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Linking University Research to Production Systems within the Context of a Poverty Reduction Strategy: Case Study of Cameroon

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Abstract

The university and the entire Cameroonian system of knowledge production are under transformation in order to better support economic development and to contribute to the National strategy of poverty reduction. More specifically, university research is becoming more targeted to societal needs, particularly those of the informal production system where 80 % of the poorest people of the country are to be found. In this study we analyse published research articles on the domestication and the development of the products of two multipurpose traditional plants *Ricinodendron heudelotti* and *Canarium schweinfurthii*.

The study identifies the different perspectives demonstrated in the selected research articles in order to examine the arguments used by the researchers to: 1) justify the societal relevance of their work when they constructed their research object; and 2) determine the consequence of the researchers' choice on the interactions between their potential partners. The study incorporates two different theoretical approaches. The first is historical and cultural activity theory in which the unit of analysis is an activity system. The second approach is triple helix theory in which the unit of analysis is the set of interactions between the university, industry and government.

The arguments used by the authors to justify the social context of their research or the importance of their study were classified and analysed from both theoretical perspectives: as a research object construction and as an interaction between actors. The dual definition of the research object which distinguishes between a research and an application object (Miettinen 1998) was adopted and adapted to demonstrate how researchers developed simplified technology and procedures different from those used by industry. Two types of application objects can therefore be distinguished: one destined for

industry and one destined for the rural population (and eventually the informal sector). The second type of application object is reputedly possible to accomplish at minimum cost using locally available materials. Researchers have produced artefacts and product processing techniques but only under laboratory conditions. The transfer of application objects from the university laboratory to rural communities has not yet taken place, nor has there been an appropriation of technologies, even simplified ones.

Researchers from another type of institution identify the participation of rural farmers in the research process as a critical element for their strategy. One of the institutional objectives is to integrate scientific data with traditional know how for the development process. This institution is a branch of an international organization that is funded by a multilateral fund to promote the commercialization of research in the rural sector. According to our findings, university research does not seem to be integrated in this process.

This study shows that research initiatives demonstrate a change in attitude concerning informal economic actors in general and farmers in particular. An organizational mechanism is required in order to be able to transfer knowledge and technologies produced by the research to the targeted users. The incubator appears to be an ideal organizational structure for professional training outside the context of formal courses and may be a good candidate for the needed organizational mechanism for knowledge transfer. A well thought out adaptation of the participatory process for the development of research goals and for the dissemination of research results is also a good candidate to form the basis of good research management practices.

Introduction

The university, like other Cameroon State institutions, is called upon to contribute to the National poverty reduction strategy, in addition to fulfilling its traditional roles of education, research, socioeconomic development support, and professional training. These roles are defined and refined by the Council of Graduate Education, Scientific and Technical Research (“Conseil de l’enseignement supérieur et la recherche scientifique et technique”) (Ministère de l’éducation nationale, 1974; 1982). It has already been shown that the Cameroon University is not sufficiently transformed in order to be able to assume some of these roles (Affa’a and Des Lierres, 2002) as reinforced by publications stemming from the 1993 reform (Ministère de l’enseignement supérieur, Cameroun, 1993). This reform divided the public university system into six institutions, of which two are situated in the political capital

Yaoundé and four were in the provinces. Finally it can be noticed that university research is becoming more targeted to societal needs and that the institutions are taking on these new roles. This brings us to presume that the following formula proposed by Etzkowitz (2002: 7) can be roughly applied to the Cameroon University system:

The university is undergoing a dual transformation: an expansion of missions to include economic and social development as well as training, cultural reproduction and research and a shift from an individual to an organisational focus in each mission.

The knowledge production conditions are, in effect, changing everywhere. Some don't hesitate to treat this as a generalized revolution which will change and subsequently transform the university (Arocena and Sutz, 2001; Etzkowitz, 22-03-2005; Etzkowitz and Carvalho de Mello, 2004). It is therefore not surprising that these transformations are the subject of an international debate on the role the university should play in the production and transfer of knowledge and technologies. The analytical methods used to study this phenomenon and the models developed to understand them are also changing at the same pace making it a significant challenge to study these developments.

Given that the university and the entire Cameroon system of knowledge production is changing in order to support economic development and reduce poverty, this study is limited to some research case studies that address a combination of knowledge production and the development of technologies, products or services. The study examines research articles published on the processing of two types of African plants that have multiple traditional uses: *Ricindendron heudelotii* and *Canarium schweinfurthii*. The research involved with these plants addresses their domestication and the development of their products.

Two types of research institutions served as the sources of articles selected for analysis: Public Cameroon Universities and the ICRAF (International Centre for Research in Agro-Forestry) in Yaoundé. ICRAF is a satellite of the World Agro-Forestry Centre, an international organization that makes use of applied research in agro-forestry to contribute to poverty reduction, improvement in nutritional security and the growth and rebuilding of tropical ecosystems. The organization works in partnership with national research units in agriculture such as universities, NGOs and private organizations in both the South and the North (ICRAF, 2001), which makes ICRAF a good source of research articles for this study.

Although a variety of products of these two plants have been used in the regions extensively in the past, it is still necessary to persuade potential users to integrate the oils extracted from the fruits and seeds of these plants into their dietary habits. They will also have to learn the domestication procedures, how to

transform products and commercialize them as well as how to establish production standards in order to ensure quality end products. Researchers will also have to convince the industry to invest in the transformation of these seeds and the fruits as they have not been involved in the development of these new products up until now (Silou and Massamba, Internet document 28 September 2004). What sorts of arguments are used by researchers in the formulation of the object of their articles? What are the consequences of their choices with respect to the development of a research object and the interactions between potential partners?

This study is based on two theoretical approaches that serve to identify the different perspectives demonstrated in the selected research articles. The historical and cultural dimensions of activity theory are used to study the construction of a research object (Engeström, 1987; 1999; Miettinen, 1998; Miettinen, 1999; Hasu and Engeström, 2000; Miettinen and Hasu, 2002). Activity analysis of scientific research and technological development activities allows the differentiation of a research object from an application object (Miettinen, 1998). It is hypothesized that an application object can be characterized in terms of its complexity and inherent difficulties in its appropriation by potential users.

The study also examines the interactions between actors using the triple helix theory (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2003; Etzkowitz, 22-03-2005; Etzkowitz and Carvalho de Mello, 2004). It is proposed that the specific characteristics of the target population, such as the literacy level together with inherent challenges in appropriating new technologies justifies the division of the of the application object into two categories: one for the industry and a more simplified version for the informal population sector. This requires the addition of a fourth component, the informal system, to the triple helix model.

It should be noted that in activity theory, the unit of analysis is an activity system whereas in triple helix theory, the unit of analysis is the set of interactions between the university, industry and government. The two hypotheses in this study stem from these two different perspectives.

1. Data Collection Methodology

Publication abstracts on *Ricinodendron heudelotii* and *Canarium schweinfurthii* that originated from Cameroon were extracted from the Cab database Pour in order to examine the arguments used by the researchers to justify the relevance of their subject matter and their articles. Each selected article had at least one author who was affiliated with a research institution in Cameroon. Two research institutions were predominantly due to the subject matter addressed: “École nationale des sciences agro-

industrielles of Ngaoundéré University, a public institution, and ICRAF in Yaoundé, which is part of an international organization. ICRAF intervenes within the program *Diversification of Smallholder Farming Systems in West and Central Africa through Cultivation of Indigenous Trees* funded by International Fund for Agricultural Development (IFAD) (FIDA, 1999).

The titles of the selected abstracts were compared to those extracted from other databases such as Science Citation Index-Expanded, Kluwer Academic, Biological Abstracts, as well as documents published on the Internet. The full text articles were then retrieved from ScienceDirect, Kluwer Academic, Wiley InterScience, Bioline International, etc. A few texts found from Asian and African sources have not yet been obtained. To date, 15 articles on *Ricinodendron heudelotii* and 13 on *Canarium schweinfurthii* have been retrieved as full text articles.

Those articles which address the different processes of transformation, conservation and commercialization of the products of these two plants were analysed. Articles which addressed participatory inventories and the domestication of plants with multiple traditional uses for natural forest populations were also included in this study.

Each article was analyzed to identify the arguments underlying what Locke and Golden-Biddle (1997) refer to as the “intertext.” These are arguments that are used by the authors to justify the social context of their research or the importance of their study. This is a mosaic of citations that represent the eclectic choice of the authors. In the introductory section of the article, this mosaic of citations is reorganized in such a way as to emphasize the relevance of the published work. As stated by Locke and Golden-Biddle (1997: 1030) : *we can say that each research study places itself in an intertextual field of its own making.*

The arguments used by the authors themselves in their discussion or conclusions were also analyzed. These arguments described the interactions between the researchers and the informal sector, primarily research that was produced by ICRAF. Table 1 shows examples of arguments extracted from articles of both case studies. The arguments have been placed in three categories that enable their analysis from the two different theoretical perspectives: as a research object construction or as an interaction between actors.

Table 1: Examples of arguments used by researchers to demonstrate the social relevance of their work on *Ricinodendron heudelotii* and *Canarium schweinfurthii*

Reference in text	Arguments related to a government program /Arguments describing interactions between actors	Arguments that address the need for industrial commercialization	Arguments related to traditional uses or addressing the informal sector
Kapseu and Tchiegang, 1995. <i>Journal of Food Lipid</i> 2: 87-98.		<p>(p. 94) Djansang seed oil may serve as a valuable component to coating industries similar to tungseed oil, which contains similar trienic conjugated bonds.</p> <p>(p. 94) This seed oil represents a versatile edible oil source from which it is possible to make a tremendous number of products.</p>	<p>(p. 88) These seeds are important ingredients in culinary usage.</p> <p>(88) They are known as Djansang, Nzone1, Ezezang.</p> <p>(p. 94) Djansang seed oil may serve as a valuable component for inclusion in infant formula due to its high polyunsaturated fatty acid content especially in developing countries.</p>
Tchiégangandal., 1997. <i>Journal of Food Engineering</i> 32: 1-10.		<p>(in the title) Potential primary material for tropical agro-food industries....</p> <p>(p. 1) The identification of the nutritional value of the proteins show a chemical index that is inferior to that of soya or cotton but it presents a good chemical equilibrium with respect to amino acids that can serve nutritional needs.</p> <p>(p. 2) The lack of detailed information on the chemical characteristics of almonds is a serious handicap for the development of a technology to extract the oleaginous oil to serve human nutritional needs.</p> <p>(p. 8) <i>R. heudelotii</i> contains more oil, salts, minerals and azotic materials than cotton or soya. Its oil can be used in paint and stain manufacturing, and as a table oil It can also be used in soap-making.</p>	<p>(p. 9) The high level of azotic materials in <i>R. heudelotii</i>, as well as a good balance of amino acids makes it possible to use them in certain infant formulas.</p>
Tchiégang <i>et al.</i> , 2003. <i>Journal of Food Engineering</i> 58: 363-371.		<p>(p. 364) In addition to its rich oil, Moundipaandal. (1998) showed that the consumption of the raw oil increased the level of HDL cholesterol while decreasing the amount of LDL cholesterol, which is in contrast to palm oil. This important property makes the oil of Njansang a good dietary supplement to combat cardiovascular illness and atherosclerosis, due to its hypo cholesterol and hypo triglyceride activities.</p> <p>(p. 364) Polyunsaturated fatty acids are popular with pharmaceutical nutraceutical and food industries as natural sources that can be produced in good quantity and quality (Ackman & Dha, 1996; Ackman, 1999).</p>	<p>(p. 364) ... with respect to its triple interest in the food, technology and nutritional sectors, the extraction of its oil can constitute a good source of revenue for the population and can contribute to the fight against poverty.</p> <p>(p. 370) The craft-based approach on a small scale can be used to extract the virgin oil of <i>R. heudelotii</i> ...at a minimal cost with the use of local materials available to all.</p>
Aboubakar Dandjoumaandal., 2004. <i>La Rivista Italiana Delle Sostanze Grasse</i> 81 : : 299-303		<p>(299) Due to the presence of the acid α-elaeostearic, the oil of <i>Njansan</i> can be used in the manufacture of stains, paints and impermeable materials.</p>	<p>(p. 299) Given the widespread poverty in Africa since the devaluation of the franc, the populations don't always meet their nutritional needs. In Cameroon, the rate of coverage of lipid needs is</p>

Reference in text	Arguments related to a government program /Arguments describing interactions between actors	Arguments that address the need for industrial commercialization	Arguments related to traditional uses or addressing the informal sector
		(299) Despite its potential for technological, industrial and nutritional industries, there has been little work on the extraction and commercialization of this oil. .	around 49%. These populations have available to them a number of oleaginous plants that have been under-utilized.
Kapseu and Parmentier, 1997. <i>Sciences des aliments</i> 17: 325-331	(p. 326) in the case of diversification of lipid resources and the marking of oleaginous agro-resources in Cameroon, we have determined the composition of fatty acids and the commercialization of oleaginous agro-resourcesof the seeds and fruits consumed by the population....	(p. 330) The fruits appear more promising than the seeds – the oleaginous fruits constitute a source of primary materials for the cosmetic and pharmaceutical industries.	
Tchiégang <i>et al.</i> , 2001. <i>Journal of Food Engineering</i> 47: 63-68.		(p. 64) In Nigeria, in the context of commercialization of non-conventional oleaginous materials, , Ajiwu, Okeke, Ogbuagu, Ojukwu, and Onwukeme (1998) investigated the possibilities of manufacturing paint, wax, beauty milk treatments, and shampoos from the oil of Canarium.	(p. 64) A fruit is said to be ripe if by a simple pressure between the thumb and index finger, the pulp detaches completely and easily from the pod. This method of determining ripeness is used traditionally and does not require any training. In this way, the number of ripe fruit can be easily determined and we can then calculate the percentage of ripe fruit for each sample lot.
Ngo Mpeckandal., 2003. <i>Food, Agriculture and Environment</i> 1(3-4) : 257-262.	(p. 257) The domestication programme at World Agroforestry Centre is based on vegetative propagation of trees identified as “superiors” by farmers collaborating with scientists. (p. 258) With the assistance of farmers in all villages, <i>Ricinodendron heudelotii</i> trees were identified, mapped and located (p. 261) The Domestication Program of high-value multipurpose indigenous trees from West and Central Africa at ICRAF is based on cultivar development using vegetative propagation as the means to capture the characteristics of trees identified as “superiors” by farmers collaborating with scientists. (p. 262) ICRAF-West Africa is developing nurseries at village-level, based on vegetative propagation of “plus trees” identified by farmers collaborating with scientists.	(p. 257 abstract) Kernels from the fruit of the species, commonly known as “ndjanssang”, constitute one of the most traded non-timber forest products in Cameroon (p. 257) <i>Ricinodendron heudelotii</i> is among the economically most important indigenous fruit species, accounting for a significant proportion of local and Cameroon border trade in NTFPs. In Europe, its kernels are frequently found in the stalls of shops specializing in tropical products. (p. 257) The kernels, used as a flavouring agent in local food dishes, are also a good source of oil (49.25 to 63.18% oil content) ⁸ that can be used to make soap and varnish.	(p. 257 abstract) <i>Ricinodendron heudelotii</i> , an indigenous fruit tree species to humid lowlands of West and Central Africa, has been identified through user surveys to have high potential for improving the nutrition and income of rural poor. (p. 257) Genetic variability in this species needs to be determined for traits of nutritional, medicinal and economical importance to end-users (farmers and market). Because of the domestic and market importance of the kernels, farmers in the humid lowlands of Cameroon have identified the following characters for selection: fruit size, reduction of time to bearing, reduction of tree height; so justifying the need for domestication.
Ngo Mpeckandal., 2004. Reviewed papers presented at ANAFE Symposium on Tertiary Agricultural Education, April 2003. ICRAF, Nairobi, Kenya. pp 196-206.	(p. 197) World Agroforestry Centre (ICRAF) in collaboration with the Institut de Recherche Agricole pour le Développement has initiated a participatory tree domestication programme based on the vegetative propagation of tree identified as “superior” by farmers collaborating with scientist (Tchoundjeu <i>et al.</i> , 1998). This programme aimed at investigating the potential of these species for agroforestry.	(p. 197) The increasing nutritional and commercial importance of the kernels and other products of this valued fruit tree has led to several domestication initiatives in Cameroon (Nguele, 2000; Shiemo <i>et al.</i> , 1997; Mapongmetsem, 1994). (197) To be successful, the domestication of indigenous fruit species should be linked to commercialisation and market	(196 Abstract) The results obtained here highlight the possibility for researchers and farmers to produce planting material that fulfils the dual aims of high genetic variation and reasonable performance to farmers. (p. 197) Studies conducted in the humid forest zone of Cameroon in recent years on the uses and commercialisation of Non-Timber Forest Products (NTFP's) have

Reference in text	Arguments related to a government program /Arguments describing interactions between actors	Arguments that address the need for industrial commercialization	Arguments related to traditional uses or addressing the informal sector
	<p>(196) In collaboration with farmers and national research partners in Humid Lowlands of West and Central Africa (Cameroon, Gabon, Ghana and Nigeria), ICRAF conducted a priority-setting exercise identifying the following indigenous species for domestication through participatory household surveys: <i>Irvingia gabonensis</i>; <i>Dacryodes edulis</i>; <i>Ricinodendron heudelotii</i>; <i>Chrysophyllum albidum</i> and <i>Garcinia kola</i> (Fanzelandal., 1996). (p. 197) The use of this diversity for the selection of 'elite trees' by farmers and researchers (Tchoundjeuandal., 1998), is seen as the starting point for the wider domestication of this species, because the quantification of the species variability available at farmer level can be used for the identification of "ideotypes" to guide cultivar's development.</p>	<p>expansion (Leakeyandal., 2000).</p>	<p>shown the potential of <i>R. heudelotii</i> to improve the livelihoods of rural populations and urban poor (Ndoye and Ruiz-Perez, 1999; Ayukandal., 1999). (p. 197) ... new initiative in agroforestry are seeking to promote poverty alleviation and environmental rehabilitation in developing countries, through the integration of indigenous trees into farming systems ... in order to provide marketable products that will generate cash for resource-poor rural and peri-urban farmer (ICRAF, 1997).</p>

There is an unequal distribution between the three categories – there is little that addresses the interaction with the State. A survey of the different expressions used shows a pronounced emphasis on arguments that address the informal sector in general and the rural milieu in particular. One has however to notice that arguments addressing the interactions between the administration of ICRAF, its researchers, organized in multidisciplinary team, and traditional agriculture introduce a model of good practices that have been tested and successfully used in other countries.

2. A re-reading of Miettinen's dual definition of a research object

Research that has as its stated objective the solution to practical problems faced by society are often highly complex objects. The construction of such objects requires the intervention of researchers from different disciplines who work together in a network and collaborate with other actors who share the same research object (Miettinen, 1998). In this perspective, the object is a research object and an application object. The research object aims to develop methods, instruments, and looks at facts and theoretical models that are transferred as explicit knowledge – often published in scientific journals.

The application object, aims to develop industrial processes, production system models, pilot production systems, and industrial manufacturing methods. The application object is ideally

simultaneously developed by a network of innovations that is composed of researchers, manufacturers and users of the end product, service, procedure or technology. These two objects, the research and application object, don't, however, always go hand-in-hand. They are produced by different activity system networks that have different goals, motivations and time perspectives. The duality of the definition of a research object by Miettinen (1998) is revisited by Gopalakrishnan and Santoro (2004) who distinguish between the two at the level of processes of knowledge and technology transfer.

In order to situate the object in the cited article Miettinen (1998) draws upon a number of studies that have already analyzed the different complex processes involved in developing a research object. The construction of intertextual coherence (Locke and Golden-Biddle, 1997) shows that different cited studies share a common orientation: they analyze the emergence of facts or artefacts as a social construction instead of as a mirror image of reality. This type of research is usually completed when a fact or an artefact is accepted by the research community concerned. The publication of the results of the research is the end result of the research activity. The knowledge produced is, at best, accessible to members of the scientific community. In other words, the result research does not reach the actual potential user in a product or service development systems.

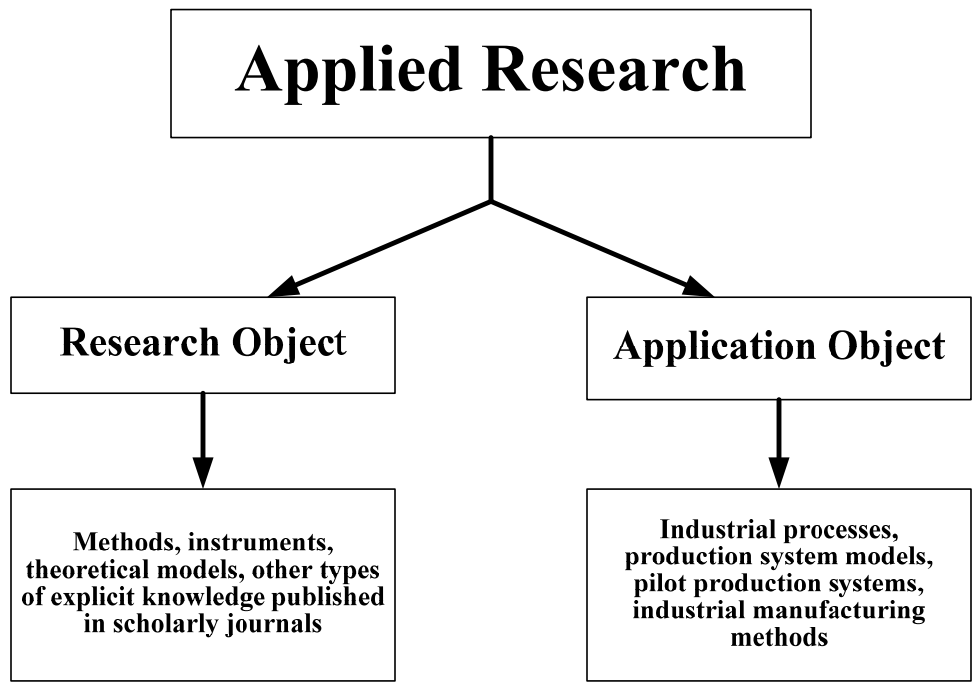


Figure 1: Our dichotomous representation of research and application objects based on the dual definition of Miettinen (1998: 452)

Miettinen adds to the publication of new scientific facts a second phase that addresses the relationship between the creation of an object with society's use of the research results, outside of the scientific community. This results in a dual definition of the research object that is depicted in Figure 1, which allows us to distinguish between a research and an application object.

3. Adapting the creation of a research object to the case studies.

How does this dual definition of a research object apply to the research activities on *Ricinodendron heudelotti* and *Canarium schweinfurthii*? The comparative analysis of the arguments extracted from articles on *Ricinodendron heudelotti* (Table 1) show that the attitudes of researchers have changed during the research activities. In 1997, Tchiégang *et al.*, state that the seeds of *Ricinodendron heudelotti* represent a potential primary material for tropical agro-food industries. The authors state in the French version of their abstract which lightly different from the English one:

This study shows the nutritional potential of R. heudelotii (Bail.) which is attracting the attention of tropical agro-food industries who recognize the importance of integrating it in tropical food industries (Tchiégangandal., 1997: 1)

This confirms that industry cannot help but be interested in the transformation of this primary material. There are many arguments used that validate this. Most of the scientific data establishes that the research results of the article address industrial commercialization concerns. The authors don't lack for opportunities to emphasize the potential importance of the seeds studied for diverse industrial sectors.

Due to its richness in polyunsaturated fatty acids (79.4% of the total fatty content), and the fact that it can be used in a variety of different meals, the oil of R. heudelottican be an important table oil used to season raw food as well as in the cooking of diverse meals. As with other similar oils, it can also be used in the manufacture of paints and stains. (Tchiégang et al., 1997: 6)

Tchiégang *et al.* (2003), also refers to industries, but with less emphasis than the preceding articles. The authors cite references that show the seeds of this plant contain materials sought by industrial companies in developed countries. Here is an illustrative excerpt:

The polyunsaturated fatty acids are currently popular due to their nutritional value and their potential use by pharmaceutical, nutraceutical and food industries that are particularly interested in natural sources that can be produced in both quantity and at a high level of quality. (Ackman & Dha, 1996; Ackman, 1999). (Tchiégang et al., 2003 : 364)

The industrial reaction appears to have been fairly muted. In fact, there does not appear to have been any reaction by industry. In the subsequent articles *Canarium schweinfurthii* the term “industry” makes only very few appearances:

- 1) *These oleaginous fruits constitute primary materials for the cosmetics industry.* (Kapseu and Parmentier, 1997: 330)
- 2) *The major research on the oil of the fruit pulp were carried out to improve the extraction by enzymatic addition, and the use of this oil in the manufacturing of shampoos, wax or as a biocarburent....*(Kapchie *et al.*, 2003 : 1 citing previous studies).
- 3) *... knowledge of the behaviour during the drying of solid products is an essential element for the calculation of the size of industrial dryer and/or to define conditions of use* (Noumiandal, 2004: 71)

The enthusiasm of the researchers appears to diminish. They become less optimistic on the eventual commitment of industry in the transformation of the products studied. Very few articles propose in their results prototypes for industrial transformation of those products. Only a few make such statement (e.g. Noumi *et al.*, 2003; 2004). The presentation of knowledge is often associated with its potential industrial exploitation. The researchers show that they consider industry to be an intermediate user of their results – which they need to transform the knowledge produced by the research into a technology, product or procedure.

The researchers worked however towards an application object. They developed extraction procedures for the oil of *Ricinodendron* which is destined for rural user and not for industry. It is stated that:

With respect to its application in a rural context – it has a number of advantages due to the quality of the oil and the extraction and pressing technique that can be used. The extraction of the oil from the seed of R. heudelotii needs to be further studied in order to identify conditions where a high quantity and quality of yield can be obtained. ... (Tchiégang *et al.*, 2003: 364)

The idea is to develop a simplified technology that is different from that which can be used by industry. There are thus two types of application objects: one destined for industrial commercialization (not within the scope of this study) and one destined for the rural population. The authors of one article speak of a craft-like approach on a small scale (Tchiégang *et al.*, 2003: 370). These researchers seem to assume that the rural population will find it difficult to appropriate more complex technologies. Platt and Wilson (1999) describe technology appropriation by rural populations. The appropriation process is leaning by doing as we are working with tacit knowledge. We therefore need to distinguish 2 levels

of an application object, as shown in Figure 2: one for principal actors in an informal rural system and a second level for industrial actors. Only the first level is addressed in the articles analysed.

It is suggested that Figure 2 be read from left to right. The full line represents researchers who have met their objectives whereas broken lines represent research that has remained at the abstract or idea stage. The researchers have produced explicit knowledge that has been published in scholarly review (*mainstream journals*). The users of this knowledge are limited to members of the scientific community. Potential production system users have difficulty in accessing such vehicles of knowledge transfer.

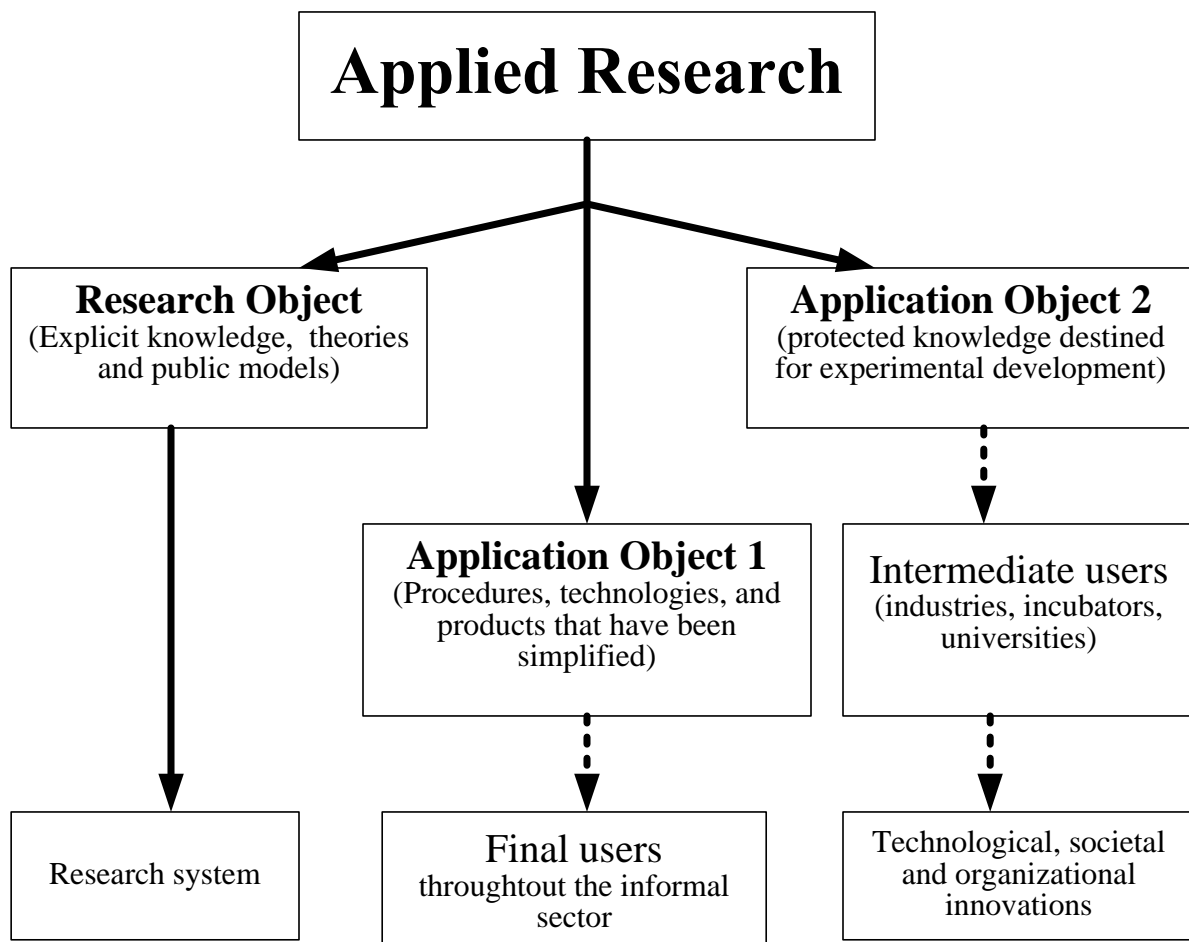


Figure 2: The applied research object and the assumed use of knowledge and technologies in the informal sector. The broken lines represent objectives that have not yet been attained.

For application object 1, the researchers have produced an artefact, a manual press for the extraction of the oil from seeds of *Ricinodendron*. They have also tested a number of procedures for the optimization of oil extraction in order to ensure storage at room temperature but only under laboratory conditions.

For the fruit of *Canarium*, researchers developed oil extraction and conservation procedures. Simple fruit storage procedures were also tested. They carried out oil extraction from fruit in a number of different states in order to minimize loss after harvesting. In all cases, the technology and the proposed procedures were simplified in order to be cost-effective in the rural context. The formula used by the authors can be applied to all application objects to make use of the craft-like approach on a small-scale: [...] *that can be carried out at a minimum cost using locally available materials* (Tchiégang *et al.*, 2003: 370).

The modalities and the organizational structures also play a role in the transfer of application objects to potential users. The broken line represents these gaps – cases where the transfer of application objects from the university lab to rural communities have not yet taken place, nor the appropriation of technologies, even simplified ones, have not occurred. It is likely that a mediation process and structure are required here. This process can be broken down into two phases: promotion and dissemination. Promotion refers to making the information or the technology known by those that can then disseminate it. Dissemination consists of increasing the level and accelerating the pace of the uptake of research results in order to develop them into applications for targeted end (Garforth, 1998). We are still labouring under the assumption that rural users are handicapped in the appropriation of any technologies due to illiteracy (Kapseu *et al.*, 2002).

Consider the application object 2. The researchers have remained at a speculative level with few concrete products based on what they proposed. They have multiple citations concerning potential industrial commercialization of primary materials studied but without any prototyping, for example. Our understanding is that they consider development at this level as not being part of their objectives nor of their contribution to the economic development goal or mission. This is shared by other authors and societal actors such as industry and researchers in other disciplines. They are late in joining the activities initiated by the research and have not contributed to their commercialization. Does the government have a role to play here?

4. University researcher initiatives that seek to link research to the informal sector.

The arguments shown in Table 1 were distributed in order to highlight the researchers' initiatives directed to the informal sector, the industry and the government. In many of the analyzed articles, the authors have used a variety of different means of linking their research to the informal sector.

The simplest form of link between research and the traditional production sector is in the names of the plants using one of the official languages of Cameroon: *They [seeds] are known as Djansang, Nzonel,*

Ezezung (Kapseuand *et al.*, 1995: 88). The terms are used to introduce the research: *In this paper, the fatty acid composition of pulp, shell, membrane and kernel of « mbeu »...* (Kapseuand *et al.*, 1996: 78). Other examples are shown in Table 1. It is assumed that the researchers use these terms in order to demonstrate their willingness to link their knowledge production to the activities involved in traditional production systems.

In another text, the research objective is linked to the *fight against poverty* (Noumiand *et al.*, 2003: 317). Many articles point out that the population of Cameroon can meet only 49% of their lipid requirements and the proposed research purports to correct this deficit. This argument emphasizes a goal of reducing malnutrition, perhaps by improving the distribution channels. This would permit the *distributors and retailers to generate more profit* (Jiokap Nono and Kapseu, 1999: 21 and 22), which in turn will improve the general quality of life.

More explicit goals are stated by researchers who describe initiatives to profit the poor and the informal sector such as *...these transactions will feed the informal economy...* (Jiokap Nono and Kapseu, 1999: 21). The same authors identify women as the principal beneficiaries of the improved informal economy. Here are two excerpts: 1) *Fresh or heat-processed fruit can be sold in baskets by woman ..* (Jiokap Nono and Kapseu, 1999: 21). 2) *These products bring a greater value and allow women to not just conduct small businesses but to increase their family revenue* (Jiokap Nono and Kapseu, 1999: 26).

The proactive approach makes research results available to the traditional production sector: *In other respects the Black olives producers live in rural areas mainly.. Small scale techniques are available to enable people of rural areas to process their own oilseed locally* (Tchiégang *et al.*, 1998: 566). There are also less direct means such as: *the technique of conservation using humidity was studied in the context of simplifying this so that it lends itself to a craft-like approachthis technique requires only know-how, organic acids and locally available sites* (Tchiégang *et al.*, 2002: 303).

On the other hand, certain research appears to have been inspired by traditional practices which they have attempted to systematize and enrich. Examples are methods of determining fruit ripeness for *Canarium* (Tchiégang *et al.*, 2001).

5. Government initiatives to promote a participatory process

A participatory process is a key requirement of the International Monetary Fund and the World Bank, as introduced in the document, *The Poverty Reduction and Growth Facility (PRGF)*. An extract from this demonstrates this requirement clearly:

Crucially, the new framework rests on a departure in the way objectives and policies are chosen. The country and its people will need to take the lead. PRSPs [poverty reduction strategy papers] will be prepared by the government, and based on a process involving the active participation of civil society, NGOs, donors, and international institutions. (IMF and WB, 1999 Internet document).

This requirement was introduced during the reform of programs which at the time could be considered a *management fad* (Gibson and Tesone, 2001: 22). Management fads are innovative organizational practices designed to improve certain aspects of their performance. Management fads may evolve to become new management practices or be abandoned altogether if they fail. The appropriation of these fads and their conversion into stable management practices requires time, effort, organizational learning, political willingness and a follow up on the part of the directors at all levels of the State and the organization.

The participatory process has been used by the government to prepare a national strategy for poverty reduction. This strategy should then serve to orient university research as discussed in the preceding paragraph. On the other hand, many government programmes were created and implemented in order to promote and sustain user need driven research themes. Among these programmes is *Programme stratégique du gouvernement en matière de Science et de Technologie pour le Développement* implemented in 1997. The aim of this programme is to

... promouvoir au Cameroun la maîtrise de la science et de la technologie au plus haut niveau de l'excellence, de favoriser la mobilisation par les Camerounais des connaissances scientifiques et technologiques mondiales nécessaires pour la lutte contre la pauvreté, l'amélioration rapide et durable des conditions de vie des populations et le développement économique, social et culturel de la nation (MINREST, Internet document)¹

Another programme of interest is the *Programme national de vulgarisation et de recherche agricole* which is made of six components: agricultural commercialization, research, training and the development of human resources, support to organizations and rural associations, participatory development of village communities and a follow-up of commercialization activities. These two programs both advocate objectives of support, promotion and brokering between university research and potential users to which the research is targeted.

¹ ...promote in Cameroon the mastery of science and technology of the highest level of excellence, to promote the leveraging of world scientific and technological knowledge by the people of Cameroon to fight against poverty, to rapidly improve the quality of life in a sustainable way and to develop the social and cultural economy of the nation.

While the analyzed articles do not explicitly state a recognition of support or interactions between university research and one or both of these programs, there are quite a few analyzed articles where the co-authors were researchers of the Agricultural Research Institute for Development (IRAD), which heads the national agricultural commercialization program. Perhaps the IRAD researchers collaborate with university researchers as they were former students.

These interactions are highly desirable in promoting the participatory process in the definition of research problems as well as to promote and diffuse the results of internal university research. Could this be a case of an omission based on the assumption that it is taken for granted? An omission of this sort will not help integrate university research in development processes and public university researchers will be obliged to act as sub-contractors or consultants for other researchers who are directly supported by these government programmes and by international fund loan officers. This is the case with the International Centre for Agroforestry Research which benefits from financing from the International Agricultural Development Fund (FIDA) which is a specialized agency of the United Nations.

6. Researchers that have participation from actors from the informal sector.

Many articles by researchers from ICRAF (Tchoundieu *et al.*, 1999; Ngo Mpeck *et al.*, 2003 and 2004; Leakey *et al.*, 2003) discuss collaboration between scientists and traditional farmers. The participation of rural farmers in the research process is presented as a critical element for the institution. They make use of expressions such as: *With the participation of subsistence farmers; the first step in the domestication process involves household interviews to determine farmer preferences* (Leakey and Tchoundjeu, 2001: 279 and 281).

In the domestication of indigenous trees program, ICRAF's strategy is to ensure that the farmers themselves indicate which trees are the most important for them and the best way in which to improve them (Tchoundieu *et al.*, 1999). One ICRAF objective is to develop domestication techniques that integrate both scientific data in agro-forestry and traditional know how for the plants judged to be the most important by the rural sector.

The initial research problem is then defined in collaboration with a multidisciplinary team composed of economists, forestry experts, agronomists, sociologists, and traditional farmers from the informal sector. Illiteracy, which is often presented as a limiting factor in such contexts, does not seem to impede the collaboration between rural workers in a participatory inventory of plants with multiple

traditional uses. This step of the process which ends with a list of priority species in terms of their domestication becomes a stage of research problem formulation that is situated in *highly specific and local contexts of application* (Gibbons *et al.*, 1994: 30). This is also applied research where the application object is the development of plant cultivars to be domesticated.

With the preceding example, we find different dimensions of the triple helix model become fused (Etzkowitz and Leydesdorff, 2000): namely, government, university, and industry. We propose the addition of a fourth component, the informal systems, which are distinct from industry (see Figure 2). Figure 3 summarizes the assumed relationships in the adapted triple helix model.

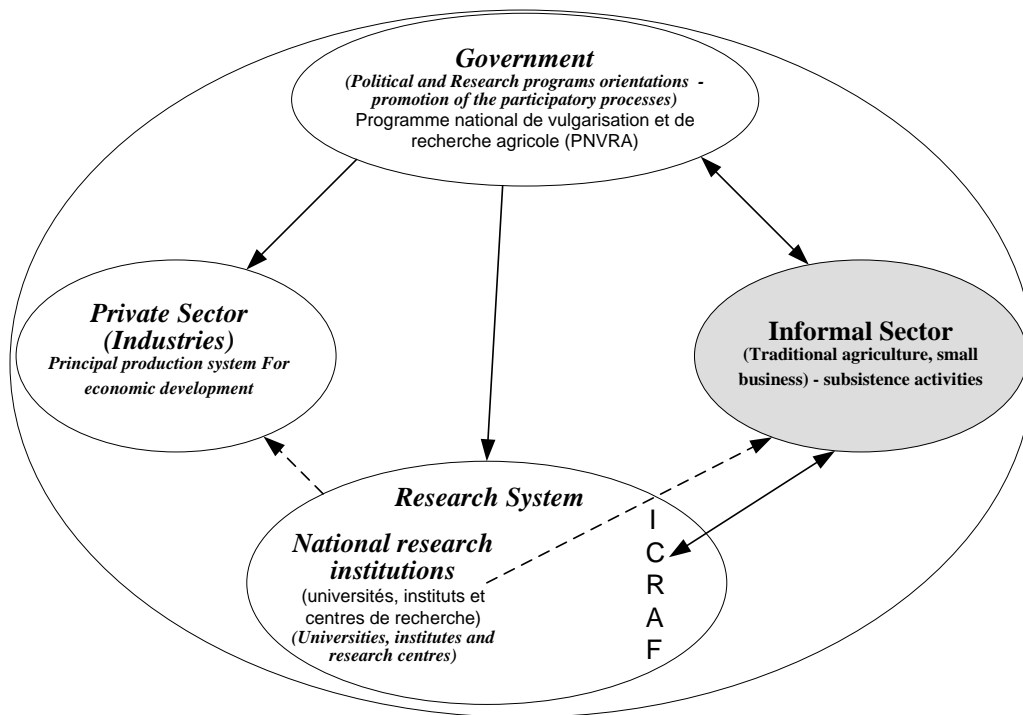


Figure 3: Relationships between government, research system, industry (designated Private Sector in the document on the Strategy to Reduce Poverty), and the informal sector. This model is a modification of the triple helix model of Etzkowitz and Leydesdorff (2000 : 111). ICRAF: International Center for Research in Agroforestry.

The government initiatives are represented as addressing a national strategy for poverty reduction. Political orientations and programs within this context are presented in the document Strategy for Poverty Reduction. This document is endorsed by the members of the UN in Cameroon during the signature of the Executive Plan of the UN for Development Aid in Cameroon for the period 2002/03 – 2006/07 (UNCT, 2002). Promotion of participatory processes was, in principle, carried out as required by the international fund sponsors. But what about the rest of the participatory process which addresses

the interactions between the public and para-public administration personnel and the NGOs, the private sector, civilian society members and the universities?

If we look at university research results that have not been conveyed to targeted users in the rural milieu, we would have to say that these modalities have not been transformed into stable management practices. The same can be said for collaboration between universities and industries. We have shown these unrealized interactions as broken lines. University research initiatives intended for the informal sector do, however, represent a significant step forward in the right direction. They signify a certain alignment between the national poverty reduction strategy with societal actors from the informal sector. But these initiatives can also help better recognize the importance of the informal sector in the economic system of a country.

The relationships developed by ICRAF with the informal sector are far more relevant for the acceleration of the integration of research to economic and social development processes than those developed by the university research. The strategy communicated by this institution which aims to promote collaboration between multidisciplinary research team and traditional farmer associations to define research problems and the transfer of research results to targeted end users is an excellent example of interactions between actors engaged in a research process within the context of an application. Our recommendation is to adopt and adapt this good practice for all the relationships between all the actors involved in the process.

Conclusions and Further Work

To conclude this exploratory study, we propose that given the number of initiatives, university researchers need to start assuming the role of contributing to the economic development of Cameroon – more specifically, to contribute to the strategy of poverty reduction. Research initiatives show a change in attitude concerning informal economic actors in general and farmers in particular. In addition to producing knowledge, researchers develop technologies and simple processes that take into account assumed limitations of actors the research results are destined for. Knowledge produced is published but the technologies and procedures developed are not transferred to potential end users. It is not due to a lack of a model of good practices because the ICRAF represents such a model at the national level.

What appears to be the problem is the organizational mechanisms required to transfer knowledge and to transfer developed technologies to the targeted user population (Figure 2). It is therefore necessary to begin a change process that will be accompanied by an organizational change of equally large

magnitude. The association of students to the process of knowledge and technology transfer and the development of structures such as incubation offices can help establish links between researchers and end users of university research results. Etzkowitz (2002: 14) proposes that *this organisational training occurs outside the classroom setting and or purposes other than education*. The incubators, such as those used in Brazil, are very versatile. They have been adapted it to a multitude of uses that are quite different from the original intent. The incubator appears to be an ideal organizational structure for professional training outside the context of formal courses. A well thought out adaptation of the participatory process for the development of research goals and for the dissemination of research results should form the basis of good management practices.

The data from this exploratory study form part of a larger project that targets the strategic analysis of research conducted in Cameroon following the university reform in 1993. The research described here addressed the work done by researchers that was destined for rural workers, their systems and their production practices, in order to conserve and manage agro-ecological ecosystems. Two subsequent studies are currently in preparation and will serve to complement the present study. These two studies comprise 1) the dynamic analysis of research conducted over two periods spread out over a span of six years and 2) the factors that affect – either positively or negatively – the formation of a critical mass of national researchers, as well as the process of innovation in this sector. We intend to continue testing our research hypotheses by postulating the rural sector and the informal system as elements of the triple helix in these future research studies.

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