



# MAJOR ISSUES THAT AFFECT THE DEVELOPMENT OF THE CULTIVATION OF THE POTATO (*Solanum tuberosum* L.) IN DIFFERENT MUNICIPALITIES OF THE PROVINCE OF HUAMBO, ANGOLA

## Principales problemáticas que afectan el desarrollo del cultivo de la papa (*Solanum tuberosum* L.) en diferentes municipios de la provincia Huambo, Angola

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**ABSTRACT.** During the period of February, 2013 until March, 2014 the present investigation was developed in four municipalities of the province of Huambo, with the objective of determining the main problems that affect the development of the cultivation of the potato (*Solanum tuberosum* L.). It was carried out a participative diagnosis with the direct producers to the cultivation, with the use of different techniques of the participative rural development that included interviews and questionnaires as methods of sociological investigation. It was carried out a census of problems at agroecosystems level with the producers and their families where it was possible to appreciate the problems that were affecting the cultivation of the potato and their system of current production. With all the basic information a matrix of prioritization of problems was made and also an order for the solution of the same ones. It was worked with a sample of 212 producers related directly with the potato production, that represent 57,61 % of the total producers. The obtained results allowed identifying nine common problems that affect the development of the potato. Among them, the most important ones and with a higher frequency in apparition in many territories were the bad quality of the seeds, the shadowy use of the plantation distance and the plant poor management. The low yields of the cultivation of the potato in the province of Huambo are influenced by technological irregularities and ingrained customs not compatible with the techniques that are usually applied in the cultivation.

**RESUMEN.** En correspondencia con los bajos rendimientos que existen en el cultivo de la papa en la provincia de Huambo, Angola, durante el período comprendido desde febrero del 2013 hasta marzo 2014 se desarrolló la presente investigación en cuatro municipios de la provincia, con el objetivo de determinar las principales problemáticas que afectan el desarrollo del cultivo de la papa (*Solanum tuberosum* L.). Se realizó un diagnóstico participativo con los productores directos al cultivo, con el uso de diferentes técnicas del desarrollo rural participativo que incluyó entrevistas y cuestionarios como métodos de investigación sociológica. Se realizó un censo de problemas a nivel de agroecosistemas con los productores y sus familias, donde se logró realizar un inventario de todas las dificultades que se encontraban afectando el cultivo de la papa y su sistema de producción actual. Con toda la información básica, se confeccionó una matriz de priorización de problemas y el orden para la solución de los mismos. Se trabajó con una muestra de 212 productores directamente relacionados con la producción de papa, que representan el 57,61 % del total de productores. Los resultados permitieron identificar nueve problemas comunes que afectan el desarrollo de la papa, de ellos los de mayor importancia y frecuencia entre los territorios fueron la mala calidad de las semillas, el uso indistinto de la distancia de plantación y el deficiente manejo agrotécnico de las plantaciones. Los bajos rendimientos del cultivo de la papa en la provincia de Huambo, se encuentran influenciados por irregularidades tecnológicas y costumbres arraigadas no compatibles con las técnicas que normalmente se aplican en el cultivo.

**Key words:** agroecosystems, problems, seeds, gauge, plantation

**Palabras clave:** agroecosistemas, problemas, semillas, calibre, plantación

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## INTRODUCTION

Potato growing in Angola, has an important economic potential and runs fifth after corn (*Zea mays* L.), cassava (*Manihot esculenta* Crantz), coffee (*Coffea arabica* L.) and beans (*Phaseolus vulgaris* L.). The estimated annual average yield was 7 t ha<sup>-1</sup> during the production and sales process, it generates jobs for several families<sup>A</sup>.

In Angola, the main potato growing areas are located in the Huambo plateau, particularly in Ekunha, Caála, Calenga, Catchiungo and Huambo; all of them belong to Huambo, with 50 % of production volumed sold. There are also commercial productions in other regions like Malanje, Kwanza-Sul and Benguela.

The annual average yield of the crop in Huambo province ranges from 5 t ha<sup>-1</sup> to 7 t ha<sup>-1</sup>. They are very low compared to those of South Africa; the closest Angola neighbor, which are from 24 t ha<sup>-1</sup> to 34 t ha<sup>-1</sup> (1).

There are different factors influencing the low potato yields in Angola. Their knowledge would allow to join efforts and implement the necessary actions for growers might increase yields and achieve a higher family maintenance. In Huambo province, there is a dry temperate climate, it is an area with acceptable agroecological conditions to reach high-yields in potato production throughout the year, which does not happen (2). It leads to think that the human factor and inadequate cultural practices could be the causes behind low yields.

Trying to figure out the largest quantity of possible problems and inconsistencies through a diagnostic of the different potato agroecosystems using participative methods, is a priority for Huambo province in order to make a complete characterization of the situation and adopt the necessary measures to increase yields.

These conceptions play a major role when combined with the techniques of a participative rural development approach where growers are the main characters and whose communities are the playground to implement adopted actions. In this context, different tools to find ideas and standards to solve these problems have been applied (3).

Considering the above, the objective of this research has been to determine the main problems affecting potato growing (*S. tuberosum* L.) in the different municipalities of Huambo province, Angola.

## MATERIAL AND METHODS

This research was conducted from February 2013 to March 2014 in the following municipalities of Huambo province: Longonjo, Caála, Huambo and Ekunha.

In order to determine the main problems, a diagnostic was made to potato growers in the municipalities under study, using different participative tools for rural development (3). From exploratory tours to potato agroecosystems, they were characterized and an inventory of the interrelations among the main resources and elements present in them was made, which, in addition to the characterization of management practices by participative workshops with groups of experienced informers representing each municipality, it was possible to identify the main problems affecting the current potato production system through a census.

The collected information was used to make up a problems tree that allowed to go deeper into them to understand their relationship better and distinguish causes and effects.

With this basic information, a priority matrix was made by holding participative workshops that identified the most important problems affecting the crop in each municipality taking into account the frequency considered by growers on a certain problem regarding others identified.

Such a step allowed to establish a priority order to solve them according to their hierarchy. The main criterion used to establish priorities was its level of importance on yields and the need to solve them as soon as possible.

A sample of 212 potato growers (populational sample) accounting for 57,61 % of the total, was used. A survey was applied as a sociological research method with open and close questions apart from those stratified ones, in order to diagnose the historical and current situation of aspects like: yields, growing area, technological activities, cultivars, pests, commercialization, among others.

<sup>A</sup> Relatório sobre o comportamento dos dados estatísticos da produção e rendimento da cultura de raízes e tubérculos durante a campanha agrícola 2010-2011, Instituto Nacional de Estatística de Angola (INEA), Luanda, Angola, 2011, 50 p.

The information collected by municipality was processed with the statistical software InfoStat, for Windows (4). In so doing, the information was organized in adequate records for processing. Percentages out of the total were determined and the answers of each studied technique at the workshops were grouped by municipality. It allowed a frequency analysis according to growers' answers recorded on a double entry table.

## RESULTS AND DISCUSSION

The results of the agroecosystem characterization and farms mapping allowed to see an adequate accesibility level to natural resources and planted areas, also benefitted by the flat nature of the plantations. The current land use in all studied municipalities with the development of more than 15 species, roots and tubers, cereals, leguminose, fruit crops, vegetables, ornamental plants, flowers, pastures and fodder, among them. All identified species and the development of potato crop have collaborated with an appropriate diversity.

The climate of the region groups the four studied municipalities and its location is on the tropical zone where humid and dry climate alternate. The rainy season has a medium duration, from six to seven months, starting in October and ending early April with maximum rainfall values of 310 mm in December and annual total averages of 1 565 mm, adequate and available for potato growing (Figure 1), since it requires rainfall from 400 mm to 800 mm.

This crop, compared to others, is relatively sensitive to water deficit due to its root system so the total available water should not be exhausted in more than 30 % to 35 %, particularly during the formation and growth of the tubers (5, 6).

Annual mean temperature ranged from 19 °C and 20 °C, with maximum between 28 °C and 30 °C in August – October and lower values with minimum temperatures within the dry period between 8 °C - 11 °C. The warmest month was September and the coldest one was June, with an average of 8,4 °C at the Southern tip. For all the above, temperature behavior in this province are adequate for potato growing since it demands optimum temperatures from 15 °C to 20 °C for growth and tubers development (7).

Temperature is the main climatic variable regulating the vegetative and reproductive development of potato (8). Other processes associated to the accumulation of dry matter (foliar expansion, photosynthesis, respiration, evapotranspiration, etc.) are also affected during the life cycle (9).

The behavior of the above-mentioned variables determined relative humidity that showed an annual average of 53,85 %, with minimum average values of 10,72 % during the dry period and average maximum of 79,5 % during the rainy period. The greatest importance attached to this variable is its influence on diseases, therefore, the described values in the last five years, have met potato crop requirements.

The agroecosystems for potato growing in this region can be found in flat lands, there were no slopes lower than 2 % provided by the old quaternary. The

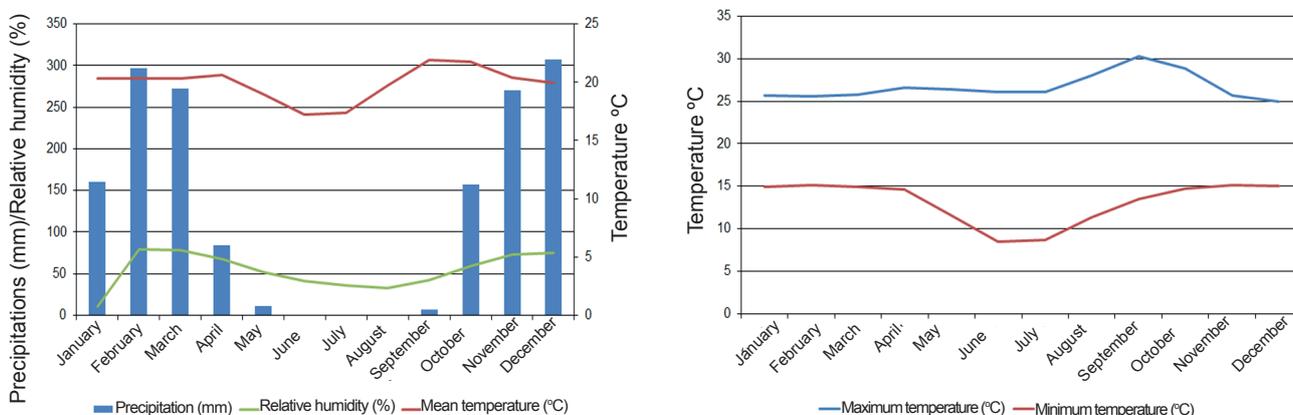


Figure 1. Climatic behavior of Huambo province in the last five years (2007-2010)

original material of the soil comes from the materials transported by the intemperism of lavic rocks, mainly of granite. In general, the soils of this potato growing region are Alfisols, Rhodic Kandistalf according to the Soil Taxonomy classification, that is correlated to an Acrisol distric and rodic soil (10).

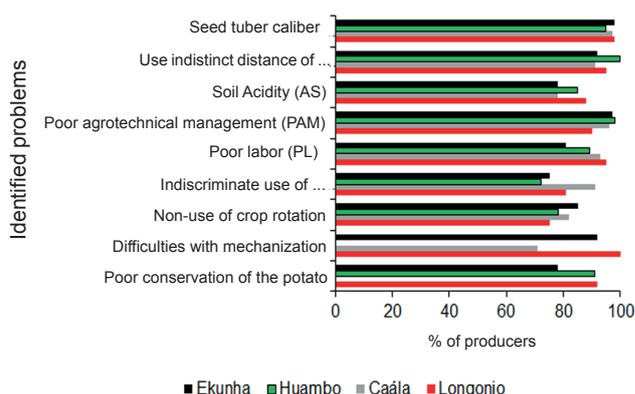
The exploratory tour and interviews to growers, allowed to confirm the presence of some restrictive factors derived from the natural edaphological features of this soil (11) like the low organic matter content, due to the excessive exploitation of these soils without efficient fertilization management and without the use of sustainable nutrition alternatives for other crops planted on them.

According to the results of the applied survey and the participative workshops by municipality, a problems's tree was made up with identified problems and their causes whose results led to four big problems:

- ◆ Inadequate cultural practices: It was identified as the main problem in the four municipalities. Other problems have influence on this:
  - inadequate seed tuber size due to deep-rooted conceptions, lack of knowledge and growers' financial constraints.
  - no associations or crop rotations are practiced to increase the efficient use of soil because of lack of training.
  - inadequate use of spacing for lack of assistance and extension actions. It is necessary to reach a better knowledge on appropriate spacing, the prevailing climatic conditions and the variety used.
  - excessive use of chemical fertilizers due to lack of knowledge and growers' financial constraints.
- ◆ Inadequate edaphic conditions for crop development due to the non-application of alternatives to maintain soil fertility.
- ◆ Scarce manpower to perform cultural practices due to growers' financial constraints and manpower availability.
- ◆ Bad preservation of the final product for lack of adequate technologies.

In general, the results of the municipal workshops allowed to identify different common problems in the studied municipalities derived from the consensus of more than 70 % of the growers (Figure 2). They were:

- 1- Soil acidity (AS)
- 2- Non-use of crop rotation (RC)
- 3- Inadequate cultural practices (DMA)
- 4- Inadequate seeds (CSI)
- 5- Non-uniform use of spacing (UIDP)
- 6- Excessive use of fertilizers (UIF)
- 7- Inadequate manpower (DMO)
- 8- Mechanization difficulties (M)
- 9- Bad preservation of the final product (MCP)

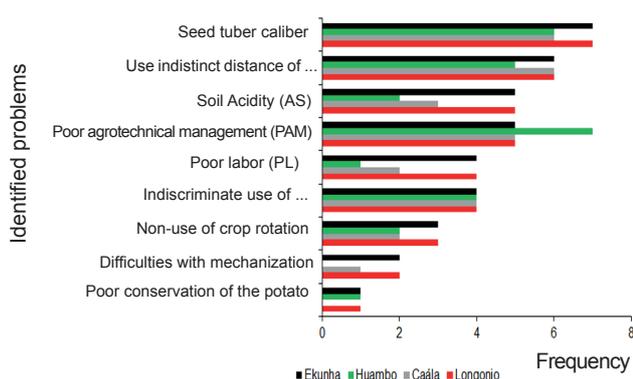


**Figure 2. Percentage of growers that identified problems affecting yield per municipality**

Over 70 % of potato growers that attended municipal workshops agreed on the main problems affecting low crop yields. The highest percentage of growers in the three studied municipalities coincided that the three main problems are related to inadequate cultural management, the inadequate use of seed-tubers size and non-uniform spacing.

These problems were given priority according to the characteristics and customs of the growers in each municipality, who were defined with different frequencies. Figure 3 shows the graphic of the resulting frequencies of the priority matrix containing the problems of the studied municipalities. Based on the results described in the previous figure, the most frequent problems limiting potato production were the three identified by the highest percentage of growers.

Growers from Ekunha and Longonjo municipalities show a higher frequency for these problems and they are also who stand out in all censused problems compared to other municipalities. However, those growers from Huambo, have more problems with cultural management practices.



**Figure 3. Resulting frequencies of the priority matrix with the problems found in the studied municipalities**

Problems related to inadequate seed tubers sizes were by growers as a problem to set up new plots. In general, sizes used by growers are:  $\leq 28$  mm, 28 mm - 35 mm, 35 mm - 45 mm and 45 mm - 55 mm; out of them 55,5 % of total growers use the first size and the rest indistinctly use other sizes, including the use of seed tubers below 28 mm.

From a more particular point of view, Ekunha and Longonjo's growers considered this problem with the same frequency (seven) regarding the rest of the problems, the same thing happened with Caála and Huambo's growers, but with a frequency of six. In this context, that 82,6 % of growers in Ekunha, Longonjo and Caála commonly use seed tubers of sizes below 28 cm, since they consider them more suitable for the market economically wise. However, out of the total growers, more than 50 % lack knowledges on the advantages of using adequate seed tuber sizes. On the other hand, 18,4 % use sizes from 28 mm to 35 mm and from 35 mm to 45 mm.

Investigations done with the use of small-size seed tubers showed that such tubers produced less quantity of sprouts and consequently less number of stems per tuber, which influenced on final crop yields (12). The adequate establishment of the crop with optimum planting materials should allow tubers to sprout, that emerge fast and that plants develop quickly to then reach a maximum foliar mass (13).

At the municipality of Huambo, 75 % of the growers use sizes of 35 mm - 45 mm, considered adequate for these conditions. It showed the existence of a better knowledge on the topic that is also related to a higher technical assistance received by this municipality.

The seed tubers should be graded with a higher size in order to provide uniformity of stems density and plants height, facilitate management and other cultural practices to increase yields. Big size seed tubers can favor a faster emergence and an earlier vegetative development without influencing on the economic yield (14). On the other hand, the number and size of the tubers depend on the competition among plants for light, nutrients and water<sup>B</sup>.

Research works made in Brazil with two types of seed tubers (60 mm - 50 mm and 40 mm - 30 mm) with different spacing between plants to evaluate its influence on the crop, concluded with significant differences for commercial productivity, so the use of seeds with less diameter and spaced at 30 cm between plants was recommended (15).

The use of non-certified seed tubers is one of the problems influencing on bad seed quality. The use of certified seeds guarantees not only varietal purity, but also a sanitary standard that allows higher commercial yields since wastes are considerably reduced and a good quality produce is attained nitarío (16).

From the economic point of view, seed tubers are the most expensive input in potato production. In Cuba, potatoes account for 40 % (1 500,00 USD ha<sup>-1</sup> - 1 700,00 USD ha<sup>-1</sup>) of total production costs. However, by using botanic seed, the production costs of potato growing can be reduced from 5 % to 10 % just because of using good seed which means more than 75,00 USD ha<sup>-1</sup> - 150,00 USD ha<sup>-1</sup> (17).

Regarding the spacing used, it was possible to confirm that a great diversity of spacings are used: 40 cm x 15 cm, 80 cm x 40 cm, 60 cm x 30 cm, 30 cm x 30 cm, 50 cm x 30 cm and 40 cm x 30 cm. 60,50 % of the growers in the four municipalities use 1 500 kg ha<sup>-1</sup> of seeds, which is related to high density plantings.

In general, these seeds are selected in their own plots and 42,5 % are bought in the local market (imported). In Venezuela, the development of new alternatives for potato seeds has become a priority, but as in many other countries like Angola, growers use a significant percentage of imported seeds from potato producing countries (18).

<sup>B</sup> Oliari, I.C.R.; Eस्कemback, V.; Kawakami, J.; Queiroz, L.R.M. y Umburanas, R.C. "Características morfológicas da batata cultivar Ágata influenciadas pela adubação e tubérculo semente", *51 Congresso Brasileiro de Olericultura*, Viçosa, Brasil, 2011, pp. 2878-2884.

In Cuba, some 10 000 ha are grown every year, which are planted with high-quality seed-tubers from Europe and Canada, that have a high market price. For this reason, the Cuban government has to invest millions of dollars to buy seeds. One of the ways to reduce seed costs is by using botanic or true-to-type seeds coming out of the residual potato reproduction (19).

Growers explained that the main reason justifying such planting distances is for the quick closing of the field, for increasing efficiency in weed control and reduce production costs. However, according to the reports of the international literature on this topic, these spacings are not among the most commonly used by potato-growing countries.

Angola has different spacings for potato growing, particularly in Huambo, where a consensus has not been reached yet and each grower proceeds as he/she considers best.

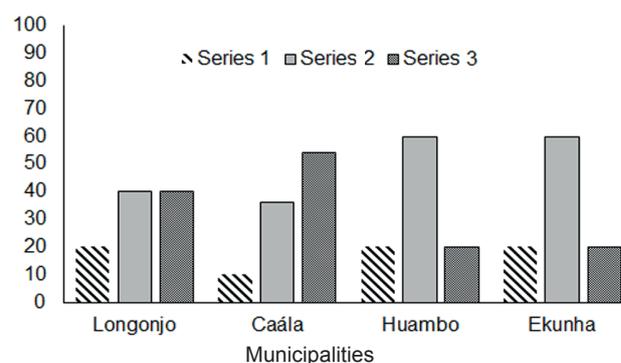
In Cuba, it was reported that spacing decisively influenced high yields. If this is very narrow, potato plants will suffer from competition and the crop can be reduced for the weight of the tubers per plant, while if spacing is wide, yield per area will be lower because though individual plant yields would be high, their quantity would be low. Another author reached high yields with the Desirée variety when used spacings of 70 and 90 cm between rows and 15 cm, 20 cm, 25 cm and 30 cm (20) between plants.

Problems with a bad preservation of the product and the difficulties of mechanization, are the less frequent problems and therefore of the least priority among growers. It can be explained because most growers have mechanisms to preserve the product, mainly that used for seeds.

On the other hand, in spite of the importance of mechanization throughout the productive cycle of potato (from planting to harvest) (21), these regions use a primitive system for maintaining potato plantations because growers have low incomes that keep them from investing in machinery, so it is replaced by cheap manpower. Also important are research works conducted in Brazil, which indicate that most potato growers associate soil mechanization with the intensive removal and in general they show little concern for its preservation (22).

The above statements allow to say that potato growing in Huambo province uses a land preparation system with less soil removal, something positive if it is considered that soil removal associated or with the absence of previous crop wastes, has shown to be inadequate because it produces reduced crop productivity (23).

Cultural practices applied by small growers in this region are totally hand-made, except soil preparation. The state sector of the country perform these operations with semi or totally mechanized approach<sup>c</sup>. The problems previously exposed notably influenced yields. Figure 4 shows potato yields in each municipality. Most of the growers (54 %) reach average yields of 5 t ha<sup>-1</sup>, followed by a 33,5 % that produces an average of 10 t ha<sup>-1</sup> and only 12,5 % have average yields of 3 t ha<sup>-1</sup>.



**Figure 4. Percentage of growers with yields from 3, 5 to 10 t ha<sup>-1</sup> in the different municipalities of Huambo province, Angola**

Low-income growers reach yields from 3 to 5 t ha<sup>-1</sup>, while growers with a high financial status, reach yields from 7 to 10 t ha<sup>-1</sup>. Even these productive results in Huambo, are found below the mean of the whole African continent (10,8 t ha<sup>-1</sup>) and of countries like Egypt, whose growers reach average yields of 24 t ha<sup>-1</sup>, with very well developed production systems<sup>c</sup>.

The highest yields were particularly found in the municipality of Caála in fields of 58 % of the growers. Coincidentally, the growers with the lowest yields are found in this municipality.

<sup>c</sup> FAO. *El mundo de la papa: África - Año Internacional de la Papa 2008* [en línea], *Tesoro Enterrado*, 2008, [Consultado: 29 de agosto de 2015], Disponible en: <<http://www.fao.org/potato-2008/es/mundo/africa.html>>, [Noticias].

According to the results of the applied survey, most growers in the flour municipalities plant potato between 2 ha - 4 ha. Therefore, 80 % of the domestic production comes from growers with faulty production technologies and highly depend on a rain-fed approach (seasonal rains) and the rest 20 % belongs to the managerial system<sup>D</sup>.

From the technological point of view, the results of the applied survey allowed to distinguish some technological inconsistencies notably influencing crop yield in the Huambo province. In this context, it was confirmed that growers lack of knowledge on the different stages of growth and development of the crop which leads to wrong cultural practices like the rate of mineral fertilizers, weed control, phytosanitary control, among others.

In general, it is common among all growers of the province, the use of compound fertilizers 12-24-12 due to their availability and easiness to buy. They apply these compounds without previous soil analysis, without applying techniques to preserve soil fertility, they do not rotate crops and do not associate their plots with other crops.

One of the most common activities in potato growing worldwide is irrigation, since this is a relatively sensitive crop to water deficit (6). However, due to the socio-economic conditions of potato growers in Huambo province, irrigation is not applied to the crop which is indicative of yield dependence to climatic conditions.

From the phytosanitary point of view, 100 % of potato growers assterted that the most frequent fungicides used were Thiodan and Malathion, which are applied from 7 to 10 times per year. However, they declared that when the crop was very much affected by pests, they cut the leaves. In this context, damage intensity by fungal diseases are according to the varieties planted. In general, fungi like *Phytophthora infestans* and *Rhizoctonia solani*, were prevalent in these agroecosystems for whose control intensive agrochemical applications are needed with the consequent effect on human health and environmental contamination (24).

## CONCLUSIONS

Nine problems affecting potato growing in the studied municipalities of Huambo province were identified; the most important and frequent were the use of faulty seed tubers, the non-uniform use of spacing and inadequate cultural practices.

The low yields of potato growing in Huambo province, are influenced by technological inconsistencies and non-compatible deep-rooted conceptions with the techniques usually practiced in agroecosystems from potato-growing countries.

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<sup>D</sup> *Resumo das actividades desenvolvidas durante o período de 2005 a 2010. Programa de Extensão e Desenvolvimento Rural [Relatório anual]*, MINADERP, Luanda, Angola, 2011, 17 p.

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