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The economic impact of Research and Extension on the improved cowpea varieties in Burkina-Faso

Souleymane Ouedrago
Agricultural Economist, l'INERA/GRN-SP,
CREAF de Kamboinsé, 01 BP. 476, Ouagadougou 01

Arahama Traore
Environment Economist, INERA/GRN-SP,
CREAF de Kamboinsé, 01 BP. 476, Ouagadougou 01

Isabelle W.P. Dabire
Attaché de Recherche, Environment Economist,
INERA/GRN-SP, CREAF de Kamboinsé, 01 BP. 476, Ouagadougou 01

Amos Koudougou
Ingénieur de recherche à l'INERA INERA/GRN-SP,
CREAF de Kamboinsé, 01 BP. 476, Ouagadougou 01

Boukari Sawagogo
Ingénieur de recherche à l'INERA INERA/GRN-SP,
CREAF de Kamboinsé, 01 BP. 476, Ouagadougou 01

ABSTRACT

This study aims to assess the economic impact of research and extension as for improved cowpea varieties in Burkina Faso. Indeed, the effectiveness of the use of financial resources allocated to research and extension is a concern for donors and governments of different countries. The economic surplus model was used as an analytical tool for this study. Thus, data were collected from research, extension and statistical data production structures. This method evaluates the impacts in terms of shift of the supply curves. The results of the model show that it is benefitting to invest in cowpea research. In fact, in this study, the internal return rate is about 48% for the period ranging from 2000 to 2013, with a net added value of more than 121 billion FCFA. Such high rates could only be achieved through the relevance of the research results and their dissemination / adoption. Therefore, for a development of the cowpea sector and an improvement of producers 'income, the investment in the research is essential.

Key words: impact, cowpea, economic surplus, extension, research, Burkina Faso.

INTRODUCTION

The green revolution has permitted the decrease in real cereal prices in international and national markets, reduction in food aid dependence, and increase in employment and income through an economic growth induced by agriculture (FAO, 1996). These achievements are the result of intense research efforts which impact on the poor in developing countries is proved.

However, in the future, achieving food security, fighting against poverty and economic and social development may be compromised to the extent that the funds available for research

become increasingly scarce. As a result, research must efficiently use the resources allocated to it. It is only in this way that it can remain attractive to continue to benefit from state and donor support.

In this context, the analysis of research and extension impact is necessary to enable decision-makers and other stakeholders to better understand the benefits of the investments made.

The overall objective of agricultural research on cowpea in Burkina Faso is to contribute to the increase of production with a view to achieving food self-sufficiency by modernizing and intensifying its production. Given the low productivity of local varieties, research on cowpea began in the 1970s. It has first identified high yielding varieties adapted to the different agro-climatic conditions of the country and subsequently developed better varieties with appropriate technological packages.

The objective of this study is to show the important role that agricultural research plays in the fight against poverty and therefore the need to invest even more in this research. To do this, the article aims to assess the impact of new varieties of cowpea in improving the economic well-being of producers and consumers in Burkina Faso.

This will involve an ex-post assessment of research and extension programs for improved cowpea varieties using the economic surplus model.

CONCEPTUAL FRAMEWORK AND METHODOLOGY

The conceptual framework of the economic surplus model

The economic surplus model measures aggregate social benefits. With this method, it is possible to estimate the investment return rate by calculating the change in consumer surplus and producer surplus through technological change. It is used with research costs to calculate the net present value (NPV), the internal return rate or the benefit/cost ratio (BCR) (Maredia & al., 2000). This model has often been used (Ahmed et al., 1991, Masters & Sanders, 1994) to determine research investments return and extension of new technologies.

The economic surplus consists of two components: the consumer surplus and the producer surplus. The consumer's surplus is the difference between the price that the consumer would be willing to pay for each additional unit up to the total quantity purchased and the price he pays for each unit of a good on the market.

By similarity, the producer's surplus is the difference between the price at which he is willing to sell each additional unit of the product up to the total quantity sold and the price at which he sells his product on the market.

The sum of consumer and producer surplus is the economic surplus. It can be defined as the amount of money the consumer would have paid for each unit consumed minus the amount of money that the producer would have sold for each unit produced before reaching the balance point between price and quantity on the market (Masters & Sanders, 1996). Any change in the economic surplus is a measure of the social benefits derived from research.

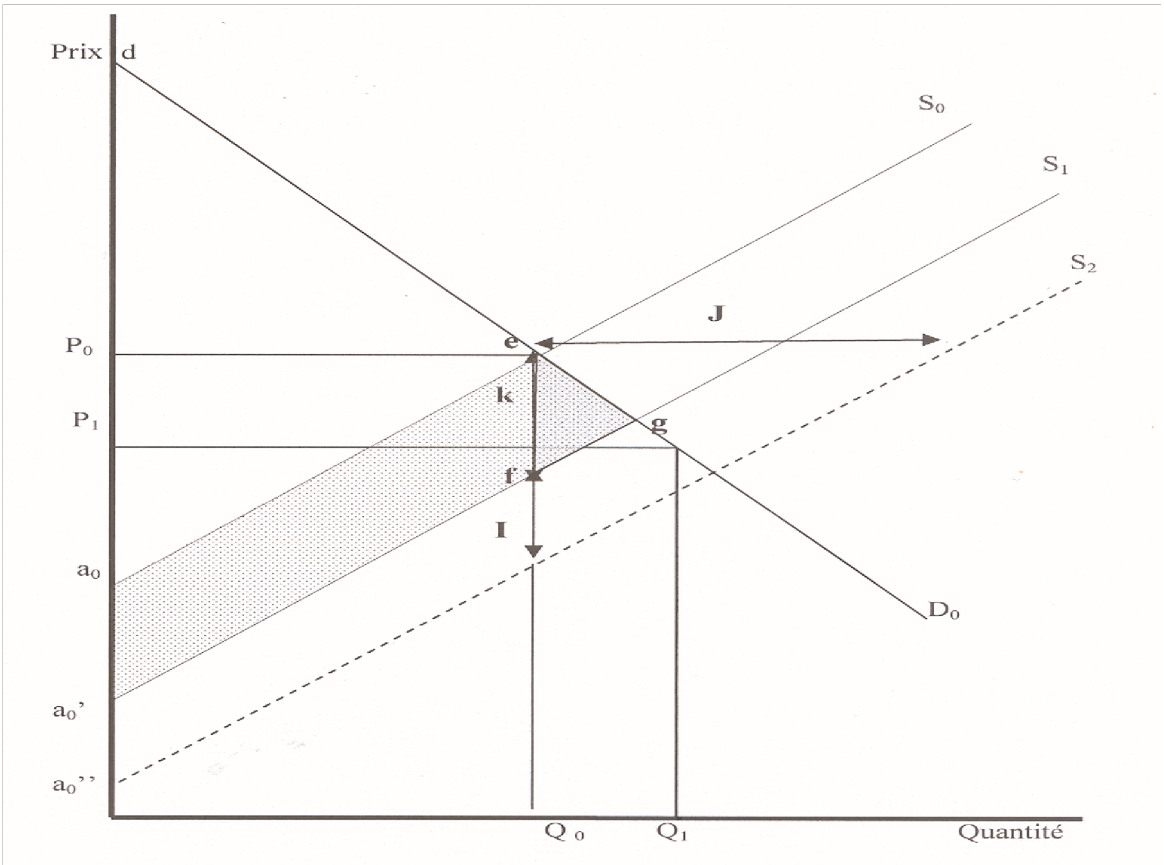

Figure 1. The economic surplus model

The essence of the economic surplus concept in agricultural research impact assessment is that the adoption of improved technology permits to produce at a lower cost or produce more at the same cost as with traditional technologies. It therefore reduces production costs per unit of product, which translates into a shift in the supply curve. This shift may be pivotal at the origin (Akino & Hayami, 1975) or parallel (Masters & Sanders, 1994). The total profit or gain resulting from this shift is measured by the total sum of changes in producer and consumer surplus. This method does the balance sheet of the costs and benefits of the "Research and Extension" investment.

Our work will assume a parallel shift in the supply curve. It postulates that the adoption of an innovation causes a parallel shift in the supply curve from [a0S0] to [a0''S2] (distance J) along the same demand line (D0) (figure 1). Distance J measures the increase in production due to technology.

This adoption requires an additional investment in inputs (seeds, fertilizers, phytosanitary products) represented in Figure 1 by the distance I. Considering J and I permits to obtain the net shift in the supply curve from [a0S0] to [a0'S1] (distance K) which is the net profit in terms of production costs reduction. With this shift in the supply curve along the same demand line D0, the social situation changes. This change is measured in terms of changes in the "economic surplus" which is a measure of wellbeing. Therefore, at the initial market price P0, the consumer surplus is equal to the area of the triangle P0 d e of Figure 1 and the producer surplus to the area of the triangle P0 e a0 of Figure 1.

The total net change in economic surplus caused by a change in the supply is represented by the parallelogram a0 e f a0' (in light gray in Figure 1) and the triangle e f g (in dark gray in

Figure 1). The sum of these areas represents the total ex-post increase in social profits (consumers and producers combined).

To calculate the economic surplus is therefore to find the surfaces of the triangle and the parallelogram (Masters & Sanders, 1994).

The surface of the parallelogram is equal to e f * Q0;
The distance [e f] = k represents the net profit in terms of production cost reduction induced by the new technology. This distance is measured by the relation k*P0 = (j/E0)- c where k is the change in the net cost of production as a proportion of the product price, P is the actual producer price, j is the proportional change in total production due to improved varieties, E0 the elasticity of the supply and c the proportional cost of adopting improved varieties;

The surface of the parallelogram is therefore equal to: k*p0*Q0; with Q0, the produced quantity of the product.

The surface of the triangle is obtained by the formula 1/2ef * ΔQ = 1/2k*p0*ΔQ. ΔQ being the difference between the quantities produced with the improved varieties and the traditional varieties (ΔQ = Q – Q0).

ΔQ = Q0 * E0*Ed * k/ (E0+Ed). (Ed being the elasticity of demand and E0 that of supply).

The Gross Social Gain (GSB) is therefore given by the formula:
GSB = k*p0*Q0 - 1/2k*p0*ΔQ
GSB = k*p0*Q0 * (1 - 1/2(k E0*Ed)/ (E0+Ed)).

Data collection methodology
Estimating social gains and investment return rate in cowpea research and extension requires lot of data. These include: cowpea production and surface area, yields of improved varieties and traditional varieties of cowpea, new technologies adoption costs, extension costs and research costs, cowpea producers prices, price indices and elasticities of supply and demand.

The basic data (area, production and yield) were collected from the Agricultural Statistics Yearbooks of the General Directorate of Sectoral Statistics and Studies (DGESS) of the Ministry of Agriculture, the Institute of Environment and Agricultural Research (INERA), the National Seed Service (SNS), the General Directorate of Plant Productions (DGPV), the National Society of Security Stock Management (SONAGESS), the National Seed Service (SNS), Regional Directorates of Agriculture and Hydraulic Facilities (DRAAH) and the Regional Center for Environmental and Agricultural Research and Kamboinsin Training (CREAF / K).

Field surveys were conducted at the level of 4 regions (3 villages per region) of the country to determine adoption rates of improved varieties in the farmer's environment. In each village, an average of 50 producers were surveyed.

Some data that was not available were estimated; this is the case of the total area planted with improved cowpea varieties, the adoption rate of improved varieties, and the costs of research and extension of cowpea.

For the research cost estimate, we have assumed that 2/3 of the overall costs of the protein crop program of INERA's plant production department are devoted to research on cowpea. These costs include capital costs, maintenance of equipment, operating costs and salaries

(researchers and technicians) paid from the national budget. The investment for cowpea research is related among others to the development of experimental fields, the acquisition of specific materials for research.

The cost of extension consists of the amounts borne by the State for the acquisition of improved seeds for the benefit of producers, the financing of the cowpea sector through the "guichet privé" of the Regional Fund for Decentralized Rural Development (FR-DRD). The "Decentralized Rural Development" (DRD) Component of Burkina Faso's Agricultural Development Support Program (PADAB 2) (direct funding to stakeholders from 2007 to 2012) and funding of cowpea micro-projects of the PROFIL project.

Price data were collected from the National Society for Food Security Stocks Management (SONAGESS) and the National Institute of Statistics and Demography (INSD). These are producer prices, consumer price indices, and supply and demand flexibility. Inflation is considered by dividing observed costs (research, cowpea extension costs, cowpea price and additional adoption costs) by a consumer price index, so that costs are expressed in constant terms for each year considered. The harmonized price index therefore transforms the nominal values into net values. This index is defined as 1 for the given 2013 base year in this study.

The supply elasticity (ε), defined as the proportional change in the quantity produced, induced by the corresponding 1% price variation; it reflects the relative difficulty of producers in increasing production (limited resources available). Normally, the estimated values of the supply elasticity are between 0.2 and 1.2.

The demand elasticity (e), defined as the proportional change in the quantity consumed, induced by a 1% change in price, reflects the relative preference of consumers for an increase in consumption. Normally, demand elasticity estimates range from 0.4 to 10 (Masters & al., 2003).

In the absence of information on the elasticities specific to Burkina Faso, those used for the sub-region of Sub-Saharan Africa were considered. They are 0.8 for supply and 0.4 for demand (Allawangaye & al, 2001). In other words, a price increase of 1% results in an increase in supply of 0.8% and a reduction in the quantity demand of 0.4%.

MODEL PARAMETERS

Adoption rate of improved varieties

The adoption rate is the ratio of the area cultivated in improved cowpea varieties on the total area of cowpea. As the areas planted with improved varieties are not available in agricultural statistics, an estimate was made of the seed quantities of the improved varieties distributed (VA) and the quantity needed to sow one hectare (D = 20 kg / ha). VAn / D gives the approximate area of "new fields" covered by improved varieties in year n. The total area in improved variety of the year n is the sum of VAn-2 / D + VAn-1 / D + VAn / D as the adopters of the year n-2 renew their seed every two years. A farmer who adopts the improved variety of cowpea in 2000, will take from his production for sowing in 2001 and 2002.

The agronomic potential of the improved seed diminishing after two years of successive use, it is in year n + 3 that it will renew its seed. This estimate gives an average rate of 56% over the period 2000-2013 (Table 1), a relatively high rate compared to that of 40% obtained based on primary data collected from 603 producers in 2014.

Moreover, the adoption rate of improved varieties is not always increasing over the years, as logic would suggest through policies, projects and programs to promote improved varieties. In fact, the production of improved seeds does not follow a linear growth but rather a stepwise evolution. In addition, it is difficult to know precisely the use rate of improved seeds due to user ignorance of varieties, systematic non-renewal of seeds and the traditional system of seed diffusion from one producer to another. (Almekinders et al., 1994). Finally, the formula for estimating the adoption rate is often a problem.

As the area under improved variety is difficult to assess, the evaluators proceed by estimation and extrapolation. For simplicity, the coverage rate (ratio of the estimated covered area in improved variety to the total area) is used instead of the adoption rate. To support the hypothesis of fluctuation of the adoption rate a brief review of the literature shows that already in 2005, 62% of local producers of Pobé-Mengao, Bougué (Soum), Bik-Baskouré (Kouritenga), Donsin (Oubritenga), Ziga (Yatenga) had adopted the improved varieties of cowpea. Compaoré et al. (2008) showed that these localities are home to INERA's demonstration tests on cowpea and all benefited from the training of leading producers throughout the cowpea production cycle (from seed to seed).

On the other hand (Brocke, 2008) gives a rate of 10% for cowpea, although various projects have helped to familiarize the producers with the genetic material of the research. Holtzman & al., (2013) indicated that 13.5% of the 2010 area of cowpea was covered with improved seed. Overall, the use rate of improved seeds is very low in Burkina Faso, ie 6.1% in 2007 (MAHRH, 2010). Depending on the size of the area, maize was 40.6%. Peanut 0.5%, cowpea 51.3%, sesame 91.4%, rice 12.9% and soybean 49.6% (CEDRES, 2011).

Table1: Adoption rate of improved varieties

Year	Area (ha) [S]	Quantity of improved seeds produced (kg)	Seed application dose (kg/ha)	New area in improved variety per year	Real area in improved variety	Adoption Rate (%)
2000	48 707	25 925	20	1 296		56
2001	47 224	37 800	20	1 890		56
2002	50 191	14 050	20	703		56
2003	33 790	276 050	20	13 803	16 395	49
2004	42 427	110 100	20	5 505	20 010	47
2005	64 154	361 410	20	18 071	37 378	58
2006	62 647	482 290	20	24 115	47 690	76
2007	77 453	530 000	20	26 500	68 685	89
2008	119 492	280 000	20	14 000	64 615	54
2009	114 013	924 600	20	46 230	86 730	76
2010	121 404	103 720	20	5 186	65 416	54
2011	99 368	301 040	20	15 052	66 468	67
2012	133 522	226 000	20	11 300	31 538	24
2013	167 196	241 000	20	12 050	38 402	23
Average rate over the period						56

Yields gains

The yields of traditional varieties are in the order of 200 to 400 kg / ha. The adoption of improved varieties provides net gains in yields ranging from 0 to over 1570 kg per hectare. The adoption of the variety IT99K-573-2-2 (Yiisyande) generates the highest production gain,

more than 100%. Indeed, improved varieties have high agronomic potential (Palé et al., 2009). They are more adapted to changing agro-climatic conditions than local varieties.

Adoption cost of the improved seeds

The costs of adopting new technologies are the difference between production costs with and without research (production costs under improved variety minus production costs under traditional variety). In making the decision to adopt the new cowpea variety, the producer faces a slightly higher production cost than usual (use of the traditional variety). It will support the cost of acquiring seed, fertilizer (increasing), phytosanitary products and hired labor (increasing due to the use of fertilizers and application of insecticides). Indeed, these seeds are accompanied by a technological package (technical itinerary, technical sheet) to best express their potential.

The study by (Ouedraogo, 2003) shows that the adoption of improved varieties leads to an increase in production and labor costs of 3.7% on average in the areas studied, totaling a net increase of 23 400 FCFA per hectare planted in improved cowpea variety. However, the gains provided by these can largely offset these costs (increase in gross margin per hectare of more than 101%).

Research and extension costs

Very high from 2000 to 2013 (Table 2) research cost dropped from 2004 before experiencing a further increase from 2008 to 2011. These increases result from the intervention of some projects in the financing of agricultural research. In fact, the 2000-2003 period corresponds to the National Program for the Development of the Agricultural Sector (PNDSA II) financed by the World Bank.

Following the end of PNDSA II in 2004, public expenditure on agricultural R & D fell until 2007, followed by a recovery period starting in 2008 (SP / CPSA, 2013). This recovery is attributable to the project Alliance for the Green Revolution in Africa (AGRA), which has injected a lot of money into cowpea research. Since 2004, most research funding has come from bilateral and multilateral partnerships,

The analysis of table 1 below shows a change in the cost of extension from one year to the next. These costs range from 4,875,000 FCFA to 662,454,403 FCFA. The largest amount is observed in 2009, the year of implementation of the State's policy of improved seed distribution.

Table 2: Research and extension cost (in thousands of francs CFA)

Year	IPC (Base:2013=100)	Nominal cost of research (FCFA)	Nominal cost of extension (FCFA)	Total nominal cost (FCFA)	Total real cost (FCFA)
2000	70,94	807 431	8 725	816 156	1 150 408
2001	74,40	807 431	20 300	827 731	1 112 471
2002	76,12	807 431	4 875	812 306	1 067 194
2003	77,66	807 431	9 475	816 906	1 051 901
2004	77,35	55 1701	50 625	105 796	136 770
2005	82,31	48 769	120 469	169 239	205 611
2006	84,25	42 658	307 335	349 992	415 401
2007	84,04	32 102	107 694	139 797	166 345
2008	93,01	142 914	275 694	418 608	450 088
2009	93,81	183 026	662 454	845 481	901 310
2010	93,24	192 143	169 926	362 070	388 327
2011	95,81	230 545	438 366	668 912	698 130
2012	99,48	189 614	412 338	601 951	605 103
2013	100	59 342	84 869	144 211	144 211

RESULTS AND DISCUSSIONS

Social Gains of research and extension for the improved cowpea varieties in Burkina Faso

This is the net profit to the society from the dissemination / adoption of the new cowpea varieties. This gain is the difference between the gross social gain (GSB) and the costs of research and extension of the improved varieties of cowpea. Where: GSN = GSB - total net costs (research and extension)

Table 3 shows that from 2000 to 2005, the net social gain is negative, indicating that during this period the research did not provide any benefit. Indeed, these years correspond to the period of research in laboratories to lead to improved varieties. As a result, there is no transfer in farmer environment at this time. From 2006 onwards, varieties are obtained and transferred to farmers, so that the net social gain is positive. As price volatility and investment in research and extension are not stable, social gains also vary by year.

Table 3: Social gain of research and extension for improved cowpea varieties from 2000 to 2013 (millions of francs CFA)

Year	Gross social gains (GSB) GSB=kPQ-0,5*kPΔQ	Total real cost (FCFA)	Net social gains
2000		1 150	- 1 150
2001		1 112	- 1 112
2002		1 067	- 1 067
2003		1 052	- 1 052
2004		137	- 137
2005		206	- 206
2006	30 159	415	29 744
2007	38 516	166	38 349
2008	67 156	450	66 706
2009	21 604	901	20 703
2010	90 602	388	90 213
2011	80 465	698	79 766
2012	143 039	605	142 434
2013	92 539	144	92 395

Indicators of economic return

The Net Present Value (NPV)

The NPV measures the excess of profits over the costs of a project when these are valued on the basis of a given interest rate.

NPV at 10% being equal to 121,474,242,059 FCFA representing the net profit generated by the adoption of improved varieties for the period 2000 to 2013.

The Internal Return Rate (IRR)

Our study revealed that the calculated internal return rate (IRR) is 48%. This rate represents the interest that came from the resources invested in the research and extension of cowpea in Burkina Faso from 2000 to 2013. This means that 100 FCFA invested in the research and extension activities of the cowpea yielded 48 FCFA of net profit, showing that investing in research on this crop is very profitable.

Sensitivity analysis

It aims to assess the impact of certain variables on the model's results, in particular the variables that affect the return rate and the NPV by simulations. Three scenarios have been tested (Table 4).:

Scenario 1: Underestimation of research and extension costs

If the costs of research and extension have been underestimated, a cost increase of 30% results in a decrease in IRR of 3%. A cost increase of 50% results in a reduction of the IRR of 4% while a 100% increase in costs reduces the IRR by 7%.

These simulations show that even in the pessimistic underestimation of costs, the IRR remains high, reflecting the profitability of investments in cowpea research.

Scenario 2: A rise in the interest rate

Assuming a rise in the bank interest rate (high credit), the NPV shows a significant variation: an interest rate of 20% results in a fall in the NPV of 119,948,017,344 to 37%. 359,604,259 or a fall of more than 68%. A rate of 40% gives a NPV of 2,578,718,973, a drastic decrease of more than 97%. This is to say that when the cost of credit is very high, investment in research and extension of improved cowpea varieties yields net profits less and less important for the whole society. Indeed, credit being expensive, farmers cannot go into debt for the adoption of new technologies.

Scenario 3: An increase in yield gain

Assuming an increase in the yield gain of 10%, the IRR gains four points more, it would be 52%. It is the same for the NPV which increases by 3%. The yield gain of improved varieties is a parameter that positively impacts both IRR and NPV. It is therefore the "key" element on which research must operate to increase IRR and NPV and achieve food security while increasing the overall well-being of the entire nation.

Table 4: Sensitivity of the return rate compared to research and extension cost

An increase of costs at :	30%	50%	100%
Internal Return Rate (IRR)	45%	44%	41%
Net Present Value (NPV) at 10%	119 948 017 344	118 930 534 200	116 386 826 341

CONCLUSION

The results of this study show that investments made in research and extension on the improved cowpea varieties are benefit and have a real impact on production. In fact, the yield has considerably increased since the beginning of the agronomic research on cowpea. The adoption of new technologies has facilitated the evolution of production systems towards more sustainable farming systems capable of generating surplus production for the market.

These investments have produced an internal return rate of 48% and net profits of over 121 billion CFA francs for the society between 2000 and 2013, with a positive impact on the well-being of the entire population. Investments made have been more than benefit and will continue to be highly benefit for the society for solving food insecurity and poverty issues. It is therefore necessary to continue to invest in creation/adoption of new varieties.

These results make it possible to say that seeds of improved varieties not only correspond to the needs of producers but are also adapted to their socio-economic conditions.

Support to agricultural research on cowpea should continue in order to consolidate the results achieved and address new challenges. In fact, this considerable and constant increase of yields and areas will require a consulted effort from research to continue the development of adapted and improved varieties and production techniques.

BIBLIOGRAPHY REFERENCE

Ahmed, M., Sanders, & J.H.L. (1991). The Economies impacts of Hageen Dura-I in the Gezira scheme, Sudan 'in' proceedings, international sorghum and millet. *CRSP Conference, Corpus christi,TX.INTSORMIL publication 92-1.* Nebraska: University of Nebraska.

Akino, M., & Hayami, T. (1975). Efficiency and equity in public research : rice hreeding in Japan'S economie development. *American Journal of economie development.*, pp. 1-10.

Allawangaye, M., & al. (2001). *Analyse economique de l'impact de la recherche sur le riz au Tchad.P22.* Ndjamena: Institut tchadien de recherche agronomique pour le developpement.

Almekinders, C., & al., &. (1994). Local seed systems and their importance for an improved seed supply in developing countries. *Euphytica*, pp. 207-216.

Brocke, V. (2008). *Rapport des activités en coopération sur l'amélioration variétale du sorgho au Burkina Faso 2005-2008 P.52.* Ouagadougou: INERA, CIRAD.

CEDRES. (2011). Burkina Faso: cinquante ans de politique economique. *Actes de la SEDECO 2011.* Ouagadougou: CEDRES.

Compaore, M., Naon, F., Yamanaka, & K. (2008). *Etude de la situation actuelle sur la production et l'utilisation des semences améliorées dans les provinces de l'Oubritenga, du Passoré, du Séno, du Houet et du Boulgou du Burkina Faso.PNDSA, JICA. 101 p.* Ouagadougou: JICA.

FAO. (1996). *Rôle de la recherche dans la sécurité alimentaire mondiale et le développement agricole 96/Tech/12 WFS version provisoire.* Rome: FAO.

Holtzman, J., & al. (2013). *Burkina Faso: Iindicateur de l'Agro-business P.161.* Washington: World Bank.

MAHRH. (2010). *Diagnostic du secteur semencier du Burkina Faso.* Ouagadougou: MAHRH.

Masters, W. A., & al. (2003). *L'Impact Economique de la Recherche Agricole: un guide pratique. Document de travail.* West Lafayette,: Purdue University.

Masters, W., & Sanders, J. (1994). *Impact économique de la recherche agricole. Institut du Sahel.* Bamako, Mali.

Masters, W., & Sanders, J. (1996). *Monitoring, evaluation and policy implication of agricultural research: lesson from purdue's Africa projects.* West Lafayette, Indiana: Purdue University, 95-112.

Ouedraogo, S. (2003). Impact économique des variétés améliorées du niébé sur les revenus des exploitations agricoles du plateau central du Burkina Faso. *Tropicultura*, pp. 204-210.

SP/CPSA. (2013). *Revue diagnostique des dépenses publiques de base dans le secteur agricole (2004-2012).* Ouagadougou, Burkina Faso: Ministère de l'Agriculture de l'Hydraulique et des Aménagements Hydrauliques.