www.jard.edu.pl http://dx.doi.org/10.17306/J.JARD.2017.00207

Journal of Agribusiness and Rural Development

pISSN 1899-5241
eISSN 1899-5772

1(43) 2017, 5–16

CONDITIONS FOR TECHNOLOGY TRANSFER IN THE AGRICULTURE OF CONGO REPUBLIC*

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Abstract. The majority of the population in Sub-Saharan Africa is employed in agriculture. Nevertheless, the productivity of the sector is relatively low in comparison with other regions of the world. Based on convergence theory, technology transfer can enhance growth. However, the effective transfer of technology requires a certain absorption capacity from the recipient. Based on the qualitative research on cassava production in Congo Brazzaville, we identified key factors that influence the transfer process. These factors have been divided into four key areas: market, institutions, technology, and social capability. Cassava production value chain in Ignie region served as a case study for the evaluation of technology transfer absorptive capacity in Congo agriculture. We learned that the lack of agro-technical education, shortages in infrastructure, unavailability of business services, and market structure are among the main barriers of the intensification of technology use in agriculture.

Keywords: economic development, Sub-Saharan Africa, Sub-Saharan agriculture, technology transfer, cassava transformation

INTRODUCTION

According to the World Bank's aggregated data, the contribution of agriculture to the creation of GDP in the Sub-Saharan region decreased during the last twenty years. This is especially true as regards the Republic of Congo where the average figures were 15.6% in the 1970s, 10% in the 1980s and 1990s, and only 5% of GDP after 2000. Such a limitation of the role of the agriculture sector in some of the region's economies is believed to result from improper management of the structural adjustment programs. As a consequence, the Republic of Congo became a food-importing country (Interview, Person 1, 2015). Note also that some countries, despite their potential (including the climate and soils), are unable to maintain and develop the agricultural production and to participate to the international trade exchange. The need to restore the importance of and further develop the agrarian sector are major steps in supporting the country's economic growth, and may help in overcoming the problems brought by globalization (Deszczyński, 2009). Irrespective of whether the industry or the agriculture is assumed to be the essential driver for growth (Dorosh and Mellor, 2013), the Sub-Saharan region needs to improve the condition of agriculture due to both the existing potential and the considerable number of people who depend on agriculture.

The importance of technological process for boosting the economic growth is justified by both endogenous and

*With acknowledgements to: studies financed with the funds of the SONATA DEC-2013/09/D/HS4/01849 grant from the National Science Center.

The Author would like to thank Prof. Etienne Koulakoumouna from Institut de Gestion et de Developpement Economique in Brazzaville for his support and assistance with the project realisation in Congo and to Prof. Claude Albagli Président of CEDIMES for supporting this cooperation.

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classic theories (Kasse, 2013). The improvement of the agrarian sector situation in Sub-Saharan Africa through an increased use of technology is also well founded in the context of the absolute beta convergence theory (Abramovitz, 1990; Silverberg and Verspagen, 1995; Sala-i-Martin, 1996; Rapacki and Prochniak, 2009; Munemo, 2013). However, the transfer of technology is a complex, time-consuming and capital intensive process (Morrissey and Almonacid, 2005) which requires specific competences both from the provider and from the recipient. Today, it is also believed to be a process of searching for methods of leveraging the competitive edge in a global environment rather than just transferring the technology between two entities (e.g. from the North to the South) (Audretsch et al., 2014, p. 302). It is about looking for effective mechanisms of knowledge transfer which would enable better competitiveness and productivity in the agriculture sector (Necoechea-Mondragón et al., 2013).

Congo used to be an exporter of agricultural products, including coffee and cocoa. In the last decade, the local economy was primarily based on oil extraction which represents around 90% of GDP. In that period, the average share of agricultural production was less than 5% of the domestic production, and reached the lowest level (as little as 3.4% of GDP) in 2011. The agricultural sector demonstrates poor efficiency (World Bank, 2015). The growth of production, which is driven by the increase of cultivated areas, has only doubled during the last two decades. The development and intensification of the agricultural sector are of key importance for the continued economic growth in Congo and elsewhere in that region.

The purpose of this paper is to identify the key factors affecting the use of technology in the Sub-Saharan agriculture, as illustrated by the case of cassava farming in Congo. The assumed hypothesis is that the main obstacle for the technology transfer are the deficiencies in technical and general education. The literature review and the experience gained during field studies were the basis for creating a typology of factors conditioning the capability of technology transfer absorption, as seen from the market, technological, social and institutional perspective.

RESEARCH METHODOLOGY

This is an explorative study aimed at verifying the possible development of agriculture through an increased use of technology in the cassava production process in Congo. The inductive approach was adopted in order to examine the technology transfer conditions in the agriculture. The first stage was a field study during which the research material was collected based on a simplified value chain, with the use of direct interview and non-participant observation methods. At the second stage, the typology of technology transfer factors was created based on a review of the literature and on experiences brought by field studies. Afterwards, the collected material related to the cassava production process was analyzed based on that typology. The last stage of this study was an attempt to generalize the results of the cognitive research on the conditions for technology transfer to the agriculture sector.

The field study was performed during three research tours to Congo in 2015. The study included observations carried out in agricultural areas of the Ignie district with a total population of 29,290, located north from Brazzaville, in the Pool department with a total area of 33.955 km^2 (Statoids, 2016). Pool, an agricultural region, surrounds the national capital from the north, west and south. Also, a total of 10 structured in-depth interviews were carried out with persons knowledgeable in the topics involved in the study, in rural areas and in Brazzaville, the national capital. The interviewees were persons involved in agricultural production processes (Person 5, 6), a representative of the sectoral administration (Person 3), the ex-minister of agriculture (Person 1), representatives of research centers (Person 4, 7, 8), a representative of a foreign investor implementing a project in the agricultural sector (Person 9), and representatives of a non-government organization (Person 2, 10). The interviewees decided to remain anonymous. Additionally, information was acquired from persons involved in the cassava production process during the observations (women employed in cassava transformation, suppliers, drivers, machine owners). The scope of observations included cassava farming, agricultural holdings (vegetable and fruit farming, raising of poultry) and the process of transporting the agricultural products to outlets. The analysis of the process based on a simplified value chain allowed to refine the outcomes of interviews and observations with respect to its essential stages.

As the interviews were conducted personally by the author based on the Delphi method, there were no predefined questions. The experts were asked for information on their experience in technology transfer to the agriculture sector, with particular emphasis laid on cassava production. In tropical countries, cassava is the third most

important starch-based food ingredient after rice and corn. Its resistance to poor acid soils and unpredictable rainfall is what makes it competitive to more valuable plants (Akinpelu et al., 2011). The world's leading cassava producers include Nigeria, Brazil, Thailand, Indonesia and the Democratic Republic of Congo, with more than a half of cassava farming areas being located in Africa (Prakash). Although Congo is not among the leaders (1.25 million tons per year, which is 0.5% of the global production), from the national perspective, cassava is the basic crop and the source of 84% of calories consumed. Therefore, cassava farming provides an important reason to discuss the technology transfer to the national agriculture sector (Trèche, 1996; FAO, 2010; 2016).

CASSAVA PRODUCTION AND PROCESSING IN CONGO

Cassava farming. There are three essential stages in cassava production: farming, processing and distribution (Fig. 1). They form a simplified value chain which may be the basis for examining the key problems and challenges involved in increasing the production volumes, as shown in Table 1. In Congo, cassava is grown by small farmers, operating on a small scale, with low income and limited access to financing. The consequences of this situation are particularly severe when it comes to cassava diseases. Faced with the risk of shortage of cassava for ongoing consumption, the producers interested in maintaining or increasing (on an ad-hoc basis) the production volume use infected cassava seedlings (usually with the mosaic virus). This leads to a further propagation of the disease to crops, and results in reducing the production scale, triggering a vicious circle (Interview, Person 4, Person 8, 2015).

The farming process is manual to a significant extent, although agricultural mechanization initiatives are put in place in the country, including in cooperation with IPHD (International Partnership for Human Development). Their primary objective is to promote the adoption of tractors which are lent by organizations supporting the agricultural development and by entrepreneurs, whether on a commercial basis or with a state subsidy. Meanwhile, there is a lack of intermediary technological solutions which would allow for increasing the efficiency: simple agricultural tools, irrigation systems etc. (Interview, Person 4 and 10, 2015).

From the producers' perspective, the underdeveloped road infrastructure is an important barrier in their operations. The national road heading from south to north enables agricultural products to be imported from Cameroon. However, it does neither solve the issue of domestic transport of crops nor the underlying problem posed by the lack of an internal road network. To address these problems, the World Bank in cooperation with local authorities finances the construction of transverse roads enabling the transport of cassava to the main road. This helps extracting cassava from farmlands located inside the country (Interview, Person 4, 2015).

The producers sell cassava to villages where it undergoes the necessary transformation before it becomes edible. Cassava is purchased by villagers based on oral agreements which are regarded by the producers as a way of securing the marketing. The raw material (cassava roots) is delivered with small trucks. The price for a batch is fixed and equal for all producers.

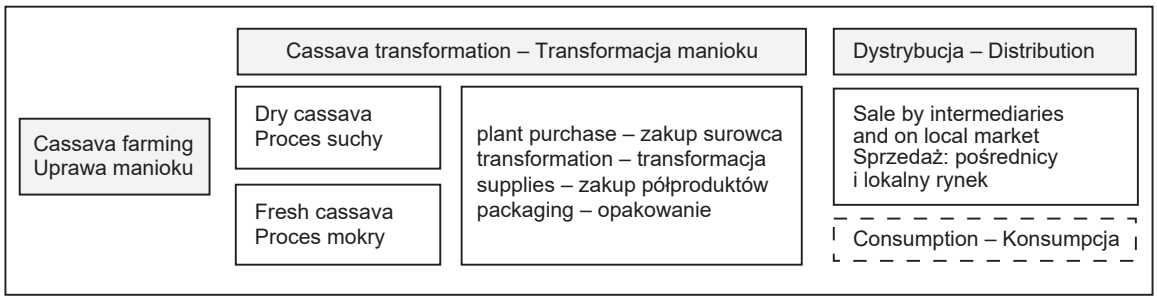

Fig. 1. Simplified chain of cassava production value chain
Source: own elaboration.
Rys. 1. Uproszczony schemat łańcucha wartości produkcji manioku
Źródło: opracowanie własne.

Table 1. Barriers of cassava production process according to simplified value chain
Table 1. Bariery procesu produkcji manioku na podstawie uproszczonego łańcucha wartości

Barriers of production – areas of potential changes – Bariery procesu – obszary potencjalnych zmian		
Farming – Uprawa	Transformation – Przetworzenie	Distribution – Dystrybucja
cassava diseases choroby manioku	limited access to mechanical shredding ograniczona dostępność do usług rozdrabniania	higher demand for fresh cassava większy popyt na maniok tradycyjny (przetworzenie mokre)
soil fatigue wyjaławianie gleby	lack of exploatation infrastructure (limited access to electricity) and service equipment in countryside brak infrastruktury eksploatowania (ograniczone dostawy prądu) i serwisowania urządzeń w terenie wiejskim	road infrastructure limitations ograniczenia infrastruktury drogowej
lack of agronomic formation brak wykształcenia agrotechnicznego		lack of sufficient cassava supply brak wystarczającej podaży manioku
weak road infrastructure słaba infrastruktura drogowa	lack of specialization brak specjalizacji	unformal logistics transport niesformalizowany
difficult access to agriculture machinery niska dostępność maszyn rolniczych	lack of quality competition brak konkurencji jakościowej	lack of transportation quality control brak kontroli warunków transportu
high cost of renting machines wysoki koszt wynajmu maszyn	burdensome traditional process uciążliwość tradycyjnego procesu	simple packaging (nonsterile, nonhermetic) opakowania niesterylne, niehermetyczne
lack of simple tools brak dostępu do prostych narzędzi	deliveries of intermediate products dostawy półproduktów	
lack of quality based competition brak konkurencji jakościowej		

Source: own elaboration.
Źródło: opracowanie własne.

Cassava processing. Generally, women are the only ones involved in the processing of cassava into fresh bread or *foufou* flour, as they are more economically active than men in rural areas. Also, children contribute to a limited extent by cleaning the delivered cassava at the first stage of transformation (Interview, Person 1, 2015). As a part of wet processing, cassava is chopped, poured with water, wrapped in leaves and thermally treated. During dry processing, it is dried in the sun and ground into powder.

An important element that streamlines the wet processing of cassava is the use of a chopping machine. An owner of such a device, who imported it from Cameroon, was among the interviewees. He works on his own due to his negative experiences with hiring temporary employees. The chopping machine is powered by a combustion engine which makes it immune to power outages (Interview, Person 8, 2015). However, in the case of failures, the engine needs to be removed and transported to the city (on a motorbike) in order to be repaired. There are over a dozen chopping machines on a territory with a population of approximately five thousand (Interview, Person 5, 2015). There is a growing demand for chopping services as they accelerate and facilitate the processing (Interview, Person 3, 2015). Generally, cost reduction is the main reason for choosing manual work over the chopping machine (Interview, Persons 5 and 6, 2015).

The preparation of cassava bread is a long and tedious process because of its complex nature, the need to use physical force, and inconveniences resulting from thermal treatment and the odor released by the plant. In addition to the optional chopping machine, simple tools and utensils (bowls and barrels) purchased in the city are used in this process. Also, it is necessary to purchase intermediate products (leaves and cords) which

are used as packaging for trading purposes. Traditionally, cassava bread was wrapped in leaves from the nearby rainforest. Today, the area of wooded land decreased to such a point that leaves need to be sourced from remote parts of the country. This represents as much as 25% of the sales price of the final product (Interview, Persons 6 and 3, 2015). Research is in progress to determine whether natural leaves may be replaced with cheaper plastic (Interview, Person 4, 2015). Already now, synthetic cords are used instead of natural fibers.

Dry processing is less complicated in terms of technology. It requires the roots to be thoroughly dried (in the sun) and grinded with a machine (which, although larger, is operated by a single person, just like the chopping machine). This form of cassava consumption is believed to be the preferred one in the future as it enables longer storage periods (Interview, Persons 1, 3, 4, 8, 2015). In the case of wet cassava and cassava flour, the time limit for consumption is up to 5 days and about one month, respectively. However, today, cassava bread is definitely much more popular, as confirmed by the operator of the machine which grinds dry cassava into *foufou*, claiming that there is little demand for his services. *Foufou* flour is packed in plastic or in leaves, optionally (Interview, Person 4, 2015). It should be assumed that the use of more technologically advanced packaging would extend the time limit for consumption.

Cassava distribution. Once processed, cassava is consumed or sold. Local sales is organized in small stalls or in special exchange points (markets) established as a part of a government project and located along the main road where cassava is purchased by the local population or professional intermediaries. Due to higher demand, the trade in fresh cassava is prevalent. Intermediaries buy cassava and transport it to the city for resale. The transport is of semi-formal nature: taxis are fully loaded with cassava (including passenger seats and trunk which is usually left ajar). To reduce the unit cost of transport, no additional protection other than cords is used during carriage. The transport conditions are not subject to inspections. Taxi drivers sell cassava wholesale on the Brazzaville market where it reaches the final recipient in the city through local intermediaries. The process becomes structured: deliveries are performed on a regular basis, e.g. once or twice a week, and are planned in advance under an informal agreement (Interview, Person 3, 2015).

THE POTENTIAL FOR TECHNOLOGY ABSORPTION IN CASSAVA PRODUCTION

The actual capacity of the recipient to absorb and the actual capacity of the provider to transfer the technology are important factors of the decision regarding technology transfer. The costs of integrating an external technology with the recipient's value chain may be compensated only if the provider has the capacity to effectively transfer the technology owned (Ceccagnoli and Jiang, 2013). In the case of the agrarian sector, due to its multidimensional nature, economic, social, political, legal and environmental factors must be taken into account when analyzing the technology transfer process (Czyżewski and Kułyk, 2015). Based on the results of empirical research, this paper focuses on identifying these factors within four key areas of the technology absorption capability. These include the technology development, social context, institution building, and market aspects (Fig. 2). Each of these areas is assumed to include factors of relevance from the perspective of the technology exploitation mechanisms, starting from the initiation phase (searching, contacting and making the acceptance decision) up to the transfer phase (from the initiation of actual technology implementation activities to the further dissemination thereof).

As regards the technology aspect, the key factors affecting the effectiveness of technology exploitation are as follows: the starting level of technological development and the absorption capability, including without limitation the levels of human capital and infrastructure, and the adjustment to local needs. The technology development level is intrinsically related to the market condition of the area under review, defined as a system of relationships between entities operating under specific macro-economic conditions. This includes the issue of product development based on supply or demand considerations, the existing institutional support for entrepreneurs, the existing competition and the access to finance and business development services (Andrzejczak, 2014a). Under this approach, market is supported by a system of institutions structured by the legal system and by social factors. From the legal perspective, the factors under consideration are the underpinning safety measures for business operations, the protection of intellectual property, the available commercialization tools for technical solutions, and the existing effective

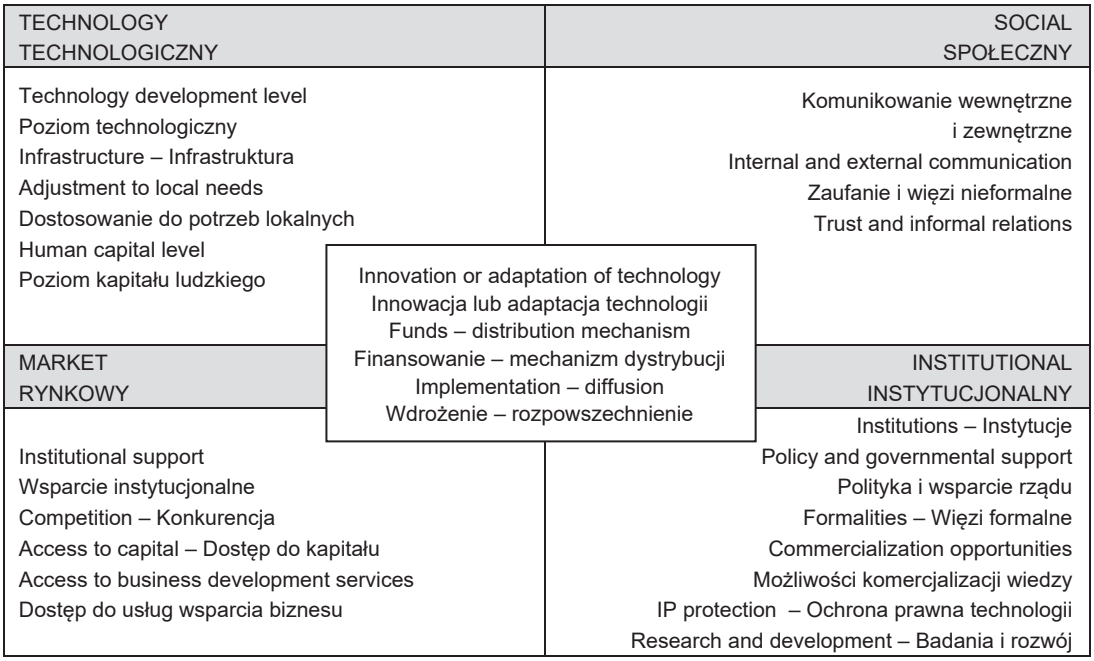

Fig. 2. Key aspects of technology absorption capability
Source: own elaboration.
Rys. 2. Kluczowe obszary zdolności do absorpcji technologii
Źródło: opracowanie własne.

transfer channels which enable converting the research capacities and human capital into a resource that drives economic growth, competitiveness and improvement of life quality (CNOP-CONGO, 2012). The social aspect includes, without limitation, the issue of attitudes towards new technology, and the ability to communicate in relationships between the technology recipient and provider, and between technology recipients at the same or various stages of the value chain. These aspects are not considered separately because the factors defined for each of them are interrelated. Depending on their quality or development level, they may support the effective operation of technology exploitation mechanisms in the economy (agriculture and local cassava production, in this case).

Market aspect. For the Republic of Congo, agricultural production of cassava is of key importance as it is the basic starch-based food ingredient in local households, reaching as much as 84% of the energy value consumed by the population (FAO, 2010). Cassava farming is also a form of self-supply (Interview, Persons 1, 5, 2015) which means is it mainly used by producers to feed their own family. The small scale of production and limited access to capital are the factors that restrict the ability to intensify the business activity, to control the quality and to comply with sanitary requirements for crops due to lack of financing.

The Congolese agricultural market is underdeveloped, non-formalized, fragmented and inefficient. The reasons for this situation include the privatization of numerous state-owned companies operating in the textiles, tobacco and beverages sectors as a consequence of structural adjustment processes. Their disappearance encouraged concentration exclusively on the extractive sector which was beneficial to tiny elites and foreign investors (Interview, Person 1, 2015). The dependence on the extractive sector strongly affects the government's ability to finance other parts of the economy. A decrease of oil prices will reduce the state budget revenue and, thus, will decrease the expenditure on scientific research, technology development or agriculture development (in a broad sense), among other expenses.

Farmers are mainly individual producers with low income, and private holdings owned by rich Congolese citizens (Interview, Person 9, 2015). The volume of farming (or breeding) production is usually increased with the use of extensive methods. According to the literature, one of the basic factors for decision making on the technology transfer are the technology implementation costs (Ceccagnoli and Jiang, 2013). In that context, Congo demonstrates a limited propensity to implement technology in agricultural production. The low labour cost discourages the landowners from investing in more capital-intensive methods of increasing the production volumes (Interview, Person 9, 2015). The same is true for biotechnology research (which becomes increasingly popular in some countries of the Sub-Saharan region): the main barrier for using GMO is their excessive cost and technology development level compared to the absorption capacity existing in Congo (Interview, Person 8, 2015).

Although the institutional support mechanisms for farmers are developing (infrastructural projects, individual financing projects, consultancy), the scale of activities is insufficient and some assumptions are incompatible with the sector's actual needs. There is a deficiency of business support services on the market. Despite the existence of micro-credit institutions, the capital is difficult to access due to low incomes and low creditworthiness of farmers. Also, the unavailability of B2B services, such as onsite machine maintenance, decreases the efficiency of cassava processing. Despite the traditional nature of cassava processing, intermediate products need to be sourced, thus increasing the production costs and making the local producers dependent from intermediate product supplies. As a consequence, small farmers are unable to compete with large holdings on the domestic and regional markets.

Technological aspect. The Congo's technology absorption capability is limited by the infrastructure development level. The road network remains underdeveloped despite the increasing number of dedicated Chinese investments. The ex-minister in charge of agriculture believes this issue to be the key barrier preventing the commercialization of crops and the creation of sales structures. Although previous projects, including the construction of transverse roads, are beneficial, the scale of activities undertaken remains insufficient. The Congo's infrastructural problems also include difficult access to electric power and, periodically, to fuel. While Congo lives off of oil production, the oil sector is a non-integrated island for the national economy (direct foreign investments).

The basic challenges, both in technical and geographical terms, include cassava diseases and soil quality (Interview, Persons 1, 8, 2015). If the farming methods are not followed and not adjusted to the specifics of the soil, the soil quickly becomes leached and infertile, making it necessary to displace crops (Interview, Person 1, 2015). As the soil degrades due to repeated planting of cassava, and in the absence of agro-technical fertilizing solutions, crops are moved increasingly away from human dwellings. This is an additional burden which requires agricultural employees to move, and the harvested crops to be transported.

The agriculture mechanization level needs to be increased. An example may be the number of tractors offered in the machine rental market which, according to field information, is below the farmers' demand. Some machines are out of order to due to damages which may be only repaired with parts unavailable on the site. Also, machines are rented on a commercial or subsidized basis. In the latter case, non-governmental organizations cannot afford increasing the number of tractors in their fleet. What also needs to be noted is the underestimated role of the development of irrigation systems (currently used by a few large private holdings). The same is true for the dissemination of simple tools and small machines which could be manufactured and repaired locally. Large agricultural machines are imported from abroad together with spare parts, as the technology needed for the operation thereof is not available in the country (Interview, Person 10, 2015). Meanwhile, small producers are more willing to use labour-intensive methods than capital-intensive ones (deGraft-Johnson et al., 2014). The question therefore arises of whether the implemented projects are fully adjusted to local needs, and especially to the capability of absorbing the technologies offered.

The population demonstrates a limited level of agricultural education which affects the process of transferring the cassava production technology. Human capital is believed to be a greater problem than infrastructural deficiencies (Interviews, 2015). Middle-aged educated population represents an insufficient share in the society. Employees active in the agricultural market are older, experienced persons and young persons with

basic education. The educational shortcomings make it difficult to perform simple calculations (e.g. related to irrigation systems) (Interview, Person 9, 2015). It was concluded that the absence of knowledge and skills related, for instance, to hygiene (disease prevention) may result in reduced crop productivity in the longer term (Interview, Person 9, 2015). An indirect reason for the above are also the structural adjustment processes which have put a brake on agricultural education for more than a decade (Interview, Persons 1 and 8, 2015).

Institutional aspect. In Congo, there are non-formal and formal institutional solutions enabling cooperation between development agencies and manufacturers, with public institutions acting as intermediaries. The tradition of implementing international projects aimed at development allowed to establish an underpinning system (Andrzejczak, 2014a). As regards internal transfers, which are a potential outcome of development works performed in Congo, the corresponding institutional solutions are only now being established. Just like elsewhere in the world, Congo needs to redefine the role of universities in the society. Until recently, the responsibility of universities was to educate and carry out scientific research. Today, in parallel, they are supposed to develop knowledge fit for commercialization (Necoechea-Mondragón et al., 2013).

In Congo, there are no sufficient structures for technology transfer between research and agricultural practice. While research projects are financed both by ministries and by foreign parties, two challenges persist. The first is the selection of research topics, and the second is how to disseminate the outcomes (Interview, Person 8, 2015). Also, the objectives pursued by science are not always convergent with those set by the producers and with the population's needs (Interview, Person 7, 2015). Scientists are primarily oriented at publishing the results of basic research which is a decisive factor for their own career, and some of the research is not focused on any actual commercialization purpose (Interview, Person 8, 2015). While scientists strive to discover varieties resistant to diseases, the producers are mainly interested in the size and consumption properties of the plant. Another issue of importance to them is the ability to harvest as much cassava as possible in the shortest time possible, which allows them to rapidly sell and earn money. The solutions proposed by scientific sites are not accepted, especially if, in the shorter term, the contribute to actually reducing the production volumes or increasing the production costs. To a limited extent, initiatives are also taken to group the scientists and producers together, e.g. contact groups spreading the knowledge developed by IRA (Institut de Recherche Agronomique, Agronomy Research Institute). This is a venture of insufficient scale, because technology dissemination is organized by a research body without adequate institutional and financial support from the government. The issues involved include the absence of funds for the distribution of healthy biological material and seedlings to the producers (Interview, Person 8, 2015).

Congo also demonstrates insufficient maturity of the culture of valorization and commercialization of research results. Contributory factors for this deficiency are the scientists' low awareness of their ability to commercialize and disseminate the research results, and the absence of adequate mechanisms. This is also true for solutions which have a potential to exploit (Interview, Persons 7 and 8, 2015). Even the university staff have little knowledge of the protection of intellectual property rights. Moreover, no funds are secured in the system, and no institutional solutions are available to transfer the technology from the level of experimental knowledge to local field operations (Interview, Person 7 and 8, 2015).

Social aspect. Social issues remain an important factor contributing to the technology absorption capability. They include general rural exodus trends as well as matters focused on the cassava production process itself. An important social phenomenon is a general reluctance of young people to seek employment in the agricultural sector. The young generation finds it more attractive to work in government organizations, in the services or industrial sector, including in international companies and in the extractive industry. A contributory factor for this situation is the absence of a properly developed agronomic education system which would prepare for working in modern agriculture. Due to the traditional nature of cassava processing, which is largely based on manual methods (risk of burns, intensive odor), young persons (mostly women who perform these works) are not interested in engaging in such activities which differ from modern cultural patterns they see promoted in the media (Interview, Person 8, 2015). Therefore, the rural exodus of young people becomes even more intense. And the ongoing increase in levels of urbanization does

not facilitate the development of the agricultural sector either.

On the other hand, note that the entities who have the potential to increase the use of technology are not interested in doing so. This is especially true for rich Congolese owners of large holdings where more advanced technologies purchased from international companies are deployed (Interview, Person 9, 2015). Such holdings are managed within a highly hierarchical structure, often by foreign entrepreneurs whose sole objective is the production rather than the transfer of knowledge. According to Person 9, the operators of such holdings are not interested in delegating their rights to local employees mainly because of the differences in educational attainment and of the passive attitude adopted as a reaction to culture shock.

An important element of technology transfer is the communication between process participants. As demonstrated by deGraft-Johnson (deGraft-Johnson et al., 2014), a truly effective transfer is possible if technology information is delivered directly to users. In the case of Congo, what needs to be noted in that context are the positive aspects related to the approach adopted by technology providers. First of all, these include the method of contact groups, as mentioned earlier in this paper, which enable the delivery of information on the developed techniques directly to a group of producers who forward it. Although this method supports technology dissemination, it is somehow restricted by the fact that, on an incidental basis, the farmers may want to exploit their advantage resulting from the acquired knowledge and decide not to share it with other producers (Interview, Person 8, 2015).

The Congo's developed mobile communication market has a positive impact on the communication between technology providers and recipients and supporting parties. The mobile network is much more accessible than agricultural tools (Interview, Person 3, 2015), and enables communication in rural areas, too. This ensures a permanent contact between the producers and the head of the sector (a representative of the Ministry of Agriculture). The parties contact each other directly (during visits of the head of the sector) and by (mobile) phone. This is supposed to provide permanent support for the producers' group and for villagers engaged in cassava processing. In that process, an important role is played by the head of the village whose responsibility is to contact the head of the sector and inform him/her of local needs or problems. The head of the village acts as an interface between the administration and the population (cf. Kyem, 2012).

From the social angle, restrictions include the lack of specialization in cassava processing and limited confidence. Traditionally, the family (a woman) is in charge of the entire process, and the household is the focal point for production activities. This may potentially contribute to reducing the efficiency. As the supply is too low, and the prices cannot be increased due to the population's income level, streamlining the process (although contrary to the traditional approach) could improve the efficiency of cassava processing. Note also that inhabitants of rural areas prefer cooperating with family members. The lack of confidence in hiring employees is a factor that restricts the ability to increase the scale of activities (Interview, Person 5, 2015).

Table 2 uses the example of the chopping machine to illustrate how specific factors within the key areas considered affect the restrictions for technology transfer. This example shows the complexity of the technology transfer to the Congolese agriculture sector as it demonstrates that potential barriers may exist in all of the designated areas. Meanwhile, in the case of the chopping machine, factors contributing to a wider adoption of technology include adjusting the tool to local needs, streamlining the process and reducing the inconveniences involved in processing.

SUMMARY

In Congo, cassava production is a labour-intensive process based on traditional technology grounded in a complex social context. The use of machines and plant protection products, whether in the farming process or for necessary processing purposes, is not widespread. Only some of the producers use the technologies offered by foreign and domestic providers on a commercial basis or otherwise. The technology market in the Congolese agriculture is primarily shaped by the supply side. The poor adoption of technology and the reluctance to use intensive methods are the consequence of the low awareness of the existing opportunities, the lack of investment capital and the social standards integrated with the farming process in households.

The results of the research reveal that technology intensive investments in Congolese agriculture are not considered to be sufficiently profitable by potential foreign

Table 2. Technology use barriers – the example of shredder
Tabela 2. Bariery wykorzystania technologii w produkcji manioku na przykładzie rozdrabniarki

Area of factors Obszary czynników	Shredder – Rozdrabniarka
Market Rynkowe	the cost of buying device – koszt zakupu urządzenia; technology is inaccessible/hard to access locally, limited access to services technologia jest niedostępna/trudno dostępna lokalnie, niska dostępność usług; lack of simple machinery manufacturing słaby rynek produkcji prostych maszyn; lack of B2B services in rural area brak dostępu do usług B2B na terenie wiejskim; relatively high cost of service stosunkowo wysoki koszt usługi
Technology Technologiczne	lack of human capital skilled workforce – the lack of people able to produce a locally relatively simple device ograniczenia kapitału ludzkiego – brak osób zdolnych wyprodukować lokalnie stosunkowo proste urządzenie; limited infrastructure access to electricity problems braki infrastrukturalne ograniczenia dostępu do energii elektrycznej; the lack of developed transportation in case of need to service the device in the city brak rozwiniętych środków transportu w przypadku konieczności serwisowania urządzenia w mieście
Institutional Instytucjonalne	limited institutional support for technology diffusion in a large scale brak wystarczającego wsparcia instytucjonalnego dla popularyzowania wykorzystania technologii na szerszą skalę; the necessity to choose formal activities (difficulties of recording activities) or informal konieczność wyboru działalności formalnej (trudności rejestrowania działalności) lub nieformalnej
Social Społeczne	small scale of servicing activity because of trust issues with contracting workers mała skala działalności usługodawcy ze względu na brak zaufania do pracy najemnej; in limited scope attachment to traditional methods of conduct w ograniczonym zakresie przywiązanie do tradycyjnych metod postępowania

Source: own elaboration.
Źródło: opracowanie własne.

and local investors. The use of sophisticated technologies is restricted by low labour costs and shortage of qualified staff, low level of institutional and infrastructural markets development. This confirms this study's hypothesis that the insufficient level of human capital is one of the crucial obstacles for technology transfer which obstructs both the processes in progress and the initiation of new ones.

In the case of production for the purposes of self-supply or delivery to the domestic market, quality is not regarded as a priority. This is a potential obstacle for increasing the production scale. It can be concluded that the process of structuring the value chain (e.g. agreements, periodic deliveries, local markers) has begun as regards both physical (delivery places) and institutional (price setting method) aspects. However, it still has a limited impact on the production scale and quality. The fixed trading price of the raw material and finished product is the reason for the absence of qualitative competition at the farming and processing stages. There is not enough incentive to improve the production quality. Upon occurrence of unpredictable circumstances, operations at borderline profitability become unviable or have adverse effects on quality of life.

The Congolese market structure is not conducive to technology transfer as the economy focuses on oil extraction. This is a problem for many countries in this region. As a consequence, it is necessary to import agricultural tools and machines as well as food. Restrictions to the production and value chain development involve two things. The first one are the technical aspects of the

farming process (cassava diseases and resistance) while the second one are the agricultural production mechanisms (division of labour, market structure). Therefore, it is necessary to look for technological solutions that will enable reducing production losses, and to seek institutional solutions which will allow for creating operational market mechanisms and for developing the cassava commercialization process. Congo needs to adopt a coherent education and agrarian policy enabling the acceleration of the specialization and formalization processes in the value chain.

The development of education, especially in the technical domain, the establishment of mechanisms for the valorization and dissemination of local scientific research, and the investments in improving the infrastructure quality continue to be the key short-term challenges. The most urgent issue is to improve access to simple training programs which could be organized by local institutions and improve farmers' skills. This could be done with the use of the existing field organizational structure of specific sectors. At a later stage, the wider adoption of technology will depend on the development of market institutions and on social change which is the slowest process.

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UWARUNKOWANIA TRANSFERU TECHNOLOGII W ROLNICTWIE REPUBLIKI KONGA

Streszczenie. W krajach Afryki Subsaharyjskiej znaczna część ludności zatrudniona jest w sektorze agrarnym, ale jego wydajność i poziom technologiczny pozostają stosunkowo mało rozwinięte w porównaniu z innymi regionami świata. Potencjalnym sposobem na przezwyciężenie problemów rolnictwa jest transfer technologii oraz wykorzystanie efektu konwergencji. Efektywność tego procesu jest jednak zależna od możliwości absorpcji technologii. Celem artykułu jest zidentyfikowanie kluczowych czynników wpływających na wykorzystanie technologii w rolnictwie subsaharyjskim na przykładzie upraw manioku w Kongu. Na podstawie badań jakościowych (wywiady bezpośrednie, obserwacje) przeprowadzono analizę uproszczonego łańcucha wartości produkcji manioku w Kongu. Stwierdzono występowanie istotnych barier o charakterze rynkowym, technologicznym, instytucjonalnym i społecznym, wpływających na możliwości absorbowania technologii. Chodzi przede wszystkim o braki dotyczące poziomu wykształcenia ludności, dostępności rozwiązań infrastrukturalnych, struktury rynku oraz dostępności usług rozwoju biznesu, ale również o niewystarczające rozwiązania instytucjonalne obejmujące transfer technologii zarówno o charakterze komercyjnym, jak i niekomercyjnym.

Słowa kluczowe: rozwój gospodarczy, Afryka Subsaharyjska, rolnictwo subsaharyjskie, transfer technologii, przetwarzanie manioku

Accepted for print – Zaakceptowano do druku: 22.04.2016