AGRICULTURAL TECHNOLOGY DEVELOPMENT STRATEGIES IN ANGOLA – PROGNOSIS FOR THE PERIOD 2010–2020

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Abstract

Purpose: to relate outcomes of an analysis conducted in the course of the Development Project implementation as done for the MSc. Thesis working out. The analysis was done to prepare an information D-base for the following estimations of further development of agricultural technologies, installed power requirements and prediction of needs in mechanical power and animal draft for the next 10 years.

Methodology: extensive survey on agricultural land use, crop structure and power available in the agriculture in both the Bié province and national levels has been conducted. The obtained data have been classified, statistically processed and tabelized or put into graphics to get maximum refined information.

Findings: the references analysis proofed that three kinds of technologies are used in developing countries while in Angola the hand-tool technology prevails. It has been found that the present level of the installed power per hectare is very low (0.2 kW) and number of tractors per 1000 hectares reaches 0.606. The future needs in mechanical power have been calculated and found that the actual need in installed power is 0.74 kW per hectare. The growth of installed power was taken as three times faster than the agricultural production growth. This is in tune with the overall requirement on the agricultural production in Angola to grow by 55.1% in the case of cereals and by 67.2% in the case of pulses. Consider 2.6% population and consequent needed agricultural growth, with reasonable annual agricultural growth of 5%, the sustainable agricultural production will be achieved so far in 2029. The target installed power will be reached by 15% annual growth in 2017. It is necessary that in 2020 the installed power will already achieve 0.67 kW per hectare with supposed technologies structure: 25.56% hand-tool, 13.4% animal draught and 61.04% mechanical power. Thus, the needed number of tractor units will increase up to 22 513 units.

Practical implications: the above conclusions have led to recommendations on future provisions of power units (tractors) in the time space 2010–2020. The pover units can be supplied from abroad (foreign currency needed) or may be implemented through a project of Tractor Assembly Plant in Angola (determination of its yearly capacity).

Key words: hand-tool technology, animal draught technology, mechanical energy, installed power, crop structure, cultivated area, tractor, Angola

INTRODUCTION

Any agricultural strategy (including technology one) must come forth from the available agricultural land and overall (country, provincial) crop and animal structure. The demographic parameters must be taken into account, too.

In the season 2007/2008 the total area cultivated in Angola was 3 074 806 hectares which was less by 11% in comparison with agricultural season 2006/2007. The immediate arable land potential in Angola is estimated at 3.2 million hectares which represents 2.4% of the total area of the country and 4.8% of the area considered as suitable for agriculture. The population of Angola was 17 029 000 in 2008 with annual growth of 2.6% (HDR, 2009).

Land ownership varies from large governmental scale farms, large-scale farms owned by companies or private landholders, medium-scale farms owned by cooperatives and other farmers' associations to small-scale farms owned by families. Average area cultivated by farmers´ families in 2007/2008 was 1.56 hectares; in comparison with this the agricultural companies were farming in average on 29.8 hectares. In the same year, some 5847 farmer associations were officially registered counting 598 682 members; some 1126 farmer cooperatives existed with 142 660 members; 52 205 employees worked in 3715 agricultural companies which represents 16% increase in comparison with the year 2006/2007. Majority of the cultivated area was farmed by farmers' families (this area share was 97%). The farmers´ associations and

cooperatives are associated in the governmental organization UNACA (FAOSTAT, 2010).

The agriculture in Angola is under the control of the Ministry of Agriculture (MINAGRI) through its institutions like Institute for Agricultural Development (IDA). This is represented in each Angolan municipality by the Station for Agricultural Development (EDA). Technicians of the EDA are responsible for certain areas of activities such as animal production, crop production, machinery, etc. Their competencies lead to implement activities which would contribute to the social and economic improvements and strengthen development of rural communes. There are Agriculture Campaigns conducted by MINAGRI which focuse on main activities planned for the concrete agricultural season in Angola; their planning is done on the national and provincial level. The planning implementation in communes is done through EDA´s Centers and their technicians. Before each campaign, demands from farmers and local administrations are collected and requirements elaborated which include:

– area cultivated as per crop;
– quantity of inputs (seeds, fertilizers, hand-tool equipment, animal-draught equipment, animals) to distribute;
– locality of distribution;
– expected results, etc.

The agricultural campaigns are related to the Soil Preparation Campaignes conducted by Mecanagro. Mecanagro is a specialized organization of the Ministry of Agriculture responsible for machines, their distribution over the provinces, machinery repair and maintenance and mechanical soil preparation.

The output data of the crop production from the campaign 2007/08 are shown in the Table 1. Institute of Veterinary Services provides statistics that were extracted for the Countrystat database. The most recent data come from 2008 with the following figures:

The agricultural sector in Angola possessed in 2008: 4 921 205 cattle heads, 3 643 575 porks, 2 477 631 goats, 1 165 944 sheep and 18 745 398 heads of the poultry flock.

The required food balance reflects ratio between available quantity of foodstuff and required amount of these foodstuff to ensure the food security and appropriate nutritional basket (food basket) for the population. There are more segments of the requirements as to the crop production like: population consumption, amount of seeds, animal feed production and losses after the harvest. According to the results from the Agricultural Campaign 2007/2008 and population rate in the same year (16 637 913 capita), the INE projected deficits in agricultural production for 2008. The most significant deficits

Tab. 1: Crop production, yields and area cultivated in Angola in the season 2007/2008

Crop	Farmer families		Private companies		Total area (ha)
	production (ton)	yield (ton/ha)	production (ton)	yield (ton/ha)	
Maize	653 638	0.75	48 749	3.6	883 943
Pennisetum	14 396	0.12	0	0	117 998
Millet	12 757	0.09	0	0	144 470
Rice	7 348	0.47	1 068	0.96	16 551
Cassava	39 181	14.3	n/a	n/a	679 167
Potatoes	127 758	8.7	n/a	n/a	47 271
Sweet Potatoes	1 326	6.2	n/a	n/a	125 276
Beans	121 285	0.4	3 179	0.55	375 007
Groundnut	91 599	0.38	326	0.35	259 081
Soya	3 413	0.44	4 298	0.43	17 871
Vegetables	1 854 443	10.7	894 879	14.4	235 915
Bananas	1 722 508	17.6			
Lemons	106 418	11.5			
Pineapple	95 421	10			
Avocados	25 723	10			
TOTAL	4 877 214		952 499		2 902 550

n/a = data not available

Source: MINAGRI: January 2009

are in production of cereals (55.1%) and in production of pulses (67.2%). To ensure the full food security in Angola, a 100% increase in the production of cereals and pulses must be reached.

References analysis and theoretical considerations

technological levels of mechanization have been broadly classified as hand-tool technology, draught-animal technology and mechanical.power technology (Havrland, 2000, 2003). Hand-tool technology is the simplest and the most basic level of agricultural mechanization. The term refers to tools and implements which use human muscles as the power source. Draught-animal technology refers to equipments, machines and implements powered by animals, oxen are usually used in Angola. The mechanical-power technology is 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 agricultural land in less developed countries and more than 90% in developed countries (Havrland et al., 2003).

In many areas, two or even three technologies may be used on a single farm unit while in the other only one technology level prevails in existing farming system (Havrland and Kapila, 2000). Thus, only mixed technologies are usually applied. In Angola, according to data obtained during the season 2007/2008, 71% of total agricultural activities were realized with use of hand-tool technologies, 25% animal-draught technologies and only 1% with mechanical power technologies. Remaining 3% were cultivated by commercial companies of which technological structure is not known; non the less it can be estimated at 70% cultivated with mechanical power technologies and 30% by hand-tool technologies. Thus the structure of technologies per total arable land area in Angola is the following: 3.1% mechanical power, 25% animal-draught and 71.9% hand-tool. Most common hand-tool implements are machetes, European hoe, traditional hoes and saws; average farmer family owns 2 machetes, 3 European hoes and 2 traditional hoes. Most common use of animal traction is for ploughing and transport, oxen are the most utilized animals. The mechanical power is rarely used in agriculture. The situation is described according to the survey in the chapter “Results”.

It is important to suggest that advanced motorized technologies in the less developed countries brings about a range of interrelated difficulties: soil, agronomic, economic and technical problems. Risk in the case of soils refers to the danger of different sort, above all the soil structure deterioration, decreased water infiltration and increased creation of the soil crust and erosion. The agronomic problem lies in the poor time scheduling of operations (problem of meeting cultural periods) and low coefficient of time utilization. They occur because during the rainy season unfavorable conditions which do not alow the use of tractor prevail while during the dry season the land is so dry that its cultivation is not cost-effective due to high draught requirements (soil resitance) leading to the enormous fuel consumptions and low coefficients of utilization. Economic aspects include low reliability index for machines (in less developed countries the reliability index for tractor fleet is less than 50%). The common reason is poor operating practises which cause increased breakage and wear. The other economic aspects usually are poor infrastructure providing supply of spare parts and lubrificants, minimal operator competences and maintanance facilities. Technical aspects are based on negative impact of unfavorable climatic conditions on machinery resulting in accelerated wear of machines, other aspects are complicated machine design which require qualified personnel and logistics for their maintanace and repairs (Havrland et al., 2003).

MATERIALS AND METHODS

The main objective of the survey was to define requirements in mechanical power technologies use for sustainable self-sufficiency of agricultural production in Angola. Because of the war and vast damages in particularly agriculture and infrastructure caused by the war, many areas have been inaccessible and with bad communication for long time periods. As the result only incomplete statistical data for Angola as the whole and for some regions notably are available. For eample, FAO statistical database (FAOSTAT) has not changed data on the machinery use in Angola for more than ten years. No serious survey related to this issue has up-to-now been realized, thus. To some extent, the most valuable information can be got from governmental documents (reports, acts and other correspondence). Nevertless, the Government of Angola has started to elaborate agricultural statistics since 2007 by founding National Statistical Insttitute which is responsible for the data collection and processing.

The data gathering was conducted in the period from May 2009 to February 2010. Semi-structured questionnaires and interviews were mostly used tools in the survey with exclusive tractor distributers in Angola (Mahindra, New Holland and Massey Ferguson). We also

contacted the Ministry of Agriculture and Mecanagro headquarters in Luanda, selected contractors, EDAs, tractor owners and technicians in the Bié province. Moreover, reports, informative bulletins MecaInforme and internal documents were also used for the purpose of the survey (with the agreement of the Mecanagro top management).

Energy employed in agricultural production (using man-labour, draught animals or machines) can be characterized according to the amount of energy input per hectare of agricultural land (kJ/ha) or so called installed power (kW/ha) which is categorized to three grades: grade I – installed power of 0.1–0.3 kW/ha, grade II – installed power of 0.3–1.5 kW/ha and grade III– installed power over 1.5 kW/ha. Not all the energy is consumed in technological process. 52% of energy is used in other forms e.g. irrigation, fertilizer and chemicals, technological processes take 48% part of total energy consumed in the agricultural processes (Havrland et al., 2003).

Energetic inputs needed to cover food production self-sufficiency of the country were calculated considering required production of staple crops (cereals and pulses) to achieve the above food self-sufficiency. For every percentage of increase in gross agricultural output, an energy input growth of 3% is necessary (Havrland et al., 2003).

RESULTS AND DISCUSSION

General aspects

It is to state that the increase of the mechanical-power technology in agriculture since 2002 has been enormous. There are signifiantly negative factors that impact valuable utilization of the mechanization and above all lifetime of the machines. The most significant (negative) factors are lack of the maintanance and reparation facilities including qualified staff, lack of the qualified mechanicians and machines‘operators, lack of spare parts and utilization of tractors and implements not suitable for the conditions in Angola. Other negative factor that influences slow increase of mechanical soil preparation are mines which are widely spread in some Angolan regions as the dangerous remainder of the civil war.

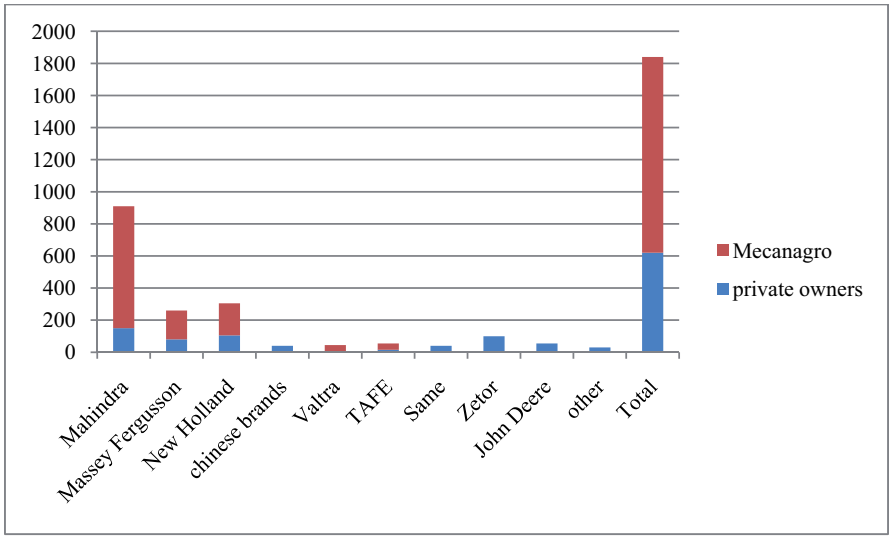
Use of tractors as mechanical power in agriculture is generally largely connected with the Government, Ministry of Agriculture and its specialized division Mecanagro. Increase of tractor cultivation is linked to governmental programs of Agricultural Campaigns and National Programme for Soil Preparation. To support private involvement and avoid lack of governmental capacity, caused mainly by lack of qualified workforce in specialized governmental divisions, idea of contractors has been adopted. In the future, the contractors should provide soil cultivation with the use of tractors on almost whole area defined to be cultivated and manage large-scale farms projected as future agricultural production bases for the country as well.

The structure of the machinery park has changed every year, as the assortment is very fast. Untill 2005, majority of the tractor park was composed of the models – the brand Belarus. In 2004, most of the tractors were not in operable status and, due to the lack of the genuine spare parts, the possibilities of repairs were limited. Therefore, Chinese tractors started to be imported since 2005. These tractors prevailed in the Mecanagro tractor park till 2007 when evaluation of their reliability was being done and their unsuitability for the Angolan conditions was stated. In 2008, Mecanagro started to distribute tractors Mahindra, Massey Fergusson, New Holland (some units were distributed by Mecanagro before), VALTRA and TAFE. These brands are still presented as a part of actual national tractor park and is estimated that their quantity will increase.

In general, despite the lack of exact data on the number of tractors in Angola (especially tractors in oparable status), except for the Mecanagro, some deductions on the actual tractor park structure can be done as follow: in the MecaInforme from 2008 (March) 700 tractors in oparable status was estimated, in comparison with Mecanagro 338 tractors in the Soil Preparation Campaign 2006/2007 and 316 tractors in Soil Preparation Campaign 2008/2009. According to these data it could be assumed that in the period 2007–2008 about 350 tractors in operating condition were owned by lanholders.

When considering the information obtained by interviews with the tractor distributors, every year about 230 tractors are sold to the landholders. With some deductions due to amortization and local severe working conditions, the annual growth of the tractor number in operable status owned by the landholders can be about 120 units. Therefore the estimation of the actual quantity of tractors in operable status owned by the lanholders in 2010 is 620 units. From the tractors sold to the Mecanagro technicians only 100 are estimated to be in operable status. The overall Mecanagro machinery park of tractors in 2009 reached 1176 and its actual quantity in April 2010 is estimated at about 1220. Thus, the total number of tractors in operable status in Angola (April 2010) are estimated at 1940 units. The brand structure, excluding tractors owned by the Mecanagro technicians is illustrated in Figure 1. In comparison with the data obtained through the survey, the FAO statistical database FAOSTAT indicates 9000 tractors in Angola for the period of

Figure 1: Brand structure of tractors estimated in April 2010 (exluding tractors owned by technicians)



2000–2007 which is far more. However, more actual and reliable data have not been available.

The National Programme for Soil Preparation is divided into the Campaigns for Soil Preparation (*Campanhas de Preparação de Terras*) that is parallel to the Agricultural Campaigns implemented by the Provincial Ministries of Agriculture. The campaigns are in progress from September to May of the next year which is compatible with the agricultural season in Angola. Before each campaign, a certain area is planned to be cultivated by mechanical-power technology, the areas are chosen according to the necessities of the communes and objectives for the corresponding Agricultural Campaign. For the Campaingn 2008/2009, 60 400 hectares were planned to be cultivated. However the real area cultivated was 24 519 hectares which is only 40.59% of the planned one. The Mecanagro report from the Campaign 2006/2007 refers 30 500 hectares planned to be cultivated, opposite to 25 380 hecaters actually cultivated. In the Campaign 2007/2008, from planned 30 000 hectares, only 14 709 hectares were cultivated with use of mechanical power.

In the Campaign 2008/2009, 316 tractors cultivated 24 519 hectares which was 77.6 hectares per one tractor. In the Campaign 2006/2007, 338 tractors (of which 56 units were not in operable status) cultivated 25 380 hectares with result 75.1 hectares per one tractor.

Structure of the Mecanagro tractor park has been changed significantly every year; the main reason for this fast tractor park renovation has been poor technical status of tractors. It is fore sure that the tractors owned by private companies or farmers have prolonged durability in comparison with Mecanagro which is certainly caused by increased responsibility of the first in view of the tractor purchase cost and trust for higher rentability resulting from the prolonged tractor use.

In case of Chinese tractors, the durability has generally been the lowest from all the tractor brands as it was resulting from poor tractor design and rapid wear of their main kits. Design quality of tractor brands such as Zetor, Massey Fergusson, New Holland, Valtra, Case and John Deere are considered as very high, Mahindra tractors are considered as of poorer durability in comparison with these brands, nevertheless their durability is longer than the Chinese brands.

Moreover, main reason for rapid tractors wear in Angola is poor maintenance resulting in irregular or no-change of lubrificants, unsuitable use of tractor (such as overloading not compatible to the traction power, rapid drive on poor terrains, etc.), use of unsuitable lubrificants and fuels. This is caused by many factors that are resulting from the general lack of proper tractor maintenance as the base for tractor durability. The governmental organization Mecanagro has not organized regular trainings for its technicians yet. Tractor distributors interviewed during the survey, implement fast training (up to 6 hours) for their clients although their clients, owners of medium- or large-scale farms, usually do not practice any machinery maintenance. There are some driving schools providing courses of tractor driving and maintenance but their theoretic as well as practical lessons are focused usually only on cars, tractor design and maintenance take minimal part at practical lessons. In addition, the course (where majority of lessons are theoretical and not obligatory) is very expensive in comparison with the average salary, its price is about 790 USD driving licence not included (paid separately at the level of about 620 USD).

Estimation of future needs in installed mechanical power

The arable land in Angola is estimated at 3.2 million hectares which represents 2.4% of the total area of the country. When a total of 1940 tractors in operable status is considered the ratio of tractors per 1000 hectares of arable land is 0.606 or one tractor refers to 1650 hectares of arable land.

The present actual structure of tractor models in Angola can only be estimated because Mecanagro´s latest data are from 2009. The alterations of the tractor park have been very fast and data of private owned tractors are not available. Estimated number of known tractor models in Angola is shown in Table 2, power specifications for each model or estimated medium for group of model line or group of non-specified tractors are added too. The total installed power of tractors in Angola in April 2010 is estimated at 112.77 MW, thus the power of an average tractor in Angola is 58.13 kW. Taking into account 3.1% of total arable land cultivated by mechanical power which is 99 200 hectares and total tractor park power of 112.8 MW, the installed power is 0.87 kW per hectare. This is the minimum input. According to Havrland et al. (2003), the installed power of tractors in Angola is categorized to grade II which is just for the small part of the total Angolan arable land area.

In the Agricultural Campaign 2007/2008, 3 074 806 hectares were cultivated with 71% use of hand-tool technologies, 25% animal-draught technologies and only 0.8% with mechanical power technologies. The rest of 3.2% was cultivated by commercial companies of which the technologic structure is unknown. In this case, the installed power to ensure the field operations by commercial companies can hardly be estimated.

As a result of no available data about machinery used in Agricultural Campaign 2007/2008, the data of Agricultural Campaign 2008/2009 were utilized for the energetic inputs calculations (the data of both Campaigns are considered as similar). About 316 tractors were used in the Campaign of which almost half of models were of Mahindra make, followed by Massey Fergusson. New Holland, Valtra and TAFE makes were of lower number. The total power of the above tractors was 18.41 MW.

Tab. 2: Power of tractors in Angola estimated in April 2010

Model	Power (kW)	Number of units estimated	Total installed power (kW)
New Holland 7630	75	60	4 500
New Holland 8030	201	50	10 050
New Holland 7010	67.1	95	6 374.5
New Holland TL 75 E	55.5	110	6 105
Massey Fergusson 425	52.2	146	7 621.2
Massey Fergusson 465	89.5	35	3 132.5
Massey Fergusson 680	127	4	508
Massey Fergusson 440	61	35	2 135
Massey Fergusson 283	50	50	2 500
Mahindra 6000	44.7	470	21 009
Mahindra 705 DI	52.2	450	23 490
Valtra BH 180	134.2	15	2 013
Valtra BM 125i	93.2	40	3 728
TAFE 8502	55	55	3 025
Same 603 DC	44.7	25	1 117.5
Same II Explorer	69.4	25	1 735
Zetor Proxima	60	20	1 200
Zetor Major	medium 29.9	40	1 196
Zetor Crystal	medium 70.8	40	2 832
Dong Feng 600	44.7	15	670.5
other chinese tractors	medium 37.3	35	1 305.5
other tractor brands	medium 52.2	125	6 525
Total		1 940	112 772.7

With 24 519 hectares realized by the Mecanagro tractors, the installed power was 0.75 kW per hectare which is grade II.

Animal-draught power was used to cultivate 768 701 hectares. The most usual animal used as power source in Angola is ox. Statistical data on ox number in Angola are not available but its estimation is close to 300 000 heads. According to Havrland et al. (2003), an average ox has a power of 0.56 kW thus the total power of oxen in Angola is estimated at 168.0 MW. The installed power for animal-draught technology is therefore 0.22 kW per hectare which is grade I.

Hand-tool technologies were used to cultivate area of 2 183 112 hectares. Consider 9 306 260 people working in agriculture and 1 861 252 farmer families, there are 5 members that are involved in agricultural activities in the farmer's family. According to the age composition of people working in agriculture and 52% share of women, resulting total human power is 413.23 MW. The installed power for hand-tool technologies is 0.19 kW per hectare which is grade I.

Total area cultivated, except for the area owned by the commercial companies, was 2 977 193.5 hectares in the agricultural season 2007/2008. The total power (hand-tool + animal draught + mechanical energy) was 599.63 MW. Thus, the total installed power was 0.2 kW per hectare which is grade I. Division of installed power per technology and total installed power are shown in Figure 2.

The energy input needs can be deduced from crop production and food balance. With the most recent accessible data from agricultural season 2007/2008, the basic calculations were done (without data of private companies because the base for staple food production is family farm). The farmer families produced in the 2007/2008 season 688 178 tons of cereals and 216 297 tons of beans which is a major part of the pulses production in Angola. But the required production was 1 645 470 tons of cereals and 379 564 tons of pulses. The difference is evidently more than double in the case of the cereals. The installed power was calculated (in the previous chapter) as 0.2 kW per hectare. More proper indication as initial for following calculations can not be obtained because the data for technologies used in particular crop production are not available.

To satisfy the population food requirement, there was need to increase the productions of cereals by 58.2% and of leguminouses by 43%. With consideration of HAVRLAND statement (2003), energy inputs should increase by 174.6% in the case of cereals and 129% in the case of pulses. In total it is 165.9% increase of the energy input at the same arable land area. The resulting energy input requirement would be 0.74 kW per hectare, thus, installed power of technologies would be 0.36 which is grade I. According to the annual population growth in Angola of 2.6% (HDR, 2009), agricultural production has to increase annualy by the same 2.6% and energy inputs by 7.8% which annually would be 0.06 kW per hectare (for the year zero), and even more for the following years.

CONCLUSION

The Country Technology Strategy is always composed of more components parameters of which are so defined

Figure 2: Installed power by technologies used in Angola, agricultural season 2007/2008

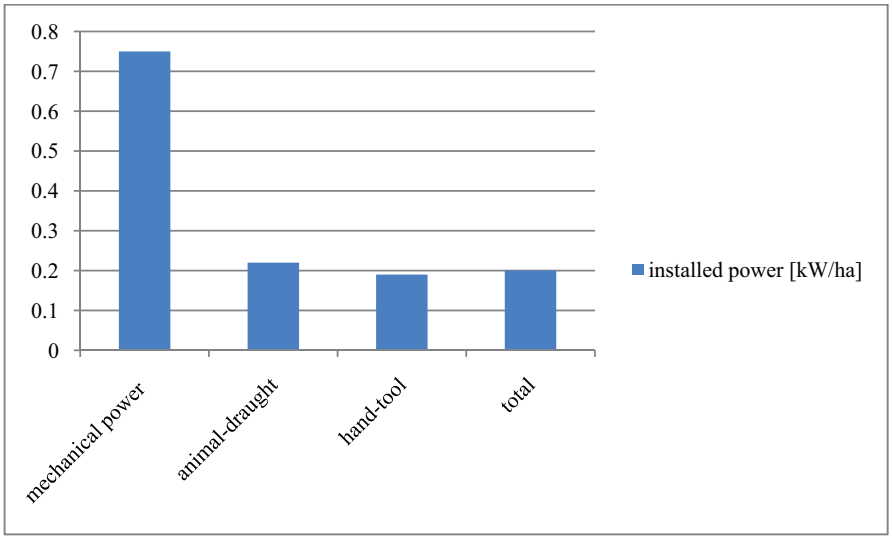
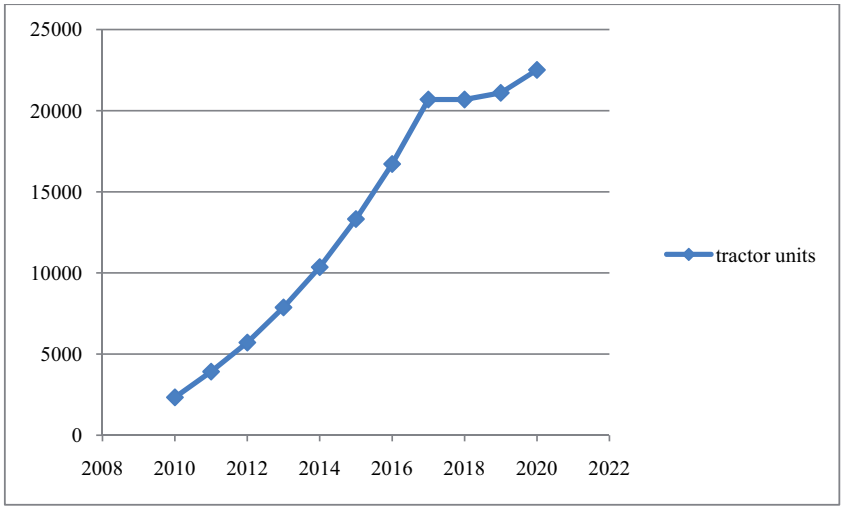


Figure 3: Required tractor units growth in the period 2010-2020



that the self-sufficiency in agricultural production could be achieved. When considering the Strategy components as well as specific Angola's food supply requirements, the most recommended measure could be support to creation of private medium- or large-scale farms managed by private companies with governmental support. It is because the arable land area represents 2.4% of total country area whereby 4.8% of the Angolan territory is considered as suitable for agriculture.

Other recommendation will be based on the increase of installed power in general which is particularly the case of private farms (it is supposed that they will especially be developed). These farms are namely projected to use mechanical power technologies use at the level of 70% of total energy inputs of technologies. In harmony with this princpiple (and governmental soil preparation strategy), the number of tractors are estimated to increase gradually and especially on the contractor basis.

As mentioned above, the satisfaction of country´s food basket requirements will need the installed power should increase up to 0.36 kW per hectare from actual 0.2 kW per hectare which means that the annual installed power growth should achieve 7.8%. Such a considerable energy input growth cannot be achieved in a short period. A realistic annual agricultural production growth can be estimated at 5%; the relevant 15% of installed power is than necessary. The calculations have been done with year 2009 as the "year zero"; the data used for the calculations were taken from the season 2007/2008 as most recent data available.

The annual growth of the agricultural production needed to achieving the country self-sufficiency level is found at 5% (for 2029 production of some 1 825 943 tons of cereals, production of leguminouses in 2025 to 472 149 tons). The further food production growth (since 2029) will be driven by the only population growth. With the realistic 2.6% annual population growth the installed power required can be reached already in 2017. The total energetic input in 2017 should approach 1958.4 MW while in "year zero" the total energetic input was 599.7 MW. Consequently, the technology level structure has to change, as well. If we consider the (above) annual population growth at 2.6% level and estimated 5% growth of ox herd, in 2020 total energy input should achive 1.4 kW per hectare, thus 0.67 kW of technologies input. According to this result, the resulting technology structure in 2020 will be the following: 25.56% hand-tool technologies, 13.4% animal-draught technologies and 61.04% mechanical power technologies. Average tractor in Angola is now estimated at 58.13 kW and this can be maintained for the future. With the total mechanical power of 1308.6 kW calculated, the number of tractor units need will increase up to 22 513 units in 2020. Gradual growth of number of tractor units in the period 2010–2020 is shown in Figure 3. The disruption of tractor number growth in 2016–2018 may be due to a temporary tractor market saturation corresponding to a changeover to technologies of a higher mechanichal power requirements (higher tractor power classes).

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