed rent of community tractors – the tractor operator probably cultivated the land of the farmers for a fee only to his pocket.

The medium farmers are renting tractors more frequently; they are renting the tractors from the administration or from Mr. Chiteculo. Although private hire operators could be found as more economically efficient in running the tractors (in accordance with Akinola (1987)), potential for business of tractor hiring remains very low in the municipality, the demand could be covered by the administration tractor operators. This is in conformity with the argument of Sims and Kienzle (2006) that private sector tractors have seldom proved viable for the smallholder farmers in sub-Saharan Africa, in individual or group ownership or private hire service.

One of the biggest problems in tractors use is very low work capacity of tractors. Mr. Chiteculo provides four tractors for rent, nevertheless, each tractor worked only on 40-50 ha; usual work productivity is two hectares per day corresponding to total 120-150 working hours in the conditions of the Catabola municipality. In India, annual usage of tractors is 900 h and 550 h of implements (Parminder et al., 2012). Except for high price which is affordable for only few farmers, important constraint is based on problematic access to remote areas as well as disintegrated locations of particular fields belonging to small farmers.

### 6.2.6 Typological classification of small farmers

Table 13 refers to the typological classification of small farmers into categories based on technology use in combination with the hiring of extra labour: (i) farmers using only hand-tool technology with no record of extra labour hire – farmers using the power of the farmer family members only (HT farmers), (ii) farmers using only hand-tool technology with the employment of hired labour (HTH farmers), and (iii) farmers using animal draught and/or mechanical power technology with/without some/any record of hiring extra labour (AM farmers).

**Table 13: Typological classification of small farmers in Catabola municipality (N = 151)**

| | Farmers total | | HT farmers | | HTH farmers | | AM farmers | |
|---|---|---|---|---|---|---|---|---|
| | [Number] | [%] | [Number] | [%] | [Number] | [%] | [Number] | [%] |
| Liunde | 19 | 12.7 | 16 | 84.2 | 1 | 5.3 | 2 | 10.5 |
| Sashonde | 20 | 13.2 | 15 | 75.0 | 0 | 0.0 | 5 | 25.0 |
| Cavinda | 8 | 5.4 | 4 | 50.0 | 3 | 37.5 | 1 | 12.5 |
| Canjoio | 15 | 9.9 | 15 | 100.0 | 0 | 0.0 | 0 | 0.0 |
| Embala Gonde | 23 | 15.2 | 8 | 34.8 | 15 | 65.2 | 0 | 0.0 |
| Bimbi | 20 | 13.2 | 6 | 30.0 | 11 | 55.0 | 3 | 15.0 |
| Bairro Santinho | 20 | 13.2 | 7 | 35.0 | 11 | 55.0 | 2 | 10.0 |
| Dembi-1 | 11 | 7.3 | 10 | 90.9 | 1 | 9.1 | 0 | 0.0 |
| Ongué | 15 | 9.9 | 7 | 46.7 | 8 | 53.3 | 0 | 0.0 |
| **Farmers total** | **151** | **100** | **88** | **58.3** | **50** | **33.1** | **13** | **8.6** |

Regarding the data in Table 13, use of specific technology and employment of hired labour do not depend on community provenance but is connected more with the village origin.

## 6.3 Factors influencing level of technology used by small farmers

The results of the ANOVA statistics show statistically significant differences between three farmer groups in four of ten tested variables. Data (F, p, F crit.) of the ANOVA test are available in Table 14; a sum of the variables' sample means and standard deviations is presented in Table 15.

**Table 14: ANOVA statistics for farmers in nine villages of Catabola municipality divided according to the farmers' typology (N = 151)**

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *HT x HTH* | | | | | |
| ***F*** | 0.572 | 1.189 | 0.002 | 1.081 | 9.909 | 2.276 | 1.658 | - | 0.026 | 0.703 |
| ***p*** | 0.462 | 0.294 | 0.965 | 0.316 | 0.007 | 0.155 | 0.234 | - | 0.873 | 0.416 |
| ***F crit.*** | 4.600 | 4.600 | 4.600 | 4.600 | 4.600 | 4.667 | 5.318 | - | 4.600 | 4.600 |
| | | | | | *HTH x AM* | | | | | |
| ***F*** | 6.373 | 1.964 | 1.716 | 1.093 | 1.610 | 0.257 | 1.246 | 0.589 | 4.742 | 2.809 |
| ***p*** | 0.030 | 0.191 | 0.219 | 0.321 | 0.233 | 0.626 | 0.315 | 0.461 | 0.054 | 0.125 |
| ***F crit.*** | 4.965 | 4.965 | 4.965 | 4.965 | 4.965 | 5.318 | 6.608 | 4.965 | 4.965 | 4.965 |
| | | | | | *HT x AM* | | | | | |
| ***F*** | 10.189 | 4.264 | 2.178 | 0.113 | 0.459 | 2.451 | 0.467 | - | 6.049 | 9.629 |
| ***p*** | 0.008 | 0.061 | 0.166 | 0.743 | 0.511 | 0.146 | 0.517 | - | 0.030 | 0.009 |
| ***F crit.*** | 4.747 | 4.747 | 4.747 | 4.747 | 4.747 | 4.849 | 5.592 | - | 4.747 | 4.747 |

Notes:
HT farmers = farmers using only hand-tool technology with no record of extra labour hire – farmers using the power of the farmer family members only; HTH farmers = farmers using only hand-tool technology with the employment of hired labour; AM farmers = farmers using animal draught and/or mechanical power technology with/without some/any record of hiring extra labour
(1) Total cultivated area, (2) Area cultivated per farmer family members, (3) Annual income, (4) Power of farmer family, (5) Share of family members working on field, (6) Share of children age 5-14 working on field, (7) Share of children age 15-17 working on field, (8) Annual labour-days of hired workers, (9) Education level of farmer family - parents, (10) Highest education level reached by children of farmer family.
*Not enough data available (number of respondents in the age category) to run the correlation test.

**Table 15: Summary statistics for farmers in nine villages of Catabola municipality (N = 151)**

| Variable - village | HT SM | HT SD | HTH SM | HTH SD | AM SM | AM SD |
|---|---|---|---|---|---|---|
| *1) Area total per farmer family (ha)* | | | | | | |
| Liunde | 1.50 | 0.43 | 3.00 | 0.00 | 4.75 | 3.25 |
| Sashonde | 2.24 | 0.73 | | | 7.40 | 5.24 |
| Cavinda | 1.89 | 0.74 | 1.69 | 0.47 | 10.0 | 0.00 |
| Canjoio | 1.79 | 0.49 | | | | |
| Embala Gonde | 3.28 | 1.09 | 3.33 | 1.77 | | |
| Bimbi | 2.12 | 0.55 | 2.35 | 0.68 | 3.15 | 0.08 |
| Bairro Santinho | 5.01 | 2.00 | 4.48 | 1.82 | 4.02 | 0.00 |
| Dembi-1 | 3.16 | 1.14 | 4.05 | 0.00 | | |
| Ongué | 2.22 | 0.65 | 2.00 | 0.77 | | |
| *3) Income (thousands of AKZ)* | | | | | | |
| Liunde | 29.0 | 18.9 | 85.0 | 0.0 | 37.5 | 2.5 |
| Sashonde | 23.3 | 13.7 | | | 94.4 | 28.0 |
| Cavinda | 21.5 | 6.3 | 41.7 | 6.2 | 105.0 | 0.0 |
| Canjoio | 124.3 | 147.7 | | | | |
| Embala Gonde | 80.0 | 30.3 | 64.3 | 24.9 | | |
| Bimbi | 145.0 | 84.4 | 140.0 | 121.1 | 423.3 | 265.4 |
| Bairro Santinho | 30.9 | 12.1 | 59.6 | 28.9 | 52.5 | 2.5 |
| Dembi-1 | 15.7 | 1.1 | 15.0 | 0.0 | | |
| Ongué | 71.7 | 25.9 | 22.8 | 5.8 | | |
| *5) Share of family members working on field out of farmer family members total (%)* | | | | | | |
| Liunde | 62.8 | 25.0 | 100.0 | 0.0 | 87.5 | 12.5 |
| Sashonde | 53.3 | 20.0 | | | 73.4 | 27.6 |
| Cavinda | 75.8 | 25.6 | 89.0 | 15.6 | 50.0 | 0.0 |
| Canjoio | 84.9 | 17.9 | | | | |
| Embala Gonde | 69.4 | 25.8 | 70.0 | 20.6 | | |
| Bimbi | 56.2 | 21.4 | 88.2 | 17.5 | 100.0 | 0.0 |
| Bairro Santinho | 57.9 | 21.5 | 70.0 | 20.8 | 53.5 | 13.5 |
| Dembi-1 | 70.0 | 30.4 | 100.0 | 0.0 | | |
| Ongué | 74.6 | 25.0 | 80.0 | 23.1 | | |
| *7) Share of children age 15-17 working on field out of children total per farmer family (%)* | | | | | | |
| Liunde | | | | | 100.0 | 0.0 |
| Sashonde | 100.0 | 0.0 | | | 100.0 | 0.0 |
| Cavinda | | | 0.0 | 0.0 | | |
| Canjoio | 100.0 | 0.0 | | | | |
| Embala Gonde | 100.0 | 0.0 | 75.0 | 25.0 | | |
| Bimbi | 66.7 | | 100.0 | 0.0 | | |

| Variable - village | HT SM | HT SD | HTH SM | HTH SD | AM SM | AM SD |
|---|---|---|---|---|---|---|
| *2) Area total/farmer family members (ha.person$^{-1}$)* | | | | | | |
| Liunde | 0.43 | 0.26 | 1.00 | 0.00 | 1.19 | 0.81 |
| Sashonde | 0.38 | 0.15 | | | 1.27 | 0.69 |
| Cavinda | 0.88 | 0.70 | 0.42 | 0.19 | 5.00 | 0.00 |
| Canjoio | 0.35 | 0.16 | | | | |
| Embala Gonde | 1.06 | 0.60 | 0.69 | 0.67 | | |
| Bimbi | 0.51 | 0.23 | 0.77 | 0.54 | 1.13 | 0.31 |
| Bairro Santinho | 0.87 | 0.50 | 0.78 | 0.38 | 0.74 | 0.06 |
| Dembi-1 | 0.82 | 0.42 | 2.03 | 0.00 | | |
| Ongué | 0.71 | 0.40 | 0.53 | 0.27 | | |
| *4) Power total per family (kW)* | | | | | | |
| Liunde | 131 | 75 | 153 | 0 | 175 | 18 |
| Sashonde | 168 | 76 | | | 197 | 88 |
| Cavinda | 126 | 69 | 190 | 62 | 59 | 0 |
| Canjoio | 229 | 83 | | | | |
| Embala Gonde | 126 | 66 | 202 | 65 | | |
| Bimbi | 130 | 58 | 187 | 115 | 150 | 49 |
| Bairro Santinho | 183 | 80 | 200 | 66 | 134 | 27 |
| Dembi-1 | 137 | 67 | 97 | 0 | | |
| Ongué | 126 | 22 | 161 | 48 | | |
| *6) Share of children age 5-14 working on field out of children total per farmer family (%)* | | | | | | |
| Liunde | 100.0 | 0.0 | 100.0 | 0.0 | 100.0 | 0.0 |
| Sashonde | 36.5 | 35.4 | | | 100.0 | 0.0 |
| Cavinda | 100.0 | 0.0 | 100.0 | 0.0 | | |
| Canjoio | 86.5 | 25.2 | | | | |
| Embala Gonde | 62.5 | 41.5 | 71.5 | 36.1 | | |
| Bimbi | 37.5 | 41.5 | 71.4 | 37.5 | 100.0 | 0.0 |
| Bairro Santinho | 55.0 | 40.0 | 77.4 | 23.5 | 50.0 | 50.0 |
| Dembi-1 | 44.4 | 45.8 | | | | |
| Ongué | 50.0 | 40.8 | 66.7 | 40.8 | | |
| *8) Labour-days of hired workers per year (day.year$^{-1}$)* | | | | | | |
| Liunde | 0 | 0 | 32 | 0 | 25 | 25 |
| Sashonde | 0 | 0 | | | 0 | 0 |
| Cavinda | 0 | 0 | 274 | 155 | 675 | 0 |
| Canjoio | 0 | 0 | | | | |
| Embala Gonde | 0 | 0 | 21 | 46 | | |
| Bimbi | 0 | 0 | 35 | 34 | 57 | 42 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bairro Santinho | 100.0 | 0.0 | | | 100.0 | 0.0 | Bairro Santinho | 0 | 0 | 91 | 164 | 30 | 10 |
| Dembi-1 | | | | | | | Dembi-1 | 0 | 0 | 10 | 0 | | |
| Ongué | 100.0 | 0.0 | 100.0 | 0.0 | | | Ongué | 0 | 0 | 18 | 15 | | |
| *9) Education level of parents (-)* | | | | | | | *10) Highest education level reached by children of the farmer family (-)* | | | | | | |
| Liunde | 5.0 | 3.1 | 7.0 | 0.0 | 5.5 | 2.5 | Liunde | 3.0 | 1.4 | 4.0 | 0.0 | 5.0 | 0.0 |
| Sashonde | 2.3 | 2.0 | | | 3.6 | 0.5 | Sashonde | 3.7 | 1.2 | | | 5.2 | 2.3 |
| Cavinda | 1.8 | 0.4 | 1.7 | 0.5 | 14.0 | 0.0 | Cavinda | 2.5 | 1.5 | 4.7 | 0.5 | 7.0 | 0.0 |
| Canjoio | 5.7 | 3.2 | | | | | Canjoio | 4.7 | 1.4 | | | | |
| Embala Gonde | 2.8 | 2.3 | 3.9 | 2.6 | | | Embala Gonde | 2.8 | 1.3 | 4.1 | 1.5 | | |
| Bimbi | 5.5 | 3.1 | 4.7 | 3.0 | 7.3 | 0.9 | Bimbi | 3.5 | 1.5 | 4.4 | 1.8 | 3.3 | 1.7 |
| Bairro Santinho | 3.7 | 2.1 | 4.2 | 2.4 | 6.0 | 2.0 | Bairro Santinho | 3.1 | 1.0 | 3.6 | 1.1 | 4.0 | 0.0 |
| Dembi-1 | 1.0 | 0.0 | 1.0 | 0.0 | | | Dembi-1 | 3.0 | 1.3 | 1.0 | 0.0 | | |
| Ongué | 4.6 | 2.0 | 1.5 | 1.0 | | | Ongué | 3.0 | 1.2 | 3.8 | 1.5 | | |

Notes: SM = Sample mean; SD = Standard deviation
HT farmers = farmers using only hand-tool technology with no record of extra labour hire – farmers using the power of the farmer family members only; HTH farmers = farmers using only hand-tool technology with the employment of hired labour; AM farmers = farmers using animal draught and/or mechanical power technology with/without some/any record of hiring extra labour

The AM farmers differ statistically significantly from the two other groups in the variable **(1)** *Total cultivated area*. Farmers using more sophisticated technologies have larger holdings than farmers using only hand-tool technology, contrary to the results of Toro and Nhantumbo (1999) but in conformity with Gaemelke (2011). The average area cultivated varies from the 2.42 ha of HT farmers and 3.14 of HTH farmers to the 5.69 ha of AM farmers. Regarding land area, there is an exception in Bairro Santinho village where the mean land area of farmers using only hand-tool technology is higher than that of farmers using animal traction. The difference can be explained by the short length of time from the start of draught animals ownership (less than two years), thus it is to be supposed that the owners will increase their land area in the future. Farmers using more sophisticated technologies have a larger area than farmers using only hand-tool technology, contrary to the results of Toro and Nhantumbo (1999) proving that ownership of animal traction in Mozambique does not seem to have a big impact on increasing the area cultivated.

The differences between the groups of AM farmers and the HT farmers are statistically significant in the following variables as well: **(9)** *Education level of farmer family – parents* and **(10)** *Highest education level reached by children of farmer family*. In both these factors, a higher education level was reached by the AM farmers in comparison with HT farmers. The mean value for literacy of HT farmers is equal to illiteracy of one parent, in comparison with the mean for AM farmers-parents that are both literate. The data show in the both variables a closer similarity between the HT and HTH farmers (in the both groups, more than 50 % of farmer-parents are illiterate) than between HTH and AM farmers. The mean of the highest education level reached by children varies from the $5^{th}$ - $6^{th}$ class of HT and HTH farmers to $10^{th}$ -$12^{th}$ class of AM farmers. In addition, more than 30 % of the AM farmers' children attend schools in Kuito. The lower education level of HT and HTH farmers' children results from decreased school attendance as well as frequent recruitment of children to do farm tasks, in accordance with Delgado-Matas and Pukkala (2014). A low level of education could impede adequate awareness of animal draught farming, which may result in a conservative approach to the use or adoption of draught animals for farming, in conformity with the findings of Bawa (2008), Abubakar and Ahmad (2010) or regarding new agricultural technology adoption, in line with the results of Feder (1981), Mittal and Kumar (2000), Fuller and Aye (2012) and Awais and Khan (2014).

The difference between the groups of farmers using only hand-tool technology (HT and HTH farmers) is statistically significant only in one variable: **(5)** *Share of family members working on the field*. HTH farmers involve their own family members to the field operations more than HT farmers do, 77.9 % and 67.0 %, respectively. Interestingly, for both HT and HTH farmers, the share of cultivated land per one family member regularly working in the fields is 0.96 ha. With the addition of the key difference between the two groups, hiring of extra labour, HT farmers could be defined as farmers employing labour in the field operations in a more effective way. This conclusion may be associated with a common method of hired labour payment in the Catabola municipality – reciprocal help on the fields of the hired persons/farmers. This is consistent with the Jul-Larsen and Bertelsen results (2011) that most of the farmer households in Angola have hired extra labour as well as having reciprocally worked for other households in the village, even though the frequency of working for others is mostly prevalent among poorer households. In this context, the system of hiring labour is much more than an economic institution since it may be as much a response to various types of social obligations (Jul-Larsen and Bertelsen, 2011).

Regarding child labour, none of the three groups differ from the other significantly. On average, 58.7 % of HT farmers' children aged 5-14 are involved in field operations, in comparison with a 74.9% involvement of children aged 5-14 by HTH farmers and 85.7% by AM farmers.

In the age category 15-17, the involvement in field operation is higher: HT farmers involve 82.6 % of children of this age category, HTH as many as 91.3 % and AM farmers even 100 %. The relatively low rate of child labour of HT farmers in the both age categories in comparison with HTH and AM farmers might be explained by the argumentation of Baland and Robinson (2000) that child labour is a device for transferring resources from the future in to present; and as poor families have no reason to expect any change in their future income, they have no motivation to involve the children in field operations. This may be a possible explanation for the even higher involvement rate of AM farmers' children in the age categories 5-14 and 15-17 as well. As AM farmers tend to expect change in future incomes, all of them involve children in the age category 15-17. As against these explanations, the results of Badmus (2011) from Nigeria indicate that households headed by an illiterate person have the highest incidence of child labour.

The basic output of the ANOVA is the rejection of the hypotheses H2 that there is a difference in labour utilization and adoption capacities between two categories of farmers using only hand-tool technology: HTH farmers were supposed to be transitional farmers' group, moving towards the application of innovation in the form of draught-animal or mechanical-power technology. The HTH farmers are similar to the HT group. Hiring extra workers could be considered a factor needed to increase the working power of the family which is ineffectively used. However, Delgado-Matas and Pukala (2014) define labour needs as a major constraint in the Umbundu system that is strongly dependent on the availability of women labour.

Another important output of the ANOVA is partial acceptance of hypothesis H1. The education level of both children and parents and size of cultivated field affect technology use, whereas income and structure of the family members working on field do not. Hypothesis H3 is rejected as the HT and HTH groups of farmers are not different from the AM farmers in child labour use. Even when ANOVA was realized for comparison of AM farmers with all other farmers, for the variable child labour age category 5-14 years the results remain similar: $F = 1.674$, $p = 0.222$ and F crit. 4.844.

Regarding the statistical significance of the selected variables, all the factors based on methodology of Coelli and Batesse (1996) are statistically significant; while those specified only by the local agriculture extension workers are statistically significant only in some cases. This finding might indicate insufficient knowledge of the extension workers related to the circumstances of technology use by the small farmers and in a more general way, the specific factors influencing agricultural development in the municipality.

## *6.4 Strategy of agricultural development in the Catabola municipality*

To increase agricultural productivity, Sims and Kienzle (2006) and Ker (1995) recommend increasing the efficiency of human power, together with the efficient application of draught animal power. According to Starkey (1996), animal power is most suited to small-scale family farms of 1-10 ha. Thus, in the case of small farmers in the Catabola municipality, the strategy should focus on improvement of human labour productivity and wider adoption of animal-draught technology with regard to economic efficiency.

### 6.4.1 Areas needed to be considered in the Strategy

Adoption of animal traction and/or mechanization is directly connected with education level and size of cultivated field. Nevertheless, there are other factors that influence agricultural development on small-scale farms connected with more sophisticated technologies than hand-tool in the Catabola municipality. These include structure of produced crops, market accessibility, support to farmers' associations and cooperatives, manufacture of implements, access to credits, local breeders and promotion of animal traction, diversification of animals' work and legislation and programmes for agricultural development.

**Education and know-how transfer**

Considering the results of ANOVA regarding education level of farmers (parents as well as children), general education of both parents and children is crucial. In the long-term prospect, the quality of the basic education up to 9$^{th}$ class should be primarily focused. In this context, increase of subjects' content quality and improvement of teaching methods are essential. In the short- and medium-term vision, informal education could take an important part as well, mainly in the form of FFSs. Nevertheless, technical education reflecting agricultural aspects is particularly important for the agriculture development.

Agricultural extension and advisory efforts have significant and positive effects on knowledge, adoption and productivity (Davis, 2009). Thus activities concerning know-how transfer should be supported by the municipality administration. Except for EDA, support should include other governmental organizations, NGOs, producer organizations, other farmer organizations and private sector actors such as purchasers of agricultural production, input suppliers and training organizations. With regard to the results of Mazancová and Havrland (2010), recommendations regarding know-how transfer in the Catabola municipality are as follows: (i) provision of know-how transfer in Umbundu language; (ii) improvement of training methods; (iii) respect the principle of clearness, adequacy and comprehensibility of the training topics.

Including of the topics related to animal-draught technology into extension curricula of EDA and subsequent regular specific know-how transfer among farmers in the municipality can be recommended for further animal traction adoption. The topics should cover basics of breeding, nutrition needs of cattle, structure of appropriate feed, health care, housing, handling animals within work, maintenance of implements, diversification of cattle use (manure utilization, etc.).

Establishment of animal training centre in the Catabola municipality is reasonable. The centre should serve for short-term trainings (about 4 weeks) regarding manipulation with draught animals and principles of the cattle breeding. The centre can be established within the current structures of the Wongo Centre in case of the Catabola municipality. First training should be provided for the extension workers. Consequently, trainings in the Centre can be organized by the EDA, reasonable frequency of the training is once or twice per year, regarding the interest of the farmers. Actually, in Bié province, only FAO provided training on animal traction for extension workers, duration of the training was 2 days with no further effect on know-how transfer to farmers.

**Field size**

Size of *naca* fields is of higher importance than *lavra* in the context of technology adoption in by the small farmers the Catabola municipality. As traditional areas suitable for *nacas* are limited to the close water resources, although Catabola is richer in water resources in comparison with other municipalities of the Bié province (according to MINADER head), the government should focus on sustainable enhancement of the *naca* fields close to the rivers and streams and. In the long-term strategy, adoption of modern and affordable approaches in irrigation should be considered.

With regard to Table 16, in case of field size, lavra field should increase by 2 ha up to 5 ha. Nevertheless, *naca* field should increase more significantly – by 0.4 ha up to 0.58 ha.

**Table 16: Comparison of cultivated areas' sizes regarding technology use**

| | ***lavra* (ha)** | ***naca* (ha)** | **total field size (ha)** |
|---|---|---|---|
| *Farmers using animal traction and/or tractors* | | | |
| Sample mean | 5.15 | 0.58 | 5.81 |
| Standard deviation | 3.83 | 0.64 | 4.11 |
| *Farmers using manual power only* | | | |
| Sample mean | 2.55 | 0.16 | 2.65 |
| Standard deviation | 1.54 | 0.31 | 1.48 |

**Agricultural production**

With regard to favourable conditions for the citrus production in combination with its history in the Catabola municipality, special consideration to the citruses orchards' restoration should be taken part in the strategy of agricultural development. Establishment of specialized nursery for citrus propagation through grafting and budding of several varieties in Wongo Centre is highly recommended. The nursery should be at least economically self-sufficient.

It could be considered that the structure of the cultivated crops is indirectly influencing technology applied on the field. The government should consider promotion and distribution of cash crops varieties suitable for local conditions. In this framework, testing of the varieties is essential; this could be organized at Wongo training centre and subsequently at demonstration fields or within the FFSs.

Promotion of the animal traction should be done in line with the introduction / promotion of seeds of good quality – new potential crops, cash crops and fodder crops preferably. Appropriate cultivars are recommended to be cultivated under experimental conditions in the Wongo Centre before distribution among farmers. The most convenient methods of their cultivation should be shared through extension services alongside the seed distribution or promotion.

**Market accessibility**

Another important factor of agricultural development is market accessibility which is directly connected to the road conditions. As there is no asphalted road in the municipality and majority of the farms location could be considered as remote, the main challenge in increase of markets' accessibility for the small farmers in the municipality remains with the Angolan government. In addition, poor road condition negatively affects accessibility of fields by tractor significantly.

Currently, restoration of the unpaved roads is done with use of machinery once per three up to five years on the main road and less often on the roads connecting Catabola town with the communities' centres, World Bank has been active in roads reconstruction. In order to increase the markets' accessibility, the unpaved main road from Kuito to Zambia should be asphalted and frequency of the restoration of the community roads must increase. Establishment of cooperation with the communities on these roads reconstruction as well as maintenance could be recommended.

**Implements manufacture**

High cost of improved technologies (mainly in the form of implements' affordability) is connected with high custom duty. Except for decrease of the custom tariff which is considered not to be probable, other option is to provide power sources, equipments and implements manufactured in Angola.

From the long-term point of view, implements and tools manufacture and services network is essential to establish, in order to ensure more effective use of hand-tool, animal-draught as well as mechanical-power technologies. In the first phase, blacksmith training programmes should be established by the government, the concept of the programme could be based on the experiences of the respected institutions recommended by IFAD (1998): Palabana Farm Power and Mechanization Centre in Zambia and/or Institute of Agricultural Engineering in Zimbabwe as Wichmann (1996) pointed out that countries with similar climate can better adopt agricultural technologies from each other. In the second phase, credits together with the proper equipment availability will be necessary to start the business of the training programmes' graduates. The possible model of blacksmith network for Bié province could consist of one medium-size manufacture situated in Kuito as there is electricity available almost 24 hours every day. In this unit, simple as well as more sophisticated implements could be manufactured and repaired. Furthermore, in each municipality and later on in each community, small blacksmith unit should be established. The small units should primarily serve for manufacture and repair of simple implements, such as hoes, machetes, axes. The blacksmith units should be able to manufacture specific designs according to the needs of farmers.

**Support to farmers' associations and cooperatives**

Associations and cooperatives can be considered as more successful in technologies spread and adoption in the context of smallholder farming systems in Angola (Chipaco, 2010). Thus should be considered as early adopters in the strategy of agricultural development with regard to technologies use. This role is even more important with regard to farmers' adoption behaviour characteristic with aversion to risk.

The government should continue in the facilitation of the farmers' cooperatives and associations' establishment and their further support. According to MINADER as well as EDA Catabola, there are significant delays in administrative processing of the cooperatives and associations' establishment, thus bureaucratic difficulty of the process should be decreased.

**Access to credits**

Further increased accessibility of credits and micro-credits for purchasement of draught animals and relevant implements at the Angolan banks should be considered as well. The repayment period of the credit should be at least 4 years. The shorter period is not reasonable as the net return is positive for farms owning draught animals only after some years, even 10 years according to Barrett in Reardon et al. (1997).

**Local breeders and promotion of animal traction**

Establishment of small-holder breeding herds should be encouraged and promoted, the breeders themselves should participate in the promotion of draught-animal use. In 2011, there was one breeder with such kind of capacity, Isidro Costa Dias.

Small farmers with larger field size as early adopters should be considered more in the promotion for animals' purchasement, whereas hire of draught animals should be promoted among the rest of the farmers.

**Diversification of animals' work**

To make ownership of the draught animals in the Catabola municipality more economically effective, increase in animals' productivity and diversification of the animals' work is essential, in accordance with Delgado-Matas and Pukkala (2014). Farmers-owners should hire the animals more and not only for ploughing but for transport as well (thus, purchasement of cart should be carried out by the owners) or even, involve the animals in non-farm work.

**Legislation and programmes for agricultural development**

In addition, legislation regarding animal traction will be needed to establish (Ramaswamy, 1994; Starkey and Koorts, 1995; ATNESA, 1998; Chipaco, 2010) as proper legislation is still missing.

The Angolan Ministry of Agriculture developed quite ambitious Strategy of Food and Nutrition Security (ENSAN) for the period 2009-2013. In the Catabola municipality, no significant actions in the strategy framework were realized nor achieved. SISAN, the information system about food security that was planned to be established within ENSAN is still not available. Likewise, no results or data reflecting ENSAN 2009-2013 are available. In this context, strategy for longer period – ten years at least – with defined actions (divided to the phases) in the specific topic areas would be recommendable.

According to the FAO Angola Country Programming Framework for 2013-2017 (2012), the Angolan Ministry of Agriculture was working on the formulation of the National Medium-term Development Plan for the Agricultural Sector (PDMPSA) for 2013-2017. Nevertheless, the Plan has not yet been published.

Even though all conditions described above are fulfilled, improvement in agricultural technologies is not guaranteed, with regard to arguments of Ker (1995) and Boserup (1965) that farmers tend to seek new technologies that would reduce their own production constraints slowly, the farmers would intensify their production only when land becomes limiting because of population pressure; and even then they would continue to use techniques adapted to more extensive systems as long as possible, until forced by starvation to adopt more labour-intensive techniques. As land is not scarce in the Catabola municipality, the adoption process of animal traction and mechanization could be expected to be slower and more limited in comparison with regions of higher population density and land less favourable for agriculture.

In order to increase success of adoption of the technologies more sophisticated than hand-tool, the respective agricultural strategy should be preferably discussed with the small farmers' representatives as well.

## 6.4.2 Quantified SWOT analysis for small farmers in the Catabola municipality

The main aim of the SWOT analysis is to facilitate decision making regarding adoption of animal traction and mechanization by small farmers in the Catabola municipality. Although some of the factors are similar or even same for animal traction and mechanization adoption, still, design of two separate SWOT analyses is considered as more convenient. The parameters' values were defined empirically on the basis of the author qualified estimate. The values were determined based on comparison of the particular criterionns parameters' values within each of the S, W, O, T category.

The SWOT analyses for animal traction and mechanization are shown in Table 17 and Table 18 respectively.

**Table 17: Quantified SWOT analysis of animal-draught technology**

| | Q (i) | P (i) | W (i) | K (fi) |
|---|---|---|---|---|
| **Strengths (S)** | | | | **240.0** |
| Existence of functional FFSs | 9 | 0.8 | 8 | 57.6 |
| Soils and climatic conditions in the municipality are affordable for intensive agricultural production | 7 | 0.6 | 8 | 33.6 |
| Extension services have been receiving support of NGOs and government | 8 | 0.7 | 6 | 33.6 |
| Existence of cattle breeders in the municipality | 9 | 0.7 | 8 | 50.4 |
| Farmers' associations and cooperatives have been supported by the governmental structures | 9 | 0.8 | 9 | 64.8 |
| **Weaknesses** | | | | **-186.7** |
| Lack of implements | 8 | 0.8 | 9 | 57.6 |
| Poor vaccination system of cattle | 6 | 0.6 | 7 | 25.2 |
| Delays in administrative processing of associations and cooperatives establishment | 6 | 0.5 | 7 | 21.0 |
| Lack of specific trainings related to animal traction for extension workers (and farmers, consequently) and cattle breeders | 9 | 0.9 | 9 | 72.9 |
| Part of cattle suitable for animal traction available in the municipality are imported breeds not adopted for local conditions | 5 | 0.5 | 4 | 10.0 |
| **Opportunities** | | | | **206.0** |
| Existence and well establishment of Wongo training center | 9 | 0.8 | 8 | 57.6 |
| Increased credit and micro-credit accessibility for farmers in majority of banks in Angola | 9 | 0.6 | 9 | 48.6 |
| Large areas not yet cultivated (and available as land convenient to become arable land) | 5 | 0.9 | 6 | 27.0 |
| Cooperation with centers and organizations focused on implements' manufacture and/or animal traction in Zambia or Zimbabwe | 8 | 0.5 | 7 | 28.0 |
| Diversification of draught animals' work | 8 | 0.7 | 8 | 44.8 |

**Table 17 (cont.)**

| | Q (i) | P (i) | W (i) | K (fi) |
|---|---|---|---|---|
| **Threats** | | | | **-201.0** |
| Low quality of general education | 8 | 0.8 | 9 | 57.6 |
| Lack of areas suitable to be transformed into *naca* field | 6 | 0.6 | 5 | 18.0 |
| Conservative approach of small farmers in new technologies adoption | 8 | 0.6 | 8 | 38.4 |
| Lack of seeds and seedlings of good quality | 7 | 0.7 | 6 | 29.4 |
| Lack of training programmes for blacksmiths | 9 | 0.8 | 8 | 57.6 |
| **RESULT** | | | | **58.3** |

Within the category S, the highest volume of the K parameter was achieved by the criterion *Farmers' associations and cooperatives have been supported by the governmental structures* as joint initiatives of farmers are strongly supported by the government and NGOs; farmers are willing to join in the associations and cooperatives as well; and as cooperatives' establishment is considered as more successful in technologies adoption by small farmers in Angola (Chipaco, 2010). High values were defined for the criterion *Existence of functional FFSs* as well, as the FFSs form functional informal educational network for farmers which is exceptional in the context of Angola.

The maximum points were determined for the criterion *Lack of specific trainings related to animal traction for extension workers (and farmers, consequently) and cattle breeders* in the category W, followed by *Lack of implements*. Current situation, where there are no specific trainings related to animal traction organized means impossibility in significant and functional animal-draught technology adoption by the small farmers in the Catabola municipality. Similarly, without network for manufacture and maintenance of implements for animal traction, use of animal-draught technology is not sustainable.

The highest values of the parameters within the category O were defined for the criterion *Existence and well establishment of Wongo training center*. The Wongo center is the only facility convenient for long-term trainings and experiments related to agriculture in the whole Bié province (and is occasionally used by the Huambo province as well), thus, if its potential is fully used for the continuous trainings related to animal traction as it is described in the chapter 6.4.1, the municipality could gain the opportunity to become example in successful adoption of animal traction.

Within the category T, the highest volume of the parameters was achieved by the criterions *Low quality of general education* and *Lack of training programmes for blacksmiths*. Stagnation in low general education quality may result in a conservative approach to the use or adoption of animal-draught technology by small farmers in the Catabola municipality, based on farmers' inadequate awareness (Bawa and Bolorunduro, 2008; Abubakar and Ahmad, 2010).

The resulting value the total criterion factor in the case of positive and negative aspects in animal-draught technology use by small farmers in the municipality is the positive number 58.3, in percentage expressed as 8.0%. The result can be interpreted as 8.0% assumption of success in animal traction adoption by small farmers in the Catabola municipality which is not high. The most critical criteria that should be considered are support of farmers' cooperatives and associations, FFSs, education in the form of general schooling as well as trainings for farmers, blacksmiths, extension workers and animal breeders. The results are in accordance with FAO (2010) statement that the constraints on animal traction adoption are rather psychological or social than technical or economic.

**Table 18: Quantified SWOT analysis of mechanical-power technology**

| | Q (i) | P (i) | W (i) | K (fi) |
|---|---|---|---|---|
| **Strengths** | | | | **167.8** |
| Soils and climatic conditions in the municipality are affordable for intensive agricultural production | 8 | 0.6 | 8 | 38.4 |
| Extension services have been receiving support of NGOs and government | 7 | 0.7 | 6 | 29.4 |
| Tractor hire service available | 8 | 0.6 | 9 | 43.2 |
| Present residues of intensive agricultural production from colonial era | 6 | 0.4 | 5 | 12 |
| Farmers' associations and cooperatives have been supported by the governmental structures | 8 | 0.8 | 7 | 44.8 |
| **Weaknesses** | | | | **-234.2** |
| Lack of implements and spare parts | 9 | 0.8 | 9 | 64.8 |
| Lack of satisfactory courses for the tractor drivers/maintainers | 9 | 0.9 | 9 | 72.9 |
| Delays and decreased realization of tillage realized by Mecanagro | 5 | 0.7 | 4 | 14 |
| Delays in tractors' distribution to each community | 4 | 0.6 | 4 | 9.6 |
| No network of services available for repairs and maintenance of tractors and implements in the Bié province | 9 | 0.9 | 9 | 72.9 |
| **Opportunities** | | | | **239.5** |
| Existence and well establishment of Wongo training center | 9 | 0.8 | 9 | 64.8 |
| Small mechanization up to 10 kW | 9 | 0.5 | 9 | 40.5 |
| Increased credit and micro-credit accessibility for farmers in majority of banks in Angola | 9 | 0.6 | 9 | 48.6 |

**Table 18 (cont.)**

| | Q (i) | P (i) | W (i) | K (fi) |
|---|---|---|---|---|
| Large areas not yet cultivated (and available as land convenient to become arable land) | 8 | 0.9 | 8 | 57.6 |
| Cooperation with centers and organizations focused on small mechanization abroad | 8 | 0.5 | 7 | 28 |
| **Threats** | | | | **-246.6** |
| Low quality of general education | 9 | 0.8 | 9 | 64.8 |
| Some areas remain dangerous for agriculture due to mines | 7 | 0.5 | 6 | 21 |
| Lack of fuel and lubricants | 8 | 0.6 | 8 | 38.4 |
| Poor road conditions | 9 | 0.8 | 8 | 57.6 |
| Lack of training programmes for blacksmiths | 9 | 0.8 | 9 | 64.8 |
| **RESULT** | | | | **-73.5** |

The values of parameters in the SWOT analysis of mechanical-power technology adoption were similar to the animal traction adoption SWOT analysis – mainly in parameters reflecting education (formal, as well as informal). In the category S, the values of K parameters are relatively low, caused mainly by low probability of the criterions' occurrence. The highest value of the K parameter was achieved in the criterion *Farmers' associations and cooperatives have been supported by the governmental structures*, nevertheless the same criterion has higher value in the case of the animal-draught technology adoption as impact and weight of the criterion is significant in the less way for adoption of mechanical-power technology.

The maximum possible values of the parameters were obtained in two criterions within the category W: *Lack of satisfactory courses for the tractor drivers/maintainers* and *No network of services available for repairs and maintenance of tractors and implements in the Bié province*, followed by the criterion *Lack of implements and spare parts*. The impact of the implements and spare parts' lack is higher for the adoption of mechanical-power technology than animal traction. Current situation regarding lack of trainings for tractor drivers and/or maintainers and no existence of services network impede successful and sustainable adoption of the mechanical-power technology by the small farmers in the Catabola municipality.

Similarly to the animal traction adoption, the highest values of the parameters within the category O were defined for the criterion *Existence and well establishment of Wongo training center* and within the category T for the criterions *Low quality of general education* and *Lack of training programmes for blacksmiths*, with the higher impact of the last two parameters for the mechanization adoption. In addition, high values were determined for the criterion *Poor road conditions* as it is critical factor for the mechanical-power technology adoption.

The resulting value the total criterion factor in the case of positive and negative aspects in mechanical-power technology use by small farmers in the municipality is the negative number -73.5, in percentage expressed as 10.1 %. The result can be interpreted as 10.1% assumption of failures in mechanization adoption by small farmers in the Catabola municipality. Thus, tractors are not considered as an appropriate technology for small farmers in the Catabola municipality. Tractor use inappropriateness for the small farmers in the Catabola municipality is in accordance with the argument of Starkey and Koorts (1995) that tractor hire can be successful only when specific economic conditions occur; these include profitable cropping systems with good rainfall and/or irrigation on fertile soils, large individual farm areas (e.g. sugar cane farms) or land that is consolidated (or not badly fragmented) and nearby infrastructural backup. Although there are favourable soil and climatic conditions for agriculture in the Catabola municipality, use of tractors will never be viable till satisfactory courses for the tractor drivers and servicemen, as well as services and spare parts will be available in Angola, according to Mr. Chiteculo, one of the two single tractor owners who provide rental service

The most critical criteria that should be considered are support of farmers' cooperatives and associations, FFSs, education in the form of general schooling as well as trainings for farmers, blacksmiths, extension workers and animal breeders.

In the long-term prospect, use of small tractors up to 10 kW could be appropriate and compatible with use of draught animals, in accordance with the suggestion of the EDA Catabola head. Nevertheless, following conditions should be fulfilled:

(i) existence of training programmes regarding use and maintenance of mechanization in Bié province;
(ii) existence of service for tractor, including available spare parts in Bié province;
(iii) existence of blacksmith manufacture in the Catabola municipality;
(iv) stable availability of fuel and lubricants in the Catabola municipality;
(v) roads accessibility for tractors.

In the further adoption of small mechanization, cooperatives and farmers' associations could be considered as early adopters with higher capacities for the more sophisticated technologies use, thus they deserve to be focused on at first.

# 7 Conclusions

The main contribution of the dissertation thesis as well as survey for practice lies in the utilization of the outcomes in the formulation of strategies of agricultural development related to the technologies use and adoption (for the Catabola municipality as well as the other provinces and municipalities, with regard to their specific conditions) by the particular governmental bodies of Angola. The thesis will be handovered to the Angolan Ministry of agriculture – to the Department for Food Security in particular. Regarding scientific contribution, methodology could be used for analysis of technologies use and adoption in other areas of Angola as well as other regions of sub-Saharan Africa.

The study brings new findings in agricultural technologies' adoption behaviour of small farmers. In the Catabola municipality, education level of both children and parents and size of cultivated field affect technology use, whereas income and structure of the family members working on field do not. From the point of view of hiring extra labour, farmers using also human power of hired external workers are similar to farmers using only human power of their own family members. Hiring extra workers could be considered as a factor needed to increase the working power of the family which is ineffectively used. One of the most important findings of the survey reflects the relatively high engagement of child labour in field operations. With the exclusion of childless families, 62.7 % of small farmer families are regularly using children of ages 0-14 for operations on fields; 63.88 % of the children age 5-14 are involved in the field operations.

The vast majority of small farmers in the Catabola municipality use only hand-tool technology as it is employed in 95.38 % of the cultivated land of small farmers. Hired labour is used by 38.0 % of small farmers, usually during the harvest peak season. Animal traction is partially used by 6.6 % small farmers for specific tasks. Tractors are rarely used by the small farmers (by only 2.6 % of them), usually for the first tillage of the virgin/long-abandoned land.

As it is mentioned above, the adoption of the agricultural technologies by small farmers in the Catabola municipality is directly connected with the size of cultivated fields and education level of both parents and children. As a result of the civil war, majority of the rural adult population in the Catabola municipality remains illiterate. Similarly, low rate of animal traction use is predominantly caused by the continuing civil war consequences. Illiteracy among children older than 6 years occur only in 1 % of the households, nevertheless the quality of general education remains very poor. In the long-term prospect, the quality of the general basic education up to 9th class should be primarily focused. In this context, increase of subjects' content quality and improvement of teaching methods are essential. In the short- and medium-term vision, informal education could take an important part as well, mainly in the form of FFSs. Size of *naca* fields is of higher importance than *lavra* in the context of technology adoption by the small farmers in the Catabola municipality. The governmental strategy should focus on sustainable enhancement of the *naca* fields close to the rivers and streams and. In the long-term strategy, adoption of modern and affordable approaches in irrigation should be considered.

Other factors that influence agricultural development on small-scale farms connected with more sophisticated technologies than hand-tool in the Catabola municipality include structure of produced crops, market accessibility, support to farmers' associations and cooperatives, manufacture of implements, access to credits, local breeders and promotion of animal traction, diversification of animals' work and legislation and programmes for agricultural development. The government should consider promotion and distribution of cash crops varieties suitable for local conditions. In this framework, testing of the varieties is essential; this could be organized at Wongo training centre and subsequently at demonstration fields or within the FFSs.

As the study does not include variables which might be important in the adoption process of animal traction and/or mechanical power, such as access to credit or labour-days, there is potential for a more refined analysis, if such data were available. Deeper analysis form the gender point of view needs to be provided as well.

In the Catabola municipality, there is an 8.0% assumption of success in animal traction adoption by small farmers which is not high. The most critical criteria that should be considered are support of farmers' cooperatives and associations, FFSs, education in the form of general schooling as well as trainings for farmers, blacksmiths, extension workers and animal breeders. Although there are constraints in the wider adoption of animal-draught technology in the Catabola municipality, the chance for success is high as the municipality belongs to the region of highest agricultural potential in Angola. Contrary to animal traction, in case of mechanical-power technology, there is a 10.1% assumption of failure in the mechanization adoption by small farmers in the Catabola municipality. Thus, tractors are not considered as an appropriate technology for small farmers in the Catabola municipality. In the long-term prospect, use of small tractors up to 10 kW could be considered as appropriate and compatible with use of draught animals.

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# Annexes

**Annex 1: Map of Bié province – administrative division to municipalities and communities**


Source: Helo Trust, 2006

**Annex 2: Questionnaire for small farmers**

**Questionnaire – farmer families: Technologies used in agriculture (Catabola, 2011)**

| Village: | Name: |
|---|---|
| | |

1) **Family**

| Family members | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | | | | | | | | | | |
| Sex | | | | | | | | | | |
| Level of education (class) | | | | | | | | | | |
| Occupation | | | | | | | | | | |
| Work on field (yes/no) | | | | | | | | | | |

2) **Income**

- Income per year – family total (in AKZ):_______________________________
- Source of income (details of: agricultural products / off-farm activities / salary):

_______________________________________________________________________

- Where are the agricultural products sold:_______________________________
- Who is responsible for selling the products:____________________________
- Way of transport to markets:

_______________________________________________________________________

- Credits – obtained? Where? What for? Repayment period?

### 3) Agriculture

| | | |
|---|---|---|
| Area – *lavra* (ha): | Area – *naca* (ha): | Area – *other type of field* (ha): |

- Crops produced (maize, cassava, beans, pineapple, sugar cane, soya, groundnut, rice, wheat, vegetable (tomato, onion, garlic, cabbage, lettuce, paprika, other), potatoes, sweet potatoes, sesame, other):

- Type + No. of fruit trees produced (tangerine, lemon, orange, banana, avocado, mango, papaya, maracuja, other):

- Type + No. of animals breeded (hens, goats, sheep, pigs, cattle, other):

### 4) Technologies used in agriculture

| | | |
|---|---|---|
| Hand-tool technology (%/ha of area cultivated): | Animal traction (%/ha of area cultivated): | Mechanization (%/ha of area cultivated): |

**Implements for manual work:**

- Number of traditional hoes (+ duration + price + where it was purchased):_____
- Number of European hoes (+ duration + price + where it was purchased):______
- Number of machetes (+ duration + price + where it was purchased):__________
- Number of axes (+ duration + price + where it was purchased):______________
- Number of shovels (+ duration + price + where it was purchased):___________
- Number + type of other implements (+ duration + price + where it was purchased):

**Extra labour (manual work) (yes / no) – annual:**

- Number of extra workers (per year):___________________________________
- Number of days per worker (per year):________________________________
- Way of payment:
- Amount of payment (per day):

**Own animals for traction (yes / no) – annual:**

- Type (cattle / donkey / ??):____________________
- Number + sex:________________________
- Number of days working on own field:_________________________
- Number of days - rented:____________________
- Number of ha per day:___________________
- Price per day or ha:________________
- Who is hiring the animals:_________________________
- Who is operating the animals while use for traction:_____________________
- Kind of operations that are done within animal traction:___________________
- Type + number of implements owned and used (+ duration + price + where it was purchased):

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**Hired animals for traction (yes / no) – annual:**

- Type (cattle / donkey / ??):__________________
- Number of days:______________________________
- Number of ha per day:____________________
- Price per day or ha:____________________
- Who is renting the animals:_______________________________________
- Who is operating the animals while use for traction:____________________
- Kind of operations that are done within animal traction:_________________
- Type + number of implements used:

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**Tractor hired (yes / no) – annual:**

- Type (brand):____________________________
- Owner of the tractor:____________________________
- Number of days / ha:___________________
- Number of ha per hour (Number of ha per day):_____________________
- Price per hour or ha:___________________
- Who is operating / maintaining the tractor:_________________________
- Kind of operations that are done within tractor:______________________
- Type + number of implements owned and used (+ duration + price + where it was purchased):

**Annex 3: Organizations and individual involved in the primary data collection**

| Entity | Name of person | Position | Remark |
|---|---|---|---|
| | | ***National level (Luanda)*** | |
| Department for Food Security of the Ministry of Agriculture | Ing. David Tunga | Director | Ing.Tunga visited Catabola for several times, thus, he is one of the most competent to compare the situation of agricultural development in the context of the country |
| | | ***Provincial level – Bié province (Kuito)*** | |
| MINADER | Ing. Marculino Rocha Sandemba | Director | MINADER is responsible for agriculture strategies development for the Bié province. |
| Mecanagro | Ing. Felizardo Guilherme Brito Capepula | Director | Mecanagro is responsible for machinery distribution to its provincial departments. |
| | Valdemar António | technician | |
| IDA | Ing. Roque | Director | IDA is directly responsible for the implementation of the agricultural strategies and campaigns in the Bié province through EDAs |
| Veterinary department | Dr. Domingos da Cruz Ngueve | Head | |
| FAO | Cyprien Ndoki | representative for the Bié and Huambo province | These two organizations are of the five NGOs working on agricultural projects in Bié province. In the Catabola municipality, agricultural projects were implemented by the FAO, ADAC and CULS in the time of data collection. The other NGOs People in Need and Red Cross were working in other parts of the province. |
| Local NGO Association of Field Activities Development (ADAC) | Eurico | responsible for the agricultural projects | |
| Tractor owners | Esteban Palanga Chiteculo | Private owner of 4 tractors available for rent | 4 tractors were available for rent in Catabola municipality in the time of data collection. |
| | Cassoma | Owner of Safri | Safri is private company renting tractors which was operating in the Catabola municipality in 2009. |
| | | ***Municipal level (Catabola, Sande, Chiuca)*** | |
| EDA Catabola | Rafael Pula Pula<br>Alfredo Sapalo, Luís Cavicolo and Salomão Cangombe<br>Wimbuando Henda | EDA head<br>extension workers | EDA is direct implementer of the agricultural strategies and campaigns in the Catabola municipality. Rafael Pula Pula has been working at this position since the seventies. |
| Administration of the Catabola municipality and Sande community | Antunes Sapalo | administrator of the Catabola municipality | |
| | Evaristo Sevalunga Cipriano | vice administrator of Sande community | |

**Annex 3 (Cont.)**

| Entity | Name of interviewed person | Position | Remark |
|---|---|---|---|
| Tractor drivers | Fernando Limbo, Pedro Silvano Chipenda, Marco Chitecula Calikonde<br>Nelito Muhongo | drivers of tractors owned by Mr. Chiteculo<br><br>Tractor driver of CULS | The drivers are responsible for the tractor maintenance and basic repairs. |
| Cattle herd owner | Isidro Costa Dias | | He is the only one owner of cattle exceeding ten heads in the Catabola municipality, In the time of data collection, he owned in total 95 cattle heads. |
| Large scale farmer | Augusto José Tsonsa | | In the Catabola municipality, only one large scale farmer was detected and interviewed. The farm was personally visited. * |
| Medium scale farmers | Salumungo Kachipundo Jamba, Lopes Justo, Eurico António, Afonso Eliseu | | There were seven medium scale farmers detected. With four of them, semi-structured interviews were conducted; two of the farms were visited as well. |
| Villages: small scale farmers and village leaders | | | In total, 151 small scale farmers participated at the survey. |

Notes: *The large scale farm was established one year before the interview was conducted, thus, information obtained in view of farmer’s experiences lack are regarded as less trustworthy than of the rest of interviewed farmers who have been working at their field since at least end of the civil war.

**Annex 4: Area cultivated and average yield of selected crops in 2010**

| Community | Maize | | Beans | | Cassava | |
|---|---|---|---|---|---|---|
| | Area cultivated [ha] | Yield [t.ha$^{-1}$] | Area cultivated [ha] | Yield [t.ha$^{-1}$] | Area cultivated [ha] | Yield [t.ha$^{-1}$] |
| Sede | 29,664 | 0.8 | 18,162 | 0.6 | - | - |
| Chipeta | 6,178 | 0.7 | 3,707 | 0.5 | - | - |
| Sande | 5,149 | 0.9 | 3,089 | 0.7 | - | - |
| Cayuera | 4,911 | 0.9 | 2,946 | 0.7 | - | - |
| Chiuca | 4,803 | 0.8 | 2,881 | 0.5 | - | - |
| settlement Muquinda | 3,236 | 0.7 | 1,941 | 0.5 | - | - |
| **Total** | **53,941** | | **32,726** | | **29,092** | **40** |

Source: EDA Catabola, 2011

**Annex 5: Type and quantity of inputs received by EDA Catabola in 2008, 2009 and 2010**

| Type of input | | Quantity [t] | | |
|---|---|---|---|---|
| | | **2008** | **2009** | **2010** |
| **Fertilizers** | NPK 12-24-12 | 60 | 178 | 1.95 |
| | NPK 17-17-17 | 55 | - | - |
| | Ammonium sulfate | 55 | 170 | - |
| | Urea | 40 | 104 | - |
| **Seeds** | Maize | 60 | 74.5 | - |
| | Beans | 2 | 4 | - |
| | Peanut | 10 | 5 | - |
| | Potato | 1 | - | 2.75 |
| | Rice | 10 | 10 | - |
| **Type of input** | | **Quantity [unit]** | | |
| | | **2008** | **2009** | **2010** |
| **Implements** | European hoe | 20,000 | 22,500 | 60 |
| | Traditional hoe | 3,000 | 6,400 | - |
| | Machete | 5,000 | 36,440 | - |
| | File | 1,000 | 2,500 | - |
| | Axe | - | 600 | - |
| | Shovel | - | 600 | - |
| | Plough for animal traction | 100 | 250 | - |
| | Seeder for animal traction | - | 75 | - |
| | Harrow for animal traction | - | 2 | - |
| | Cart for animal traction | 30 | - | - |
| | Sprayer - manual | 1 | - | - |
| | Manual seeder | 30 | - | - |

Source: EDA Catabola, 2008; MINADER , 2009, 2010, 2011

**Annex 6: Price list comparison of selected products at municipal market in Catabola with prices at markets and supermarkets in Luanda in 2011**

| Product | Minimal price [AKZ.kg$^{-1}$] | | | Maximum price [AKZ.kg$^{-1}$] | | |
|---|---|---|---|---|---|---|
| | market Catabola | markets Luanda | supermarkets Luanda | market Catabola | markets Luanda | supermarkets Luanda |
| Maize | 25 | | | 30 | | |
| Beans – *Phaseolus sp.* | 80 | 250 | 349 | 250 | 350 | 570 |
| Beans – *Vigna sp.* | 20 | 250 | 265 | 25 | 300 | 570 |
| Flour from cassava | 20 | 100 | 169 | 35 | 120 | 356 |
| Flour from maize – process. in modern mill | 60 | 100 | 165 | 80 | 200 | 319 |
| Flour from maize – process. traditionally | 40 | | | 60 | | |
| Tomato | 100 | 100 | 215 | 150 | 550 | 600 |
| Onion | 50 | 100 | 200 | 100 | 250 | 300 |
| Cabbage | 50 | 100 | 230 | 75 | 400 | 600 |
| Potatoes | 100 | 150 | 195 | 200 | 500 | 252 |
| Peanuts with shell | 80 | 150 | 370 | 100 | 500 | 888 |
| Mango | 5 | | | 30 | | |
| Pineapple | 50 | 200 | 149 | 100 | 500 | 450 |
| Avocado | 20 | | | 50 | | |
| Lemon | 30 | 100 | 350 | 80 | 500 | 520 |
| Tangerine | 100 | | | 200 | | |
| Orange | 100 | 150 | 299 | 200 | 500 | 500 |
| Dried fish | 200 | 200 | 515 | 400 | 1,500 | 1,710 |
| Egg (local) – cost per unit | 20 | | | 40 | | |
| Living hen – cost per unit | 900 | 450 | | 1,200 | 1,500 | |
| Living goat – cost per unit | 5,000 | | | 8,000 | | |

Note:1 USD equals is about 105.8 AOA – March 2015; Banco Nacional de Angola 2015

Sources: EDA Catabola, 2011; IDA Luanda, 2011

**Annex 7: Areas cultivated division in Catabola municipality according to technologies used in 2008, 2009 and 2010**

| **Technology** | **2008** Area cultivated | | **2009** Area cultivated | | **2010** Area cultivated | |
|---|---|---|---|---|---|---|
| | **[ha]** | **[%]** | **[ha]** | **[%]** | **[ha]** | **[%]** |
| Mechanical-power | 206 | 0.16 | 49 | 0.04 | 442 | 0.34 |
| Draught-animal | 156 | 0.12 | 165 | 0.13 | 36 | 0.03 |
| Hand-tool | 129,638 | 99.72 | 129,786 | 99.83 | 129,522 | 99.63 |
| **Total** | **130,000** | **100** | **130,000** | **100** | **130,000** | **100** |

Sources: EDA 2011, MINADER 2009, 2010, 2011

**Annex 8: Complex table – power use on small farms in Catabola municipality (9 villages)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm (kW.ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| **Liunde** | | | | | | | | | | | | | | | | | |
| 1 | 8.00 | ATH | 0.00 | 0.00 | 114.28 | 0.00 | 0.00 | 50.59 | 164.87 | 5 | 10 | 50 | 281.98 | 350.00 | 0.00 | 796.84 | 0.10 |
| 2 | 1.50 | HT | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 44.97 | 96.08 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 96.08 | 0.06 |
| 3 | 1.50 | ATF | 51.13 | 0.00 | 51.12 | 0.00 | 43.43 | 50.59 | 196.27 | 0 | 0 | 0 | 0.00 | 350.00 | 0.00 | 546.27 | 0.36 |
| 4 | 1.50 | HT | 0.00 | 0.00 | 114.28 | 0.00 | 42.40 | 50.59 | 207.26 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 207.26 | 0.14 |
| 5 | 1.50 | HT | 41.23 | 0.00 | 62.08 | 0.00 | 0.00 | 100.22 | 203.53 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 203.53 | 0.14 |
| 6 | 1.50 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.08 |
| 7 | 2.00 | HT | 41.23 | 0.00 | 62.08 | 32.64 | 0.00 | 49.63 | 185.58 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 185.58 | 0.09 |
| 8 | 1.50 | HT | 26.01 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 138.68 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 138.68 | 0.09 |
| 9 | 1.50 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 49.63 | 49.63 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 49.63 | 0.03 |
| 10 | 1.50 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.08 |
| 11 | 2.50 | HT | 28.79 | 0.00 | 125.24 | 78.61 | 0.00 | 49.63 | 282.27 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 282.27 | 0.11 |
| 12 | 1.50 | HT | 62.83 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 175.51 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 175.51 | 0.12 |
| 13 | 1.00 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 50.59 | 50.59 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 50.59 | 0.05 |
| 14 | 3.00 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 43.43 | 50.59 | 156.11 | 2 | 16 | 32 | 112.79 | 0.00 | 0.00 | 268.90 | 0.09 |
| 15 | 1.50 | HT | 113.97 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 226.64 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 226.64 | 0.15 |
| 16 | 2.00 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 49.63 | 49.63 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 49.63 | 0.02 |
| 17 | 1.50 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.08 |
| 18 | 0.50 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 49.63 | 49.63 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 49.63 | 0.10 |
| 19 | 1.00 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 50.59 | 50.59 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 50.59 | 0.05 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm (kW.ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| **Sashonde** | | | | | | | | | | | | | | | | | |
| 20 | 14.00 | ATF | 0.00 | 58.10 | 114.28 | 0.00 | 0.00 | 50.59 | 222.96 | 0 | 0 | 0 | 0.00 | 350.00 | 0.00 | 572.96 | 0.04 |
| 21 | 13.50 | ATH | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 1 | 30 | 30 | 56.40 | 700.00 | 0.00 | 858.10 | 0.06 |
| 22 | 4.50 | ATF | 0.00 | 54.75 | 176.36 | 0.00 | 43.43 | 50.59 | 325.13 | 0 | 0 | 0 | 0.00 | 700.00 | 0.00 | 1025.13 | 0.23 |
| 23 | 2.50 | ATF | 0.00 | 0.00 | 176.36 | 0.00 | 0.00 | 100.22 | 276.58 | 0 | 0 | 0 | 0.00 | 350.00 | 0.00 | 626.58 | 0.25 |
| 24 | 2.50 | ATF | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 0 | 0 | 0 | 0.00 | 350.00 | 0.00 | 451.71 | 0.18 |
| 25 | 2.50 | HT | 75.27 | 0.00 | 62.08 | 113.20 | 0.00 | 49.63 | 300.19 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 300.19 | 0.12 |
| 26 | 2.00 | HT | 51.13 | 0.00 | 251.56 | 0.00 | 0.00 | 50.59 | 353.29 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 353.29 | 0.18 |
| 27 | 2.00 | HT | 92.36 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 205.03 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 205.03 | 0.10 |
| 28 | 3.00 | HT | 71.27 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 183.95 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 183.95 | 0.06 |
| 29 | 2.00 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.06 |
| 30 | 1.00 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.11 |
| 31 | 2.00 | HT | 43.69 | 58.10 | 62.08 | 35.91 | 0.00 | 49.63 | 249.41 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 249.41 | 0.12 |
| 32 | 2.00 | HT | 41.23 | 0.00 | 0.00 | 0.00 | 0.00 | 50.59 | 91.82 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 91.82 | 0.05 |
| 33 | 3.00 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| 34 | 4.00 | HT | 34.04 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 146.72 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 146.72 | 0.04 |
| 35 | 2.00 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 42.40 | 50.59 | 155.07 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 155.07 | 0.08 |
| 36 | 2.00 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.06 |
| 37 | 3.00 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| 38 | 1.50 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.07 |
| 39 | 1.50 | HT | 41.23 | 58.10 | 62.08 | 0.00 | 0.00 | 50.59 | 212.00 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 212.00 | 0.14 |
| 40 | 10.00 | MATH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 0.00 | 62.08 | 15 | 45 | 675 | 845.94 | 700.00 | 67100.00 | 68708.02 | 6.87 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm ($kW.ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| **Cavinda** | | | | | | | | | | | | | | | | | |
| 41 | 1.02 | HTH | 0.00 | 0.00 | 125.24 | 39.33 | 0.00 | 50.59 | 215.16 | 4 | 18 | 72 | 225.58 | 0.00 | 0.00 | 440.74 | 0.43 |
| 42 | 1.01 | HT | 26.01 | 0.00 | 125.24 | 0.00 | 43.43 | 49.63 | 244.32 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 244.32 | 0.24 |
| 43 | 1.52 | HT | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 101.71 | 0.07 |
| 44 | 2.03 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 111.71 | 30 | 15 | 450 | 1691.87 | 0.00 | 0.00 | 1803.59 | 0.89 |
| 45 | 2.01 | HTH | 81.18 | 0.00 | 63.16 | 56.75 | 0.00 | 49.63 | 250.72 | 30 | 10 | 300 | 1691.87 | 0.00 | 0.00 | 1942.59 | 0.96 |
| 46 | 2.02 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 0.00 | 63.16 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 63.16 | 0.03 |
| 47 | 3.01 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| **Canjoio** | | | | | | | | | | | | | | | | | |
| 48 | 2.07 | HT | 99.56 | 0.00 | 62.08 | 37.60 | 0.00 | 50.59 | 249.83 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 249.83 | 0.12 |
| 49 | 1.50 | HT | 88.51 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 201.30 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 201.30 | 0.13 |
| 50 | 1.44 | HT | 94.82 | 121.58 | 62.08 | 0.00 | 0.00 | 50.59 | 329.07 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 329.07 | 0.23 |
| 51 | 1.50 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.08 |
| 52 | 2.01 | HT | 0.00 | 0.00 | 125.24 | 35.91 | 0.00 | 50.59 | 211.74 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 211.74 | 0.11 |
| 53 | 3.05 | HT | 0.00 | 0.00 | 62.08 | 28.60 | 42.40 | 100.22 | 233.30 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 233.30 | 0.08 |
| 54 | 2.01 | HT | 0.00 | 0.00 | 62.08 | 116.25 | 0.00 | 50.59 | 228.92 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 228.92 | 0.11 |
| 55 | 2.55 | HT | 28.79 | 0.00 | 62.08 | 0.00 | 42.40 | 50.59 | 183.86 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 183.86 | 0.07 |
| 56 | 1.52 | HT | 26.01 | 0.00 | 125.24 | 0.00 | 0.00 | 100.22 | 251.47 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 251.47 | 0.17 |
| 57 | 1.07 | HT | 49.43 | 118.89 | 125.24 | 28.60 | 0.00 | 100.22 | 422.38 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 422.38 | 0.39 |
| 58 | 2.04 | HT | 0.00 | 58.10 | 0.00 | 68.55 | 0.00 | 50.59 | 177.23 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 177.23 | 0.09 |
| 59 | 1.54 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.07 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm ($kW.ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| 60 | 1.50 | HT | 62.83 | 0.00 | 0.00 | 39.33 | 0.00 | 50.59 | 152.75 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 152.75 | 0.10 |
| 61 | 1.50 | HT | 30.05 | 0.00 | 188.40 | 83.67 | 0.00 | 50.59 | 352.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 352.71 | 0.23 |
| 62 | 1.50 | HT | 70.02 | 0.00 | 125.24 | 0.00 | 0.00 | 50.59 | 245.85 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 245.85 | 0.16 |
| **Embala Gonde** | | | | | | | | | | | | | | | | | |
| 63 | 4.59 | HTH | 0.00 | 0.00 | 114.28 | 0.00 | 43.43 | 50.59 | 208.30 | 2 | 3 | 6 | 112.79 | 0.00 | 0.00 | 321.09 | 0.07 |
| 64 | 2.06 | HTH | 34.04 | 0.00 | 62.08 | 67.96 | 0.00 | 50.59 | 214.67 | 3 | 2 | 6 | 169.19 | 0.00 | 0.00 | 383.86 | 0.19 |
| 65 | 2.06 | HTH | 71.27 | 0.00 | 125.24 | 71.96 | 0.00 | 50.59 | 319.07 | 2 | 3 | 6 | 112.79 | 0.00 | 0.00 | 431.86 | 0.21 |
| 66 | 1.06 | HTH | 0.00 | 0.00 | 62.08 | 78.61 | 43.91 | 49.63 | 234.23 | 3 | 3 | 9 | 169.19 | 0.00 | 0.00 | 403.42 | 0.38 |
| 67 | 2.02 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.06 |
| 68 | 2.02 | HT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 44.97 | 44.97 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 44.97 | 0.02 |
| 69 | 2.53 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 1 | 1 | 1 | 56.40 | 0.00 | 0.00 | 169.07 | 0.07 |
| 70 | 8.00 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 1 | 1 | 1 | 56.40 | 0.00 | 0.00 | 169.07 | 0.02 |
| 71 | 5.24 | HTH | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 3 | 10 | 30 | 169.19 | 0.00 | 0.00 | 270.89 | 0.05 |
| 72 | 4.20 | HTH | 43.69 | 0.00 | 125.24 | 37.60 | 0.00 | 50.59 | 257.12 | 3 | 5 | 15 | 169.19 | 0.00 | 0.00 | 426.30 | 0.10 |
| 73 | 2.03 | HTH | 51.13 | 58.10 | 62.08 | 0.00 | 0.00 | 50.59 | 221.90 | 1 | 5 | 5 | 56.40 | 0.00 | 0.00 | 278.30 | 0.14 |
| 74 | 2.03 | HTH | 71.27 | 0.00 | 62.08 | 0.00 | 43.91 | 100.22 | 277.49 | 1 | 4 | 4 | 56.40 | 0.00 | 0.00 | 333.88 | 0.16 |
| 75 | 3.03 | HTH | 43.69 | 0.00 | 62.08 | 26.95 | 43.91 | 50.59 | 227.21 | 1 | 3 | 3 | 56.40 | 0.00 | 0.00 | 283.61 | 0.09 |
| 76 | 4.02 | HT | 0.00 | 58.10 | 62.08 | 67.96 | 0.00 | 100.22 | 288.36 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 288.36 | 0.07 |
| 77 | 4.03 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.03 |
| 78 | 5.03 | HTH | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 3 | 6 | 18 | 169.19 | 0.00 | 0.00 | 281.98 | 0.06 |
| 79 | 2.02 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.06 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm kW.ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| 80 | 5.04 | HT | 37.38 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 149.09 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 149.09 | 0.03 |
| 81 | 4.04 | HTH | 81.18 | 0.00 | 62.08 | 37.60 | 0.00 | 50.59 | 231.45 | 8 | 24 | 192 | 451.17 | 0.00 | 0.00 | 682.61 | 0.17 |
| 82 | 2.03 | HTH | 0.00 | 54.75 | 62.08 | 28.60 | 0.00 | 100.22 | 245.65 | 3 | 5 | 15 | 169.19 | 0.00 | 0.00 | 414.84 | 0.20 |
| 83 | 2.05 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 43.91 | 100.22 | 206.21 | 1 | 4 | 4 | 56.40 | 0.00 | 0.00 | 262.61 | 0.13 |
| 84 | 3.04 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| 85 | 4.02 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.03 |
| **Bimbi** | | | | | | | | | | | | | | | | | |
| 86 | 3.07 | MF | 0.00 | 0.00 | 51.12 | 39.33 | 0.00 | 50.59 | 141.03 | 0 | 0 | 0 | 0.00 | 0.00 | 52200.00 | 52341.03 | 17.05 |
| 87 | 2.59 | HTH | 0.00 | 0.00 | 125.24 | 65.12 | 0.00 | 50.59 | 240.96 | 4 | 10 | 40 | 225.58 | 0.00 | 0.00 | 466.54 | 0.18 |
| 88 | 3.06 | HTH | 0.00 | 60.79 | 62.08 | 21.75 | 42.40 | 50.59 | 237.61 | 4 | 20 | 80 | 225.58 | 0.00 | 0.00 | 463.19 | 0.15 |
| 89 | 1.02 | HT | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 0.00 | 51.12 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 51.12 | 0.05 |
| 90 | 1.57 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 4 | 3 | 12 | 225.58 | 0.00 | 0.00 | 338.26 | 0.22 |
| 91 | 3.12 | MH | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 5 | 20 | 100 | 281.98 | 0.00 | 52200.00 | 52583.68 | 16.84 |
| 92 | 2.05 | HTH | 0.00 | 58.10 | 63.16 | 0.00 | 0.00 | 50.59 | 171.85 | 3 | 10 | 30 | 169.19 | 0.00 | 0.00 | 341.03 | 0.17 |
| 93 | 2.52 | HT | 51.13 | 0.00 | 62.08 | 37.60 | 0.00 | 50.59 | 201.40 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 201.40 | 0.08 |
| 94 | 2.58 | HT | 51.13 | 58.10 | 62.08 | 0.00 | 0.00 | 49.63 | 220.94 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 220.94 | 0.09 |
| 95 | 3.06 | HTH | 0.00 | 58.10 | 0.00 | 0.00 | 0.00 | 50.59 | 108.69 | 4 | 30 | 120 | 225.58 | 0.00 | 0.00 | 334.27 | 0.11 |
| 96 | 2.09 | HTH | 0.00 | 0.00 | 62.08 | 26.95 | 0.00 | 50.59 | 139.62 | 4 | 2 | 8 | 225.58 | 0.00 | 0.00 | 365.20 | 0.17 |
| 97 | 2.07 | HTH | 52.21 | 0.00 | 62.08 | 41.01 | 42.40 | 50.59 | 248.29 | 3 | 5 | 15 | 169.19 | 0.00 | 0.00 | 417.48 | 0.20 |
| 98 | 3.12 | HTH | 41.23 | 54.75 | 125.24 | 0.00 | 0.00 | 50.59 | 271.81 | 5 | 5 | 25 | 281.98 | 0.00 | 0.00 | 553.78 | 0.18 |
| 99 | 2.01 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.06 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm ($kW.ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| 100 | 2.04 | HT | 0.00 | 58.10 | 0.00 | 0.00 | 0.00 | 50.59 | 108.69 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 108.69 | 0.05 |
| 101 | 3.27 | MH | 51.13 | 58.10 | 62.08 | 0.00 | 0.00 | 49.63 | 220.94 | 10 | 7 | 70 | 563.96 | 0.00 | 52200.00 | 52984.90 | 16.20 |
| 102 | 2.54 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 111.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 111.71 | 0.04 |
| 103 | 3.16 | HTH | 0.00 | 58.10 | 251.56 | 107.21 | 0.00 | 50.59 | 467.46 | 8 | 4 | 32 | 451.17 | 0.00 | 0.00 | 918.63 | 0.29 |
| 104 | 2.09 | HTH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 50.59 | 50.59 | 2 | 4 | 8 | 112.79 | 0.00 | 0.00 | 163.38 | 0.08 |
| 105 | 1.01 | HTH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 44.97 | 44.97 | 3 | 4 | 12 | 169.19 | 0.00 | 0.00 | 214.15 | 0.21 |
| **Bairro Santinho** | | | | | | | | | | | | | | | | | |
| 106 | 3.04 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 5 | 10 | 50 | 281.98 | 0.00 | 0.00 | 394.65 | 0.13 |
| 107 | 4.02 | ATH | 22.42 | 0.00 | 62.08 | 24.11 | 0.00 | 49.63 | 158.25 | 5 | 4 | 20 | 281.98 | 350.00 | 0.00 | 790.23 | 0.20 |
| 108 | 4.03 | HTH | 41.23 | 0.00 | 62.08 | 39.33 | 0.00 | 50.59 | 193.22 | 4 | 5 | 20 | 225.58 | 0.00 | 0.00 | 418.81 | 0.10 |
| 109 | 3.02 | HTH | 0.00 | 0.00 | 125.24 | 28.60 | 0.00 | 100.22 | 254.06 | 3 | 4 | 12 | 169.19 | 0.00 | 0.00 | 423.25 | 0.14 |
| 110 | 6.03 | HTH | 56.05 | 0.00 | 125.24 | 78.61 | 0.00 | 50.59 | 310.50 | 12 | 10 | 120 | 676.75 | 0.00 | 0.00 | 987.24 | 0.16 |
| 111 | 3.02 | HTH | 28.79 | 0.00 | 62.08 | 83.67 | 0.00 | 50.59 | 225.13 | 3 | 12 | 36 | 169.19 | 0.00 | 0.00 | 394.32 | 0.13 |
| 112 | 4.01 | HT | 150.87 | 0.00 | 125.24 | 0.00 | 0.00 | 50.59 | 326.70 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 326.70 | 0.08 |
| 113 | 5.01 | HTH | 62.83 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 174.55 | 20 | 30 | 600 | 1127.91 | 0.00 | 0.00 | 1302.46 | 0.26 |
| 114 | 4.02 | ATH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 5 | 8 | 40 | 281.98 | 350.00 | 0.00 | 744.65 | 0.19 |
| 115 | 4.02 | HTH | 41.23 | 0.00 | 62.08 | 26.95 | 0.00 | 50.59 | 180.85 | 6 | 4 | 24 | 338.37 | 0.00 | 0.00 | 519.22 | 0.13 |
| 116 | 3.01 | HT | 41.23 | 0.00 | 62.08 | 21.75 | 0.00 | 49.63 | 174.69 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 174.69 | 0.06 |
| 117 | 2.02 | HTH | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 8 | 1 | 8 | 451.17 | 0.00 | 0.00 | 563.96 | 0.28 |
| 118 | 5.02 | HTH | 79.92 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 192.60 | 7 | 10 | 70 | 394.77 | 0.00 | 0.00 | 587.37 | 0.12 |
| 119 | 5.01 | HTH | 51.13 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 163.80 | 8 | 5 | 40 | 451.17 | 0.00 | 0.00 | 614.97 | 0.12 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm ($kW.ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| 120 | 9.01 | HTH | 43.69 | 0.00 | 125.24 | 0.00 | 43.91 | 100.22 | 313.06 | 5 | 3 | 15 | 281.98 | 0.00 | 0.00 | 595.04 | 0.07 |
| 121 | 5.01 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.02 |
| 122 | 8.02 | HT | 0.00 | 0.00 | 62.08 | 39.33 | 0.00 | 100.22 | 201.63 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 201.63 | 0.03 |
| 123 | 3.02 | HT | 43.69 | 54.75 | 125.24 | 0.00 | 0.00 | 50.59 | 274.27 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 274.27 | 0.09 |
| 124 | 4.01 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.03 |
| 125 | 8.01 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.01 |
| **Dembi-1** | | | | | | | | | | | | | | | | | |
| 126 | 4.05 | HTH | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 5 | 2 | 10 | 281.98 | 0.00 | 0.00 | 383.68 | 0.09 |
| 127 | 5.04 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 111.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 111.71 | 0.02 |
| 128 | 4.06 | HT | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 101.71 | 0.03 |
| 129 | 3.02 | HT | 71.27 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 183.95 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 183.95 | 0.06 |
| 130 | 0.50 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 0.00 | 62.08 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 62.08 | 0.12 |
| 131 | 3.04 | HT | 0.00 | 0.00 | 62.08 | 66.20 | 43.91 | 50.59 | 222.78 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 222.78 | 0.07 |
| 132 | 2.54 | HT | 30.05 | 0.00 | 125.24 | 37.60 | 43.43 | 50.59 | 286.91 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 286.91 | 0.11 |
| 133 | 3.12 | HT | 0.00 | 0.00 | 51.12 | 0.00 | 0.00 | 50.59 | 101.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 101.71 | 0.03 |
| 134 | 3.05 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| 135 | 4.24 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.03 |
| 136 | 3.03 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.04 |
| **Ongué** | | | | | | | | | | | | | | | | | |
| 137 | 2.00 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 3 | 4 | 12 | 169.19 | 0.00 | 0.00 | 281.86 | 0.14 |
| 138 | 3.25 | HTH | 0.00 | 118.89 | 62.08 | 0.00 | 0.00 | 50.59 | 231.56 | 3 | 4 | 12 | 169.19 | 0.00 | 0.00 | 400.75 | 0.12 |

**Annex 8 (cont.)**

| Farmer (No.) | Farm land area (ha) | Techno-logy used within field operations (-) | Power of men and women of farmer family working on field (W) | | | | | | | Hired labour | | | | Power - animal traction (W) | Power - mechanization (W) | Power total (W) | Power used for field operations on farm ($kW.ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M age 5 - 14 | M age 15 - 17 | M age 18 or older | F age 5 - 14 | F age 15 - 17 | F age 18 or older | All farmer family members | Workers (No.) | Days (No.) | Labour-days (No.) | Power (W) | | | | |
| 139 | 3.05 | HTH | 0.00 | 58.10 | 51.12 | 35.91 | 0.00 | 50.59 | 195.71 | 3 | 3 | 9 | 169.19 | 0.00 | 0.00 | 364.90 | 0.12 |
| 140 | 2.05 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 49.63 | 111.71 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 111.71 | 0.05 |
| 141 | 1.69 | HTH | 30.05 | 0.00 | 62.08 | 21.75 | 0.00 | 49.63 | 163.51 | 2 | 2 | 4 | 112.79 | 0.00 | 0.00 | 276.30 | 0.16 |
| 142 | 1.00 | HTH | 0.00 | 0.00 | 62.08 | 0.00 | 43.43 | 50.59 | 156.11 | 5 | 4 | 20 | 281.98 | 0.00 | 0.00 | 438.08 | 0.44 |
| 143 | 1.05 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.11 |
| 144 | 2.03 | HTH | 28.79 | 0.00 | 62.08 | 41.01 | 43.43 | 50.59 | 225.91 | 5 | 4 | 20 | 281.98 | 0.00 | 0.00 | 507.89 | 0.25 |
| 145 | 1.00 | HTH | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 4 | 3 | 12 | 225.58 | 0.00 | 0.00 | 338.37 | 0.34 |
| 146 | 2.01 | HTH | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 8 | 7 | 56 | 451.17 | 0.00 | 0.00 | 563.96 | 0.28 |
| 147 | 2.03 | HT | 0.00 | 0.00 | 114.28 | 0.00 | 0.00 | 50.59 | 164.87 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 164.87 | 0.08 |
| 148 | 3.05 | HT | 0.00 | 0.00 | 62.08 | 0.00 | 0.00 | 50.59 | 112.67 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.67 | 0.04 |
| 149 | 2.08 | HT | 0.00 | 0.00 | 63.16 | 0.00 | 0.00 | 49.63 | 112.79 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 112.79 | 0.05 |
| 150 | 2.12 | HT | 0.00 | 58.10 | 0.00 | 41.01 | 0.00 | 50.59 | 149.70 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 149.70 | 0.07 |
| 151 | 3.14 | HT | 0.00 | 0.00 | 62.08 | 41.01 | 0.00 | 50.59 | 153.68 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 153.68 | 0.05 |
| 152 | 7.00 | HTH | | | | | | | | 5 | 30 | 150 | 281.98 | 0.00 | 0.00 | 281.98 | 0.04 |
| 153 | 63.00 | ATH | | | | | | | | 6 | 160 | 960 | 338.37 | 8750.00 | 0.00 | 9088.37 | 0.14 |
| 154 | 6.00 | MH | | | | | | | | 6 | 20 | 120 | 338.37 | 0.00 | 52200.00 | 52538.37 | 8.76 |
| 155 | 9.00 | MH | | | | | | | | 4 | 130 | 520 | 225.58 | 0.00 | 67100.00 | 67325.58 | 7.48 |
| 156 | 4000.00 | MH | | | | | | | | 15 | 240 | 3600 | 845.94 | 0.00 | 44700.00 | 45545.94 | 0.01 |

Note: HT = farmers using only power of farmer family members; HTH = farmers using power of farmer family members + hiring labour (human power); ATF = farmers using power of farmer family members + animal traction; ATH = farmers using power of farmer family members + hiring labour (human power) + animal traction; MF = farmers using power of farmer family members + mechanization (renting a tractor); MH = farmers using power of farmer family members + hiring labour (human power) + mechanization (renting a tractor); MATH = farmers using power of farmer family members + hiring labour (human power) + animal traction + mechanization (renting a tractor)

## Annex 9: Photodocumentation

**field preparation (Sashonde village)**

**focus group discussion (Dembi- 1 village)**

***naca* field (close to Bimbi village)**