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# Socio-Economic Analysis of Promising Innovations in Benin


**Adegbola Ygué Patrice, Ahoyo Adjovi Nestor René, Houedjofonon Elysée and Mensah Serge Egide Paulin**


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**Corresponding Author**
Dr Ir. Adegbola Ygué Patrice (patrice.adegbola@yahoo.fr)



**Forum for Agricultural Research in Africa (FARA)**
12 Anmeda Street, Roman Ridge PMB CT 173, Accra, Ghana Tel: +233 302 772823 / 302 779421 Fax: +233 302 773676 Email: info@faraafrica.org Website: www.faraafrica.org

**Editorials**
Dr. Fatunbi A.O (ofatunbi@faraafrica.org); Dr. Abdulrazak Ibrahim (aibrahim@faraafrica.org ), Dr. Augustin Kouevi(akouevi@faraafrica.org ) and Mr. Benjamin Abugri(babugri@faraafrica.org)

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### About FARA

The Forum for Agricultural Research in Africa (FARA) is the apex continental organisation responsible for coordinating and advocating for agricultural research-for-development. (AR4D). It serves as the entry point for agricultural research initiatives designed to have a continental reach or a sub-continental reach spanning more than one sub-region.
FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).
**FARA's vision is;** "Reduced poverty in Africa as a result of sustainable broad-based agricultural growth and improved livelihoods, particularly of smallholder and pastoral enterprises" its **mission is the** "Creation of broad-based improvements in agricultural productivity, competitiveness and markets by strengthening the capacity for agricultural innovation at the continental-level"; its **Value Proposition is the** "Strengthening Africa's capacity for innovation and transformation by visioning its strategic direction, integrating its capacities for change and creating an enabling policy environment for implementation". FARA's strategic direction is derived from and aligned to the Science Agenda for Agriculture in Africa (S3A), which is in turn designed to support the realization of the CAADP vision.

### About FARA Research Result (FRR)

FARA Research Report (FRR) is an online organ of the Forum for Agricultural Research in Africa (FARA). It aims to promote access to information generated from research activities, commissioned studies or other intellectual inquiry that are not structured to yield journal articles. The outputs could be preliminary in most cases and in other instances final. The papers are only published after FARA secretariat internal review and adjudgment as suitable for the intellectual community consumption.

## Introduction

Agricultural sector plays a key role in Benin's economic development. Indeed, agriculture provides economic function by improving productivity of all factors and also by supplying raw materials to sectors as craft industry and food industry. Since 2008, government policies have been introduced and converted into concrete action plans (APRA 2011). The objective of these interventions is to contribute to Gross Domestic Product (GDP) and poverty reduction. Despite this important role, Benin's agriculture is struggling to take off and cannot satisfy diversified agricultural products demand for a population that continues to grow over the past decade. Several technologies have been developed and implemented by Benin's National System of Agricultural Research (NSAR) and some development projects and programs over the last twenty years. However, the results of Strategic Plan for Agricultural Sector Recovery (SPASR) revealed that priority sectors show decreasing output except vegetable crops (SPDAS, 2016). The constraints to be overcome include lower soil fertility, use of rudimentary tools and inappropriate cropping techniques that have a negative impact on agricultural productivity. In order to meet these agricultural challenges, particular attention must be given to production and dissemination of appropriate technological innovations while respecting quality standards AS and sustainable management of natural resources.

Adoption of modern technologies in agriculture is widely recognized for improving productivity and welfare of poor producers in developing countries and it's a key ingredient for achieving poverty reduction, food security, rural development and a structural transformation. However, adoption of improved technologies involving improved seeds and mineral fertilizers is disappointing, especially in Africa (Evenson and Gollin 2003; Sheahan and Barrett 2014; Swinnen and Kuijpers, 2016). To capitalize on research already generated by Benin's National System of Agricultural Research, a study was conducted in 2015 with financial support of ʺ Forum for Agricultural Research in Africa (FARA)ʺ. It enabled the inventory and characterization of technologies produced and disseminated. It revealed existence of various technologies relating to crop management, inputs, equipment and new varieties or breeds. Most of the technologies developed (78%) concern technical issues. Technologies on agricultural equipment, use of improved varieties or agricultural inputs represent only 5%, 4% and 2% respectively. From different agricultural subsectors' stand point, these technologies concern 80% of agricultural production, 12% of livestock and 8% of fishing (Adégbola et al., 2015). In 2016, a complementary study was commissioned by NIARB and made it possible to update, identify and characterize the technologies and knowledge developed by the NSAR from 1996 to 2016, this time including those generated in universities and agricultural academic centers. This study revealed 260 hopeful technological innovations in fields of crop, animal and fisheries production (Adégbola et al., 2016). Vegetable production remains the most heavily covered area (80%), followed by livestock production (14%) and fish production (6%). Seventeen (17) agricultural sectors have been affected by these hopeful technologies. Sectors of meat, maize, vegetable crops are dominant in terms of hopeful technologies. Some socio-economic data have been collected on these technologies but are still insufficient to allow a good characterization for a better use. Thus, the present study aims to fill up missing socio-economic data and to carry out socio-economic analysis of hopeful technological innovations developed between 1996 and 2016, in particular for FARA priority sectors, namely rice, soybean, small ruminants and poultry. It will make available to stakeholders in agricultural sector in general and those of extension in particular, a compilation of hopeful technological innovations for large-scale dissemination.

## Objectives and Expected Results

**Main objective**
Overall, it was a matter of characterizing the promising technological innovations developed for rice, soybean, small ruminant and poultry sectors.

**Specific objectives**
Specifically, this study made it possible to:
- Establish profiles of potential users of hopeful technologies;
- Produce the socio-economic characteristics needed by a potential user to decide whether or not to adopt technological innovation;
- Produce a technical and economic information of each technological innovation;
- Produce a global report.

## Concepts and Analytical Framework

The socio-economic analysis of technological innovations involves a number of concepts and theories that need to be clarified and emphasized.

**Clarification of concepts**
Innovation is one of the main means to gain a competitive advantage by meeting the needs of market or users. Innovation means creating new products, developing existing technologies or products, but also optimizing its production system, adopting latest technologies from basic research.
The Oslo Manual of the Organization for Economic Co-operation and Development (OECD) proposes the following definition: an innovation is the implementation of a product (good or service) or a new process (Production process) or significantly improved, a new marketing method or a new organizational method in the practices of an enterprise, organization of workplace or external relations.
For classical economists, innovation is one way to gain a competitive edge by responding to market needs and business strategy. Innovation is a polymorphic and complex phenomenon that manifests itself through products, components, services, processes, social practices, software, technology and business models.

- **Technological innovation**
  According to OECD (1997), technological product innovation refers to the development / commercialization of a more efficient product in order to provide consumers with objectively new or improved services. Technological innovation process refers to development / adoption of new or significantly improved production or distribution methods. It can involve changes affecting separately or simultaneously materials, human resources or working methods.
- **Hopeful technological innovation**
  A technological innovation is hopeful according to well-defined criteria. It is:

1. Technology's development level. The promising technology must meet all the following steps:

- real environment under researcher management
- real environment under peasant management

- pre-extension

2. Easily usable by final users
3. Responding to users’ needs
4. Capable of producing positive effects in terms of productivity and income enhancement of beneficiaries.

- **Initial investment cost**

  Estimating the investment costs associated with a developed technology is a key element for its adoption. The reliability of this assessment presumes, in particular, ensuring the completeness of cost elements selected. The initial investment cost associated with an agricultural technology is the total costs incurred by user in acquiring this technology. This is the initial investment that allows implementation or use of technology.

- **Profitability of a technology**

  Déguénon (2008, quoted by Crinot, 2013) reports that term of profitability appears in first analysis very simple: capital produces profit, therefore ratio between capital and profit is translated into rate of return. Profit is very often used to refer to surplus of revenue over operating expenses. Agricultural profit is difference between monetary value of production and costs related to production. It should be noted that profitability can be assessed over a specific period of time. Profitability can be assessed from an economic or financial perspective. Clearly, profitability is linked not only to production costs but also to revenue generated. Profitability can be defined in several different ways. For example, it can be defined as difference between revenues and variable costs (gross margin), or as ratio between costs and revenues (Latruffe, 2010 cited by Crinot, 2013). Houndékon (1996, cited by Crinot, 2013) defines the net financial profitability of an activity as difference between the value and the cost of production calculated on basis of prices observed on the market. The estimate of this difference (profit) indicates the level of net financial profitability.

**Analytical framework**

Generation of technological innovations in agricultural sector follows a well-defined process from station-based experiments to its pre-extension. Users’ judgments are received before large-scale extension activities. Benin’s National System for Agricultural Research (NSAR) aim to achieve more efficient technology or practices (Crawford and Kamuanga, 1991). The main objective of socio-economic analysis of technological innovations is to determine economic profitability and feasibility of an agronomic, livestock or post-harvest practice from peasant's point of view in order to contribute to recommendations for large-scale adoption.

As objective is to formulate recommendations, profitability will be assessed according to peasant's point of view (financial profitability), which involves use of current prices, taxes or subsidies included. It is therefore not an analysis at national economy level (profitability), which would rather require use of prices prevailing on international market, net of taxes and subsidies.

The analysis or economic interpretation of technological innovations can be carried out using several methods. In this paper we present a method often used, without claiming that it is perfectly adapted to all variants of economic analysis.

In summary, the method involves development of a partial budget for each technological innovation. This includes following sub-steps:

- Estimate value of production (gross product).
- List different inputs used and estimate their cost.
- The calculation of profit. Two types of profit can be distinguished: gross profit and net profit. Gross profit is obtained after deducting variable costs from the market value of production. The net profit is obtained after subtracting fixed costs from the gross profit. It is this type of profit that is used in this study.

## Methodological Framework

The methodology used has included: different stages of study, choice of study areas, nature of data collected, and analytical tools.

**Different stages of study**

The study was carried out in three important stages: preparatory stage, field stage and analysis and report drafting stage.

Preparatory stage has consisted mainly of identifying survey areas with resource persons (FATP, RRSP, LZVFR, APAP, etc ...); development of survey forms. A session of framing and validation of data collection tools was organized with seniors of the Scientific Directorate before data collection stage.

Data collection stage was carried out through interviews, discussions in focus groups with users of each technology in areas / localities where they were implemented. Thus, according to their specific characteristics, semi-structured interview guides and structured questionnaires are used to collect socio-economic data that need to be provided.

Data collected for each hopeful technology through focus groups are entered using Microsoft Access and then exported to the Microsoft Excel 2007. Statistical analyzes were carried out using SPSS21. Financial analysis made it possible to determine profitability of each technology. Results of data analysis were discussed in light of realities observed in the field and results of previous research. This last stage ended with the final report drafting.

**Study areas**

The study covered the two departments of Center (Zou and Collines), one department in North (Alibori,) and the departments of Ouémé-Plateau and Mono-Couffo (Table 1)

**Table 1. Departments, communes and villages surveyed**

| Departments | Communes | Villages |
|---|---|---|
| Atlantique | Abomey-Calavi,Toffo, Allada | Sey, Sékou |
| Couffo | Djacotomey | Zounzouvou |
| Mono | Athiémé | Kpinnou |
| Ouémé-Plateau | Dangbo, Bonou | Klogbomey, Atchonsa |
| Zou | Ouinhi, Covè, Djidja | Mouzoungoudo, Koussin-Lélé, |
| Collines | Glazoué | Agouagon (Thio) |
| Alibori | Banikoara | Orou-Gnonrou |

The study areas were identified during an orientation session with program managers, resource persons who contributed to the production of technology or who were familiar with implementations' places of technological innovations.

**Data collection**

Data collection was done for each technology in focus groups of 15 to 20 users gathered for the occasion. The list of technological innovations is appended to this report.

Data collected relate to:

- Socio-economic characteristics of potential users interviewed;
- Technology performance;
- Technology use / acquisition cost;
- Estimated cost of initial investment for the technology;
- Labor required for application / adoption of the technology (Hj);
- Financial return on technology;
- Constraints to the technology adoption;
- Advantages of adopting the technology.

**Financial profitability**

The main indicator is the net margin (NM)

Net margin (NM) or Net Operating Income NOI

Net margin is obtained by deducting total costs of production from value of gross product, or by deducting fixed costs from gross margin.

It is given mathematically by following formula:

$$NM = GP - (VC+FC) \text{ ou } NM = GM – FC \text{ (en FCFA)}$$

VC: variable costs correspond to expenditure related to acquisition of inputs (raw materials and labor).

FC: fixed costs correspond to expenditures made by producer but not related to the volume of production; this is mainly investment expenditure. FCs are determined by applying an amortization rate to total acquisition value of the equipment.

If $NM>0$, production activity is economically profitable. The gross product therefore covers all production costs. On the other hand, if $NM<0$, the activity is not economically profitable.

**Labour requirement estimation**

The amount of work is determined in Man-Day (MD). For conversion into MD, the number of workers is first converted into Man-Equivalent (ME). Conversion into ME was made using Norman's conversion rates (1973): ME= 1 * (number of men 15-60 years) + 0.75 * (number of women 15-60 years) + 0.5 * (number of children up to 14 years of age). Then, ME is multiplied by total time (Tt) of the operation (in hours) divided by 8 to obtain the value in Man-Day. A MD is considered to be the work that would have been done during a day (of 08 hours) by a normal worker, paid by task.

## Results and Discussion

### Proportion of hopeful technological innovations by sector

Three main agricultural sectors have been selected for FARA studies in Benin. These are rice, soybean and small ruminant-poultry.

Eighteen (18) technological innovations were selected as hopeful for rice sector (Adégbola et al, 2016). As for soybean sector, six technological innovations (06) have actually gone through pre-extension stage. Finally for poultry and small ruminant sectors, ten (10) technological innovations are actually introduced in a peasant environment. A total of 34 technological innovations were subject of this socio-economic study.

Figure 1 shows proportion of technological innovations by sector. Analysis in Figure 1 shows that all technological innovations affecting soybean and small ruminant-poultry sectors are at production stage. Researches have less affected stages of processing and storage / processing over the past two decades. On the other hand, innovations affecting rice sector cover stages of production (55.55%), processing (38.89%) and storage (5.6%).

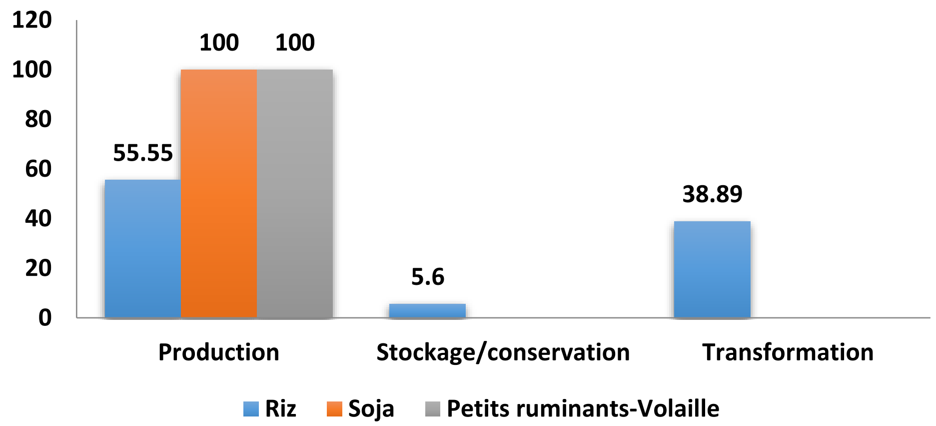


**Figure 1: Proportion of hopeful technological innovations by sector**

### Socio-economic characterization of hopeful technological innovations in rice sector

### Users' profiles of technological innovations in rice sector

Rice is one of the strategic sectors in Benin because of its increasing importance in eating habits and consumption needs of its by-products are constantly increasing. Current studies show an average consumption of 25 to 30 Kg per capita per year (NSRD, 2011). This individual consumption leads to an annual total consumption between 175 000 and 210 000 tons of rice per year. People consume both imported rice and local rice. Rice is ranked first among 26% of households in Benin, in second place for 61% and in third place for only 12% (Arinloyé et al., 2010). In addition, rice is the third cereal produced in Benin after maize and sorghum. This sector employed 72,400 individuals (agricultural workers and other intermediaries), including 53,308 men (79%) and 15,090 women (21%) (MALF, 2006).

In recent years, this sector has undergone a remarkable change characterized by development of its value chains. In addition to productive link, storage and marketing of local rice are modernizing and involving many actors. Processing link is leaded by two groups of actors:

steamers and mini-mills. Steaming is often practiced at small and medium scales by women who use traditional and / or craft methods (Houssou et al., 2016). They are constituted as a group or cooperative of 30 to 60 members. There are ten mini-mills of ESOP type in Benin. They turn paddy rice into white rice. It should be noted that these different processed rices are increasingly appreciated by Benin consumers. Although domestic production has tripled over the past decade, rice consumption needs are only covered by 47% in 2013. Better upgrading of this sub-sector through adoption of proven technologies could considerably improve the supply of rice on Benin market.

**Indicators of economic performance of technological innovations affecting rice sector**

Table 2 summarizes economic indicators estimated from data on technologies affecting rice sector.

Analysis of this table shows that all technologies developed are financially profitable with a positive net margin. The yields of rice varieties are potential yields that have been determined in a peasant environment. Producers will be able to reach them by respecting appropriate technical and cultural practices. Current average price of paddy rice on the market is 150F, that of parboiled rice is 350 F while the milled rice costs 540 FCFA.

## Table 2. Economic indicators of hopeful technologies in rice sector

| N° | Innovation's name | Operating structure | Chain stage | Yield | Performance Unit | Labour required | Cost of use / Acquisition | Estimated cost of initial investment (FCFA) | Net margin (FCFA) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Improved steaming kit of 300kg for stoving paddy rice | FATP/NIARB | Processing | 300 | Kg of paddy rice parboiled in 65 min | 8 MD | 600000 FCFA | 225300 (1 ton of paddy rice) | 19700 |
| 2 | Improved steaming kit of 180kg for stoving paddy rice | FATP/NIARB | Processing | 180 | Kg of paddy rice steamed in 45min | 8MD | 200000FCFA | 221475 (1 ton of paddy rice) | 23500 |
| 3 | Improved steaming kit of 45kg for stoving paddy rice | FATP/NIARB | Processing | 45 | Kg of paddy rice steamed in 20 min | 16MD | 60000FCFA | 180.500 (1 ton of paddy rice) | 15300 |
| 4 | Threshing machine/Fanning-mill of 15HP (Horsepower) | AfricaRice et FATP/NIARB | Processing | 1200 | kg/h | 1,5MD | 1600000FCFA | 11810 FCFA (ton of rice) | 13190 |
| 5 | Threshing machine of 6 HP (BSPT) Commonly known as Amouda for paddy rice threshing | FATP/NIARB | Processing | 400 | kg/h | 3,75MD | 800000FCFA | 16100 (1 ton of paddy rice) | 9270 |
| 6 | Threshing machine/Fanning-mill for paddy rice | FATP/NIARB | Processing | 275 | kg/h | 3,75MD | 850000FCFA | 16100 (1 ton of paddy rice) | 8900 |
| 7 | Rice sorter-sizer | FATP/NIARB | Processing | 500 | kg/h | | 950000FCFA | | |
| 8 | Variety of rice NERICA 1 | RRSP/CRA-Sud/NIARB | Output | 4500 | Kg (Potential yield) | 54,75MD | 24 000 FCFA | 412 000 (1ha) | 263000 |
| 9 | Variety of rice NERICA 2 | RRSP/CRA-Sud/NIARB | Output | 4500 | Kg (Potential yield) | 54,75MD | 24 000 FCFA | 412 000 (1ha) | 263000 |
| 10 | Variety of rice NERICA 4 | RRSP/CRA-Sud/NIARB | Output | 4000 | Kg (Potential yield) | 54,75MD | 24 000 FCFA | 412 000(1ha) | 188000 |
| 11 | Variety of rice NERICA 6 | RRSP/CRA-Sud/NIARB | Output | 5000 | Kg (Potential yield) | 54,75MD | 24 000 FCFA | 412 000(1ha) | 338000 |
| 12 | Variety of rice IR 841 | Africa Rice, CRA-Sud/NIARB | Output | 8000 | Kg/ha | 54,75MD | 24 000 FCFA | 412 000 (1 ha) | 638000 |
| 13 | Variety of rice NERICA-L 14 | RRSP/CRA-Sud/NIARB | Output | 7 000 | Kg/ha | 54,75MD | 24 000 FCFA | 412 000 (1 ha) | 638000 |
| 14 | Variety of rice NERICA-L20 | Africa Rice, CRA-Sud/NIARB | Output | 6000 | Kg/ha | 54,75MD | 24000 FCFA | 412 000 (1 ha) | 404000 |
| 15 | Cultural technique of soil fertility management by organic fertilization, seedling in line | CARDER/NIARB | Output | 6500 | kg/a | 56MD | 286500 FCFA | 452000 (1 ha) | 523000 |
| 16 | Soil fertility management by cultural system cowpea and rice in flood-risk areas | RRSP/CRA-Sud/NIARB | Output | 4035 | kg/ha | 54,75MD | 24000 FCFA | 381664 (1 ha) | 267999 |
| 17 | Soil fertility management by application of organo-mineral fertilization using small ruminant droppings on Rice Nerica | NIARB | Output | 4000 | kg/ha | 55,75MD | 75000 FCFA | 390500 (1 ha) | 209500 |
| 18 | Mixed drying of paddy rice | FATP/NIARB | Storage/conservation | 20% | Loss rate | 0,5MD | 1250 F (1 ton of paddy rice) | 221475 (1 ton of paddy rice) | 23500 |

In choosing of an improved technology, users rely on several criteria before adopting it. The different technologies on rice have been appreciated by potential users.

**Users' appreciations of hopeful technologies in rice sector**

Users appreciated each technology following on from benefits and constraints associated with that technology. Table 3 summarizes benefits, constraints and overall user appreciation.

## Table 3. Users' opinion of technologies impacting rice sector

| N° | Innovation Name | Benefits of Adopting | | | | | Constraints to Adoption | | | Users' Appreciation |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Improved steaming kit of 300kg for stoving paddy rice | Loss rate reduction | Time-saving | Good quality of rice obtained | Improving income of working women | High processing capacity | High wood consumption | Difficulty of use and maintenance | High water consumption and high cost of acquisition | Good |
| 2 | Improved steaming kit of 180kg for stoving paddy rice | Loss rate reduction | Time-saving | Good quality of rice obtained | Improving income of working women | Easy to use | Medium wood consumption | Little more expensive acquisition cost | Medium consumption of water | Very good |
| 3 | Improved steaming kit of 45kg for stoving paddy rice | Loss rate reduction | Good quality of rice obtained | Improving income of working women | Easy to use | Medium wood consumption | Low processing capacity | Low yield at time | | Pass grade |
| 4 | Threshing machine/Fanning-mill of 15HP (Horsepower) | Very high threshing performance compared to traditional practice | Time-saving | Reduction of work's hardness | Reduction of workforce's quantity | Reduced breakage rate | Lack of training on use | High cost of technology | Heavy and difficult to tow in lowlands | Very good |
| 5 | Threshing machine of 6 HP (BSPT) Commonly known as Amouda for paddy rice threshing | Very high threshing performance compared to traditional practice | Time-saving | Reduction work's hardness | Reduction of workforce's quantity | Reduced breakage rate | Lack of training on use | Relatively high acquisition cost | No system of winnowing | Good |
| 6 | Threshing machine/Fanning-mill for paddy rice | Very high threshing performance compared to traditional practice | Time-saving | Reduction work's hardness | Reduction of workforce's quantity | Reduced breakage rate | Lack of training on use | Relatively high acquisition cost | No system of winnowing | Good |
| 7 | Rice sorter-sizer | | | | | | Cannot remove trash | Low processing capacity | | Pass grade |
| 8 | Variety of rice IR 841 | Rice with long perfumed grain | Yield in the manufacturing 65-68 % | Very high yield | Good lodging resistance and panicle blast tolerant | | Vegetative cycle quite long. Loss of flavor. | Varietal degeneration | Very attacked by granivorous birds | Very good |
| 9 | Variety of rice NERICA-L20 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |
| 10 | Cultural technique of soil fertility management by organic fertilization, seedling in line | Very high yield | Improvement of soil structure | Good growth and better side branching of rice plants | Irrigation water saving | Limited or no nitrogen fertilizer use | Problems of availability of organic material in sufficient quantity | Difficulties for the transport of organic material | | Good |
| 11 | Soil fertility management by cultural system cowpea and rice in flood-risk areas | High yield | Improvement of soil structure | Limited intake of mineral fertilizer | | | | | | Good |
| 12 | Soil fertility management by application of organo-mineral fertilization using small | Improve soil structure | Increase yield | | | | Problems of availability of organic | | | Good |

| N° | Innovation Name | Benefits of Adopting | | | | | Constraints to Adoption | | | Users' Appreciation |
|---|---|---|---|---|---|---|---|---|---|---|
| | ruminant droppings on Rice Nerica | | | | | | material in sufficient quantity | | | |
| 13 | Mixed drying of paddy rice | Reduce loss rate | Improves the quality of husked rice | Low level of chalky grains with husking | | | | | | Very good |
| 14 | Variety of rice NERICA 1 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |
| 15 | Variety of rice NERICA 2 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |
| 16 | Variety of rice NERICA 4 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |
| 17 | Variety of rice NERICA 6 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |
| 18 | Variety of rice NERICA-L 14 | Pluvial rice adapted to soil and climate conditions | High yield versus local varieties | Fairly good resistance to drought | Good lodging resistance and panicle blast tolerant | | Low yield compared to IR 841 | No aroma | Less appreciated by consumers | Good |

**Socio-economic characterization of hopeful technological innovations in soybean sector**

**Users' profile of technological innovations in soybean sector**

Soybean culture has become increasingly important in agricultural production systems in Benin. Every year annual production is growing steeply. For example, it rose from less than 10,000 tons in 2006 to almost 80,000 tons in 2012 (PPDMS, 2012). This has led to a new dynamic in soybean trade between Benin and some countries in the subregion whose traders from Nigeria, Togo and Ghana come to Benin to fill the local gaps in their industries (Ayelesso, 2008). The increase in production coincided with high domestic demand by food industries. Benin local market is made up of oil factories (BCOM, Fludor,), animal feed production units and local processors of soybeans in cheese and other derivatives (PPDMS 2012, Sodjinou 2006, Ayélèsso 2008). However, producers still face thorny problem of low productivity, mainly due to the non-valorization of research.

**Economic performance indicators of hopeful technological innovations in soybean sector**

Table 4 presents socio-economic indicators of technologies studied and impacting soybean sector. The technologies developed are essentially soybean varieties combined with technology that nodulate soybean. Analysis in the table shows that all technologies are financially profitable. Net margin increases as yield of variety increases. Technology that nodulate soybean has the highest yield and therefore a higher net margin.

**Table 4. Performance indicators of technological innovations in soybean sector**

| N° | Innovation's name | Operating structure | Chain stage | Yield | Perfor-mance Unit | Labour required | Cost of use / Acquis-ition | Estimated cost of initial investment (FCFA) | Net margin (FCFA) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Soybean varieties TGX 1910-10F | NIARB, IITA | Output | 2500 | kg/ha | 54 MD | 20000 | 242000 | 258000 |
| 2 | Soybean varietie TGX 1903-3F | NIARB, IITA | Output | 2500 | kg/ha | 54 MD | 20000 | 242.000 | 258000 |
| 3 | Soybean varieties TGX 1910-14F | NIARB, IITA, INRA Sénégal | Output | 2500 | kg/ha | 54 MD | 20000 | 242 000 | 258000 |
| 4 | Soybean varietie TGX 1448-2[E] | NIARB, IITA | Output | 2500 | kg/ha | 54 MD | 20000 | 242 000 | 258000 |
| 5 | ISRA 25-72 | INRA Sénégal, NIARB | Output | 3000 | kg/ha | 54 MD | 20000 | 242 000 | 35000 |
| 6 | Rhizobium inoculum for culture of soybeans | FSA/UAC | Output | 3500 | kg/ha | 54 MD | 28000 FCFA | 250 000 | 450000 |

**Users' opinions on hopeful technologies developed on soybean**

Users have appreciated every technological innovation developed on soybean over the recent years. Table 5 summarizes benefits, constraints and overall judgment of stakeholders.

## Table 5. User opinion on soybeans technological innovations

| N° | Innovation Name | Benefits of Adopting | | | | | Constraints of Adopting | | | | User Opinion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Soybean varieties TGX 1910-10F | Shorter season soybeans (90-100 days) | Non-dehiscent pods | Oval yellow buttered seeds well appreciated by traders | It is well adapted to all regions of the country | High yield | Discontinuous, scattered and uncoordinated seed supply | Difficult access to specific soybean fertilizer | Attacks of young soybean plants after emergence by rats, crickets, grasshoppers, rabbits | | Very good |
| **2** | Soybean varietie TGX 1903-3F | Shorter season soybeans (90-100 days) | Non-dehiscent pods | Oval yellow buttered seeds well appreciated by traders | It is well adapted to all regions of the country | High yield | Discontinuous, scattered and uncoordinated seed supply | Difficult access to specific soybean fertilizer | Attacks of young soybean plants after emergence by rats, crickets, grasshoppers, rabbits | | Very good |
| **3** | Soybean varieties TGX 1910-14F | Shorter season soybeans (90-100 dayss) | Non-dehiscent pods | Oval yellow buttered seeds well appreciated by traders | It is well adapted to all regions of the country | High yield | Discontinuous, scattered and uncoordinated seed supply | Difficult access to specific soybean fertilizer | Attacks of young soybean plants after emergence by rats, crickets, grasshoppers, rabbits | | Very good |
| 4 | Soybean varietie TGX 1448-2E | Shorter season soybeans (90-100 days) | Non-dehiscent pods | Oval yellow buttered seeds well appreciated by traders | It is well adapted to all regions of the country | High yield | Discontinuous, scattered and uncoordinated seed supply | Difficult access to specific soybean fertilizer | Attacks of young soybean plants after emergence by rats, crickets, grasshoppers, rabbits | | Very good |
| 5 | ISRA 25-72 | Shorter season soybeans (100 days) | Creamy white in colour and much appreciated | Suitable for oil factory | Very high yield | Resistant to pest insects | Discontinuous, scattered and uncoordinated seed supply | Difficult access to specific soybean fertilizer | Low drought resistance | It's not cooked easily | Good |
| 6 | Rhizobium inoculum for culture of soybeans | Increases nitrogen fixation capacity by plant | Allows good growth of plant | Increases plant yield | Improves soil structure for crop antecedents | | Techniques for inoculums production are difficult to acquire and to master | Not all varieties have the same nodulation capacity | Lack of awareness of the technology by peasant | Lack of popularization of technology | Very good |

**Socio-economic characteristics of promising technological innovations in small ruminant-poultry sector**

**Users' profile**

As granary of corn or sorghum small ruminants represent saving on feet for small family farms. Its breeding occupies a large part of rural populations. Many people engage in this activity because of benefits it provides (Bank et al., 2005). As for traditional chicken breeding, it has social impact and family economy importance. Indeed, avian herd constitutes a saving on feet that allows family to meet immediate expenses and obtain some basic products (Mensah S. et al., 2011). It is an activity generally practiced by poultry farmers, including women and children. According to study on characterization of agro-ecological zones, 70% of rural population is engaged in small ruminant breeding and 90% in local chicken breeding. However, small ruminants and traditional poultry farming are faced with low productivity, due to lack of selection, lack of food, lack of hygiene and an uncontrolled sanitary environment. These identified constraints have led National System for Agricultural Research of Benin to develop some technological innovations to remove bottlenecks that impacted these sectors.

**Economic performance indicators of hopeful technological innovations in small ruminant-poultry sector**

Table 6 presents performance indicators for technologies impacting small ruminant-poultry sector. The estimates are reduced to unit of production, which means per head.

**Table 6. Economic indicators of hopeful technological innovations developed for small ruminant-poultry sector**

| N° | Innovation's name | Chain Stage | Yield | Performance Unit | Labour Required | Cost of use / Acquisition | Estimated Cost of Initial Investment (FCFA) | Net Margin (FCFA) |
|---|---|---|---|---|---|---|---|---|
| 1 | Food intake based on cassava rasping for local breed chickens at grower stage in department of Mono in southern Benin | Output | 2% | Mortality rate | 0,18MD | 120 | 620 | 620 |
| 2 | Technique for increasing egg laying rate and hatchability of eggs from local hens in rural areas | Output | 90% versus 60% | Egg-laying rate | | | | |
| 3 | Endogenous method to control ectoparasites and endoparasites in local poultry | Output | 2% versus 45% | Mortality rate | 0,25 MD | 25 | 514,50 | 626 |
| 4 | Under-basket breeding system to reduce chick mortality | Output | 56% versus 79% | Mortality rate | 0,1MD | 187 | 190 | 30 |
| 5 | Treatment of small ruminant scabies | Animal health | 0% | Mortality rate | 0,5 MD | 400 | 9600 | 3700 |
| 6 | Food intake based on *Fagara xanthonloid, moringa lucida* and cassava peels for goat growth | Output | 5 | Average Daily Gain | 2MD | 5475 | 9600 | 3700 |
| 7 | Ration composée de spondias mombin pour les chevreaux et des agneaux Djallonké<br>Food intake made of *spondias mombin* for goats and lambs Djallonké | Output | 5 | Average Daily Gain | 2MD | 5475 | 9600 | 3700 |
| 8 | Conbination's technique of *Cajanus cajan* leaves and fresh corn residues in balanced diet of weaned goats in southern Benin | Output | 5 | Average Daily Gain | 0,25 MD | 2400 | 5 800 | 1400 |
| 9 | Ration alimentaire à base des germes d'arachides dans l'alimentation des ovins<br>Food intake based on groundnut sprout sheep's feeding | Output | 5 | Average Daily Gain | 0,25 HJ | 2400 | 5 800 | 1400 |
| 10 | Suitable habitat for breeding of small ruminants in flooded areas | Output | 0% Mortality rate versus 40% | | 2,15HJ | 940 (Depreciation for an animal) | 3015 | 3987 |

Users of these technologies have very well appreciated these different aspects concerning small ruminant-poultry sectors for their financial and technical accessibility. There are no major constraints to their adoption, except that all these technologies are not known by general public.

## Conclusion and Recommendations

This socioeconomic study has been accentuated on technological innovations impacting three sectors of interest for FARA. These include rice sector, soybean sector and the small ruminant-poultry sector. A total of 34 technological innovations were subject of this socio-economic study, of which eighteen (18) involved in rice sector; Six (06) in soybean sector and ten (10) in the small ruminant-poultry sector. The study consisted of socio-economic characterization of each of these technologies, a complementary work to the inventory and characterization of agricultural technological innovations carried out in 2015.

The technological innovations developed meet the needs of users in these sectors and their added value chains. They are mainly small producers, processors, agricultural entrepreneurs, small-scale breeders. These often evolve in groups of 30 to 60 members which constitute channels for dissemination of new technologies.

All technological innovations that have been subject of this study are financially profitable. They have given positive profit margins and added value compared to old technologies or traditional practices. However, economic indicators are not enough for users to appreciate and adopt a technology. Thus, a combined analysis of profitability, advantages and constraints of use allowed users to appreciate each technological innovation. Overall, all technologies developed are hopeful and require large-scale dissemination for a lasting impact on users. The estimated socio-economic characteristics are very useful information contributing to decision-making of adoption of the technology by users. However, these data are often overshadowed in the implementation of research protocols leading to production of technologies.

Some suggestions are worthy of consideration following results and conclusions of this study. It's about:

- To systematically include socio-economic analysis in elaboration and implementation of research protocols leading to production of new technologies to provide users all information necessary for adoption decision-making
- Conduct the same study for all hopeful technological innovations identified in other sectors and included in book of technologies
- Direct research projects towards research and development activities for a participatory generation of technological innovations including categories of stakeholders (researchers, popularizers, producers, processors, etc.).
- The establishment of a macro technology transfer mechanism for the popularization and wide-scale adoption of agricultural research results and outputs; this mechanism if it focuses on principles of interactive communication, monitoring, support and advice within stakeholders of agricultural research and development system, should boost research.

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