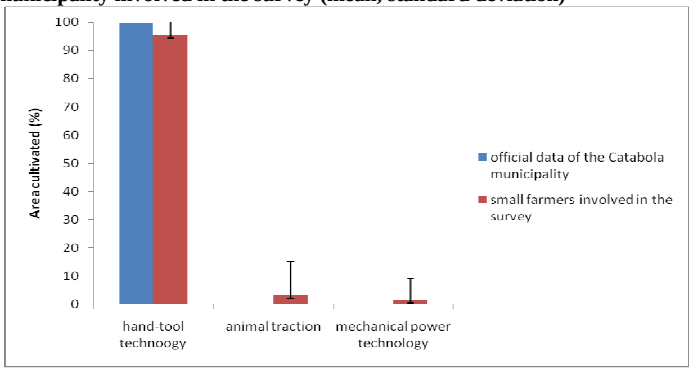
the two countries. Figure 1 shows a comparison of the technologies structure data. The mean power (regularly used) of small farmer families is 1.80 kW (with standard deviation of 2.37 kW).

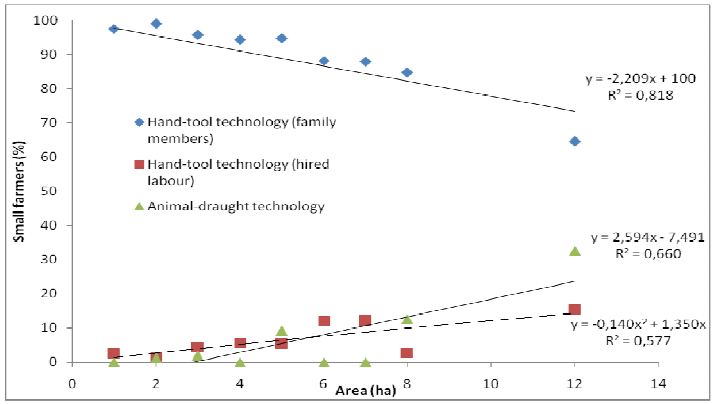
Figure 1: Comparison of technologies structure – EDA Catabola and small farmers in the Catabola municipality involved in the survey (mean, standard deviation)



Source of official data: EDA Catabola 2009

Figure 2 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 2: Technologies use in relation to the size of the cultivated area (N = 151)



CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE
FACULTY OF TROPICAL AGRISCIENCES

Strategies of Agricultural Development in Angola
Case study: Catabola municipality

Autoreferát doktorské disertační práce

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ABSTRAKT

Okres Catabola patří k nejvíce postiženým oblastem občanskou válkou v Angole. Přestože jsou klimatické podmínky velmi vhodné pro intenzivní zemědělství, drobní zemědělci jsou převážně samozásobitelé s hlavním zdrojem příjmů z prodeje fazolí, manioku a zeleniny. Mezi drobnými zemědělci v okrese Catabola převládají manuální technologie, které jsou používané na 95,38 % obdělávané půdy. Většina drobných zemědělců využívá pouze výkon členů své rodiny (s průměrem 1,80 kW a směrodatnou odchylkou 2,37 kW), placení pracovníci jsou využíváni 38 % drobných zemědělců. Kromě toho byla zjištěna vysoká míra využívání dětské práce: 63,88 % dětí ve věku 5-14 let. Primární sběr dat byl proveden v období červenec-srpen 2011, nejpoužívanějšími metodami byly semi-strukturované dotazníky a rozhovory. Do průzkumu bylo zahrnuto 151 drobných zemědělců z 9 vesnic okresu Catabola. Bylo definováno 10 faktorů, které ovlivňují závislou proměnnou – typ farmáře vzhledem k používané technologii v kombinaci s využíváním placených pracovníků. Faktory byly statisticky zanalyzovány s použitím ANOVy. Z faktorů, u kterých se předpokládal vliv na osvojení technologií sofistikovanějších než manuální, byly definovány zvýšení velikosti obdělávaného pozemku a zvýšení vzdělání jak dětí, tak rodičů coby limitující faktory v adopčním procesu potažní technologie a mechanizace drobnými zemědělci v okrese Catabola. Strategie byla formulována s použitím zjednodušené kvantifikované SWOT analýzy zvlášť pro potažní a mechanizovanou technologii. Výsledky lze interpretovat jako 8,0% předpoklad úspěchu v osvojení potažní technologie, oproti 10,01% předpokladu nezdaru v osvojení mechanizované technologie drobnými zemědělci v okrese Catabola. Používání traktorů lze tudíž označit za nevhodnou technologii pro drobné zemědělce v okrese Catabola. Nejkritičtějšími oblastmi v procesu osvojování potažní technologie je podpora zemědělských družstev a asociací, tzv. a vzdělání – formální i neformální v podobě školení pro zemědělce, kováře, chovatele zvířat a zemědělské poradce.

KLÍČOVÁ SLOVA

Manuální výkon, placená práce, dětská práce, manuální technologie, potažní technologie, osvojení technologie.

(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.

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. 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.

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. 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.

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)). 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. 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.

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 are limited in the municipality. 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). 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, 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.

5.2 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. Structure of the technologies used in the Catabola municipality is similar to the data of Toro and Nhantumbo (1999) for Mozambique; the conformity could be explained by analogous history of

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, 5th-6th class, 7th-9thclass, 10th-12th class, university
(1 USD equals is about 105.8 AOA – March 2015; Banco Nacional de Angola 2015)

In addition, strategy for agricultural development focused on technologies use was designed. The strategy is based on 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).

5 RESULTS AND DISCUSSION

5.1 Agricultural and socio-economic analysis of small farmers in the Catabola municipality

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. 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). Mean area of *lavra* is 2.77 ha (with standard deviation of 1.99 ha), contrary to mean area of *naca* – 0.15 ha

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. 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. 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). 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 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 1.

Table 1: Hypotheses of the study

Hypothesis	Summary of hypothesis
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.

3 OBJECTIVES

The specific objectives are as follows:

(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.

4 METHODOLOGY

4.1 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. 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. For the target group of small farmers, a questionnaire was designed. 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. 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. In total, 151 small farmers were involved in the survey.

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.

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.

4.2 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:

- 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),
- farmers using only hand-tool technology with the employment of hired labour (HTH farmers), and
- 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, ten factors the dependent variable – *level of technology used by farmers in combination with hiring of labour* – were defined (Table 2). There were two main sources for the factors definition: Coelli and Batesse (1996) and extension workers of EDA Catabola.

Table 2: 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

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Tewelmehidin MY, Conroy AB. 2010. The economic importance of draught oxen on small farms in Namibia's Eastern Caprivi Region. African Journal of Agricultural Research 5 (9): 928-934.

Tiwari PS, Fite LP, Pandey MM, Shrivastava AK. 2011. Pedal power for occupational activities: effect of power output and pedalling rate on physiological responses. International Journal of Industrial Ergonomics 41 (3): 261-267.

Toro A, Nhantumbo AB. 1999. Animal traction in Mozambique: results from a survey of small-scale farmers. Starkey P, Kaumbutho P. Meeting the challenges of animal traction. ATNESA, Zimbabwe, p258-263.

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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. 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. 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.

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 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. 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.

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. 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. 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.

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. 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. 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).

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. To improve economic efficiency of draught animals in the Catabola municipality, diversification of animal power could be recommended.

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. 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.

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.

5.3 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 3.

Table 3: 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

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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. 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.

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.

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					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.

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. 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. 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.

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. 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.

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.

5.4 Strategy of agricultural development in the Catabola municipality

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.

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. The parameters' values were defined empirically on the basis of the author qualified estimate. 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.

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.

6 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.

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.

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.