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# THE CULTIVATION OF CORN (*Zea mays* L.) INSIDE OF THE AGRARIAN SECTOR OF HUAMBO-ANGOLA. PART I. DECISIVE INDICATORS TOWARD STAINABILITY

## El cultivo de maíz (*Zea mays* L.) dentro del sector agrario de Huambo-Angola. Parte I. indicadores determinantes hacia la sostenibilidad

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**ABSTRACT**. The corn (*Zea mays* L.) is the alimentary main sustenance and the economic main line of the inhabitants to the Central Planalto of Angola; however, its productions are insufficient and economically unsustainable. For that reason, with the objective of knowing the corn production situation inside the agrarian sector of the Huambo province, it was carried out during the years 2010-2011 an investigation, starting from the knowledge of their qualitative and quantitative more outstanding indicators, to identify the causes of their limitations. 150 agrarian small producers were interviewed and the state of the social, economic and environmental conditions was analyzed, as well as the agricultural local situation, with emphasis in the knowledge of the variables that determine the state of productivity of the properties and its social repercussion. It could verify that in the rural areas of Huambo, Angola, still persist problems related with the three dimensions of the sustainability, finding a value of General Index (IGS) of 0,42 for corn production and of 0,54 for the three levels (NDAI, II, III); considered very distant indexes of the good values taken as starting point toward the sustainability. The analysis for dimensions of the sustainability showed the superiority of the Levels of Agrarian high and half (NDA II and III), development in the economic and sociocultural, but inferior at the level of development agrarian first low (NDAI) in the environmental dimension.

Key words: food production, indicators, community development, agricultural research

**RESUMEN.** El maíz (*Zea mays* L.) es el principal sustento alimentario y renglón económico de los habitantes del Planalto Central de Angola; sin embargo, sus producciones son insuficientes y económicamente insostenibles. Por ello, con el objetivo de conocer el estado del arte de la producción de maíz dentro del sector agrario de la provincia de Huambo, se llevó a cabo durante los años 2010-2011 una investigación a partir del conocimiento de sus indicadores cualitativos y cuantitativos más relevantes, para identificar las causas de sus limitaciones. Se encuestaron 150 pequeños productores agrarios y se analizó el estado de las condiciones sociales, económicas y medioambientales, así como la situación agropecuaria local, con énfasis en el conocimiento de las variables que determinan el estado de productividad de las fincas y su repercusión social. Se pudo verificar que en las zonas rurales de la provincia de Huambo, Angola, persisten todavía problemas relacionados con las tres dimensiones de la sostenibilidad, encontrando un valor de Índice General de Sostenibilidad (IGS) de 0,42 para la producción de maíz y de 0,54 para los tres niveles (NDAI, II, III); índices considerados muy lejanos de los valores óptimos tomados como punto de partida hacia la sostenibilidad. El análisis por dimensiones de la sostenibilidad mostró la superioridad de los niveles de desarrollo agrario alto y medio (NDA II y III) en lo económico y sociocultural, pero inferior al nivel de desarrollo agrario bajo (NDAI) en la dimensión medioambiental.

*Palabras clave*: producción alimentaria, indicadores, desarrollo de la comunidad, investigación agraria

## INTRODUCTION

Huambo province located in Angola, has a rural population up to 225 268 inhabitants, whose standard of living can be considered below the poverty line (1) and although they produce cassava, some legumes

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such as beans and vegetables, their main livelihood is corn whose yield is estimated at 400 kg $ha^{-1}$ (2) This number is extremely low (3, 4).

The causes of low yields appear to be related to inadequate agronomic crop management; especially the indiscriminate use of selective herbicides and the establishment of dominant species, their handling by the chemical via looks a little inefficient, causing severe damage to the crop (5). However, it does not have previous information indicating true causes of the low productivity of agro-ecosystems, which requires diagnostic studies, very efficient technique for the evaluation of productive systems[A] (6).

The existing poor vision between facilitators and decision makers of the town towards a holistic thinking, based on the need to implement management systems on the basis of a protectionist and efficient agroecological farming, were enough reasons for this research, the main objective has been promoted through multidimensional analysis, state of the art of corn production through sustainability indicators of community agrosystems from Huambo, in Angola.

## MATERIALS AND METHODS

To find out the socioeconomic status of the municipality, in 2010 a general analysis, which identified the problems that might be limiting the sustainability of agro-ecosystems and in particular the production of maize, for which two participatory workshops were held by the method of interviews (10 % of small producers householder)[B] with 50 actors, nine decisores[1] and four local facilitators. The workshops served to show the most significant problems and the state of the maize art production in Huambo, allowing determine the status of the three dimensions of sustainability.

Information (10 indicators with 22 variables, for the production of corn and 12 indicators 50 variables for calculating GIS per dimensions) was processed to meet the General Sustainability Index (GSI) of maize production (7). This estimate includes weighting values between 0 and 10[A] and the relationship between the actual values of the variables (*AVv*) and desired value (*Vmax*). So it holds that: $Vv=\Sigma AVv/Vvmax*Nv$; that is, the value of the variable (*Vv*) is given by Σ of the ratio of the actual value of the variable (*AVv*) on the maximum desired value of the variable (*Vvmax*) by the number of variables (*Nv*). Then the value of the indicator will be Σ, values of each variable on the number of variables, separated by dimensions.

The diagnosis was made by Domain of Recommendations (DR I, II and III), as proposed by CIMMYT[C]. For the less developed Domain (DR I) were chosen two communities, one of the Ngongoinga, "Babayera village" sector and another in Chianga "Village 27". Domain II was performed on farms "Tchissola" and "Almeida", while for the domain III reference was selected the provincial farm "Akadumbo" of 10,000 hectares, where the latest developments in the so-called modern agriculture are applied. The variables were grouped by dimensions to define the level of balance among them.

Domain of Recommendations Criteria I, II and III was adapted to conditions in the Huambo province, according to the agricultural development levels (ADL, I, II and III), according to predetermined criteria of the Directorate of Local Agriculture.

For data analysis, the data obtained are tabulated in a Microsoft base (8) It is allowing the calculation of the General Sustainability Index (GSI) expressed by the formula $GSI = \Sigma AVi/Vmax.Ni$; *AVi* being the actual value of the indicator, *Vmax*, the desired value of the indicator and *Ni* is the number of indicators.

## RESULTS AND DISCUSSION

### Situation of agriculture in Huambo. Results of the General Diagnosis

The data provided through diagnosis indicated that in rural areas are still problems related to the three main dimensions of sustainability; ie, the ecological economic dimension, and sociocultural. In particular, the sociocultural dimension was insufficient in its main indicators: food, health and education; In addition to problems related to access to basic services of water and electricity, which affect mostly women, since for traditional and unjust cultural concepts, they are working more and therefore gender equality distances surprisingly (Photo 1).

[A] Lores, A. P. Propuesta metodológica para el desarrollo sostenible de agroecosistemas. Contribución al estudio de la agrobiodiversidad. Estudio de casos. Comunidad Zaragoza. [Tesis de Doctorado]. La Habana. Cuba. INCA-CUG-FAM. 2009. 100 pp.

[B] Toledo, E. T. La cosecha en verde y conservación *in situ* de los residuos de la caña de azúcar (*Saccharum* spp.). Impacto en la sostenibilidad y restauración del agroecosistema en Huixtla, México. [Tesis de Doctorado]. Instituto Nacional de Ciencias Agrícolas. La Habana. Cuba. 2008. 100 pp.

[1] Algunos de los decisores entrevistados: i) Director del Instituto de Desarrollo Agrario; ii) Directora del Ministerio de la Familia de Promoción de la mujer; iii) Seis Gerentes de los bancos de la provincia de Huambo; iv) Coordinadora del proyecto de microcrédito de la ONG "Acción para el Desarrollo Rural de Angola (ADRA)".

[C] CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo). Planificación de Tecnología apropiada para los agricultores, conceptos y procedimientos. México. Ed. CIMMYT. 1988. 71 pp.

**Photo 1. The daily struggle of rural women in Huambo city**

Producers are economically dependent of maize, whose productivity is limited by the use of a high-input technology, imposed without unsupported resources for its successful realization from the economic point of view. Apparently the critical problem limiting their development is the lack of water, but it does not raise awareness as a fundamental problem within the framework of a lacking social development, which is reflected in the lack of technological resources to ensure the water that required food production and the total absence of initiatives to take it. For these conditions, the limited perception of the concept "quality of life" of illiterate farmer obscures the limiting factors of development progress, turning the habits and needs in customs and natural part of good living[D].

The environmental dimension is underserved, to the point that is fully aware of the new alternatives to make agriculture more harmonious with the environment. Excessive use of herbicides caused the dominance of a kind of weed, highly aggressive (Photo 2), named by local farmers "Longueso or Tchinguesso" being its scientific name (*Cyperus rotundus* L.); moreover, it impressed by the fact that farmers discount the possibility of reaching crops without mineral fertilizer. This concept does not exempt from arguments within a limited vision that prevents looking at the existence of alternatives such as bio-fertilizers, organic and green manures as a means of soil improvement (5).

**Photo 2. The weed *Cyperus rotundus* L. (Longueso o Tchinguesso), dominant in Ngongoinga**

## Determination of the General Sustainability Index (GSI)

The value of General Sustainability Index (GSI), which represents the degree of approach to sustainability was determined (Figure 1).

Depending on the Agrarian Development level (ADL) of the farmers and whose total corresponds to 97 % for small producers (ADL I), the results of the general analysis conducted, showed that the degree of approach to sustainability was 0,49.

[D] Leyva, A. Maestría de Agroecología y Agricultura Sostenible. Taller Sociocultural. IALA. Barinas, Venezuela. 2013.

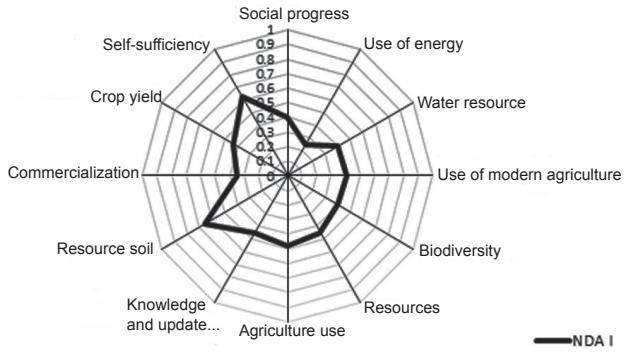


**Figure 1. Behavior of indicators that reflect the General Sustainability Index (GSI) of maize (Zea Mays) among farmers with lower economic potential**

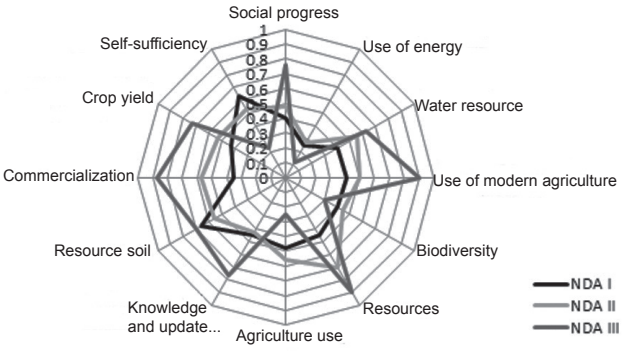


**Figure 2. Behavior of indicators that reflect the General Sustainability Index (GSI) in Agrarian Development Levels I, II, III G**

In general, variables of the selected indicators show unsustainability, which allows focusing the solution from the agroecological perspective, making greater use of the resources of agroecosystem, starting point to undertake agriculture based on agroecological principles (9).

Moreover, the limited knowledge and resources of the farmers that have led agriculture from a productivity perspective using the style of high-input agriculture have failed to convert their properties into unbalanced spaces with little biodiversity and weed dominance with high ecological plasticity, whose handling becomes increasingly difficult.

The practice of the modern agriculture principles among small farmers has caused environmental degradation in most countries that have followed such a policy, as a basis for national development (10).

The results show that Huambo is based on agricultural and livestock production, aimed at self-supply, with deficit of objective conditions to produce a high economic leap in short time, as it had already been proposed (11).

ADL II and ADL III for middle- and high producers respectively, representing a small part of producers in Huambo (3 %) show inequality among them to the indicators (i) biodiversity and (Ii) self-supply. It is true that the standard of living for ADL III improved, compared to the other two levels; however, it is insufficient to achieve desired values for basic indicators (Figure 2).

This result shows that the solution to these problems that determine the sustainability of maize production in Huambo should not be based solely on the high-input agriculture principles and therefore promote agroecological indicators as agrobiodiversity can help simultaneously strengthening of other indicators such as non-conventional energy expenditure, self-supply and improve soil properties (9, 12, 13).

## Agricultural development levels by Dimensions

To expose the differences among levels of development, the importance of variables that define dimensions and that relate to the management system (14) was assessed. Analysis of Agricultural Development Level by dimensions (*ADLd*) ie sociocultural, economic and environmental for small producers (ADL I); average (ADL II) and high (ADL III) can be seen in Table I.

Clearly, the ADL corresponding to the lower economic potential farmers (ADL I) and they have made use of modern agricultural technologies without their consequences, is the one with the lowest rate, contrary to what happens for ADL III, the more economically developed. However, analysis by dimensions provides another reading, showing that superiority only two dimensions (economic, social and cultural), while the environmental dimension showed severe damages, thus warning of the serious consequences it imposes on agrosystems this production model. This is a highly compelling reason to direct scientific efforts towards greater use of agroecological principles advocated by the holistic functioning of productive areas, on the way to the gradual restoration of agroecosystems that have been damaged[B]. The need to raise productivity levels of individual systems from the agroecological perspective, as a present mitigating, in favor of social requirements imposed by modernity is also demonstrated.

The General Sustainability Index (GSI) for maize production reached a value of 0,42 still far from being accepted (7), whereas 0,6 is assumed as the next value to sustainability. The values of indicators with their variables by dimensions are shown in Table II.

**Table I. General Sustainability Index values (GSI) and its dimensions ($GSI_d$)**

| GSI | Agricultural development level for the corn production | | |
|---|---|---|---|
| GSId (I, II, III) | Social dimension | Economic dimension | Environmental dimension |
| Values of GSI per dimensions | 0,43 | 0,37 | 0,45 |
| GSI total ∑n d/n | | 0,42 | |

**Table II. General Sustainability Index of the maize production**

| GSI | $NDA_I$ | | | $NDA_{II}$ | | | | $NDA_{III}$ | |
|---|---|---|---|---|---|---|---|---|---|
| $GSI_{d\ (I\text{-}III)}$ | $DS_1$ | $DE_I$ | $DM_1$ | $DS_{II}$ | $DE_{II}$ | $DM_{II}$ | $DS_{III}$ | $DE_{III}$ | $DM_{III}$ |
| Values of GSI per dimensions | 0,42 | 0,41 | 0,64 | 0,45 | 0,60 | 0,56 | 0,54 | 0,83 | 0,41 |
| Total values of $GSI_{d\ (1\text{-}III)}$ | | 0,49 | | | 0,53 | | | 0,59 | |
| $GSI_{total}$ ∑n ADL/n | | | | | 0,54 | | | | |
| SD Social Dimension ED Economic Dimension END Environmental Dimension | | | | | | | | | |

Within the sociocultural dimension, the lack of initiatives to transform the existing level of poverty is a constraint, which is closely related to the dominant cultural levels in rural communities. Poor knowledge of the environmental dimension importance, as a basic principle of agroecology, is one of the main constraints for optimum GSI. On the other hand, the economic dimension is affected by the limited availability of water and it was found that the spatial arrangements do not provide high population density, limiting yields and promotes the proliferation of weeds.

## GENERAL CONSIDERATIONS

Although government agencies advocate the mitigation of existing adversities, in order to promote the living conditions of Angolans, demonstrated through this research in rural areas persist limiting problems of sustainability, where the cultivation of corn has not reached desired levels of productivity. These results indicate the need to transform the agrarian thought in correspondence with which advocates globally to take agroecology as science can solve currently problems facing rural areas (6, 15). To achieve this, it will be necessary to establish training programs and permanent updating for decision makers, facilitators and local farmers.

It is necessary to implement programs that consider the trilogy soil-plant-animal as a postponed start toward increasing livestock production (16) and consequently the options of diversity in supply for the farmers and their families[E] (17). Simultaneously it will be imperative to incorporate new own local alternatives to help the productivity of maize and its predecessors and successors crops. Food diet is limited to a range that does not exceed the 10 crops, this figure represents the tenth part of that found in Cuba[F], territory of Mayabeque and represents the nineteenth part of that found in Philippines[G].

Imbalances among agroecosystems and the presence of difficult management weeds are perceived, suggesting modifications to the weed management methods. These findings invite to transform the agrarian thought in correspondence with which it advocates worldwide and assumes agroecology as science can solve the problems currently faced by rural tropics as a possible beneficial solution (18, 19) .

A vital element to consider is that farmers do not attribute the importance of biodiversity in the agroecosystem and they are not prioritized indicators in the local thinking. To achieve this, it will be necessary to establish training programs and permanent updating for decision makers, facilitators and local actors, which also includes the diversity of plants with different smells and colors in the community setting and housing of farmers.

## CONCLUSIONS

- The cultivation of maize in Huambo, Angola has not reached the desired levels of productivity and general sustainability index (GSI) showed the existence of unsustainability.
- Agroecosystems from Huambo, Angola are out of balance, resulting from the use of inappropriate high-input technology, which has led to the dominance of the species *Cyperus rotundus* (L.) of high ecological plasticity and resistant to herbicides commonly used in the corn crop.

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- The use of new indicators to show the efficiency of the maize productivity in Huambo, Angola, it is a necessity, as a way of facilitating mentality changes among local decision makers towards a more harmonious and sustainable production from an agroecological vision.

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