Short-term expertise
State of the art of cotton research in Africa:
Diagnosis and proposals for a revamping strategy

Final report
"Proposal of a detailed strategy for revamping African cotton research at the technical level"

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Final version - June 2017

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<th>Action:</th>
<th>State of the art of the cotton research in Africa: diagnosis and proposals for a revamping strategy</th>
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<td>Support for consolidation of action framework for EU – Africa Partnership on Cotton</td>
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<td>Financing:</td>
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This report follows the report titled, "Diagnosis and recommendations for the elaboration of a proposal for a revamping strategy of African cotton research" (Lamine Seiny Boukar & Bruno Bachelier, 2017).

Thanks

We wish to warmly thank:

- The Management Unit of the Support Programme for the Consolidation of the Action Framework under the EU-Africa Partnership on Cotton, for the confidence it expressed by entrusting this expertise to us,

- The individuals in National Agriculture Research Institutes, Regional Agriculture Research Centres, Producer Associations, Cotton Companies, Universities, NGOs, and Regional Economic Communities, who contributed towards the achievement of this expertise through their answers to the questionnaires, their participation in the meetings in visited countries or their reviewing of this report,

- CIRAD colleagues who contributed to enrich this report thanks to their relevant comments.

### Abbreviations

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<tr>
<td>A2C2/A2CR</td>
<td>Association Africaine des Chercheurs Coton / African Cotton Researchers Association</td>
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<td>ACA</td>
<td>Association Cotonnière Africaine / African Cotton Association</td>
</tr>
<tr>
<td>ACP</td>
<td>Afrique, Caraïbes et Pacifique</td>
</tr>
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<td>ACTIF</td>
<td>African Cotton and Textiles Industries Federation</td>
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<tr>
<td>AEA</td>
<td>Afrique de l’Est et Australe</td>
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<td>AOC</td>
<td>Afrique de l’Ouest et du Centre</td>
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<tr>
<td>APoCA</td>
<td>Association des Producteurs de Coton Africains</td>
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<tr>
<td>ASARECA</td>
<td>Association for Strengthening Agricultural Research in Eastern and Central Africa</td>
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<tr>
<td>BAD</td>
<td>Banque Africaine de Développement</td>
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<tr>
<td>BDEAC</td>
<td>Banque de développement des États de l’Afrique centrale</td>
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<td>BOAD</td>
<td>Banque Ouest-Africaine de Développement</td>
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<td>CAADP / NEPAD</td>
<td>Comprehensive Africa Agriculture Development Programme / Nouveau partenariat pour le développement de l’Afrique</td>
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<td>CAE / EAC</td>
<td>Communauté d’Afrique de l’Est / East African Community</td>
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<td>Conseil Africain et Malgache pour l’Enseignement Supérieur / African and Malagasy Council for Higher Education</td>
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<td>CCARDESA</td>
<td>Centre for Coordination of Agricultural Research and Development for Southern Africa</td>
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<td>CDAA / SADC</td>
<td>Communauté de Développement de l’Afrique Australe / Southern African Development Community</td>
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<td>CEDEAO</td>
<td>Communauté Économique Des États de l’Afrique de l’Ouest</td>
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<td>CEEAC / ECCAS</td>
<td>Communauté Économique des États de l’Afrique Centrale / Economic Community of Central African States</td>
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<td>CEMAC</td>
<td>Communauté Économique et Monétaire des États d’Afrique Centrale</td>
</tr>
<tr>
<td>CER / REC</td>
<td>Communauté Économique Régionale / Regional Economic Community</td>
</tr>
<tr>
<td>CFC</td>
<td>Common Fund for Commodities / Fonds Commun des Produits de Base</td>
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<td>CIRA/IARC</td>
<td>Centres Internationaux de Recherche Agronomique / International Agronomic Research Centres</td>
</tr>
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<td>CIRAD</td>
<td>Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)</td>
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<td>COMESA</td>
<td>Common Market for East and South Africa</td>
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<tr>
<td>CORAF / WECARD</td>
<td>Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles / West and Central African Council for Agricultural Research and Development</td>
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<tr>
<td>COS-Coton</td>
<td>Comité d’Orientation et de Suivi du Partenariat UE-Afrique sur le coton</td>
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<tr>
<td>CRRA / RARC</td>
<td>Centres Régionaux de Recherche Agronomique / Regional Agronomic Research Centres</td>
</tr>
<tr>
<td>CTA</td>
<td>Centre technique de coopération agricole et rurale / Technical centre for agricultural and rural cooperation</td>
</tr>
<tr>
<td>ESA</td>
<td>East and Southern Africa</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FARA</td>
<td>Forum for Agricultural Research in Africa</td>
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<td>FIRCA</td>
<td>Fonds Interprofessionnel pour la Recherche et le Conseil Agricoles (Côte d’Ivoire)</td>
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<td>INRA / NARI</td>
<td>Institut(s) National(aux) de Recherche Agricole ou Agronomique / National Agricultural or Agronomic Research Institute(s)</td>
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<tr>
<td>IST</td>
<td>Information scientifique et technique / Technical and scientific information</td>
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<td>ITC</td>
<td>International Trade Centre</td>
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Report “Proposal of a detailed strategy for revamping African cotton research at the technical level”

ITK
<table>
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| NTIC
| Nouvelles Technologies de l’Information et de la Communication |
| PDDAA / CAADP
| Programme détaillé de développement de l’agriculture africaine / Comprehensive Africa Agriculture Development Programme |
| PPAAO / WAAPP
| Programme de Productivité Agricole en Afrique de l’Ouest / West Africa Agricultural Productivity Programme |
| PPP
| Public private partnership |
| PR-PICA
| Programme Régional de Protection Intégrée du Cotonnier en Afrique |
| SEACF
| Southern and Eastern African Cotton Forum |
| SNRRA
| Structures Nationales et Régionales de Recherche Agricole ou Agronomique |
| UEMOA / WAEMU
| Union Economique et Monétaire Ouest Africaine / West African Economic and Monetary Union |
| WACIP
| West African Cotton Improvement Program |
| WCA
| West and Central Africa |

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Executive summary

This report, “Proposal for a detailed strategy to revamp African cotton research at the technical level” is the second part of the study entitled “State of the art of the cotton research in Africa: diagnosis and proposals for a revamping strategy”. It follows the first report, "Diagnosis and recommendations for the elaboration of a proposal for a revamping strategy of African cotton research". This study was conducted in the framework of the “Support Programme for the consolidation of the Action Framework under the EU-Africa Partnership on Cotton”, and in the form of a short-term expertise, administered by the technical assistance/Programme Management Unit (TA/PMU).

Beginning in April 2016, the study was conducted by two consultants who organized it into five phases covering twenty-four cotton-producing countries in Africa, members of the ACP (Africa, Caribbean, and Pacific). The methodology followed four principal paths:

i) An introduction of the study to stakeholders of the African cotton value chain (Burkina Faso 04/2016, Benin 05/2016).

ii) Questionnaires addressed to the actors of African cotton research, their partners in the cotton value chain, and the users of the results of cotton research.

iii) Field research in four circular rounds through twelve cotton-producing African countries of West, Central, and East and Southern Africa, enabling exchanges with national actors in the cotton value chain.

iv) The presentation of the study’s results (Belgium 10/2016, Kenya and Burkina Faso 03/2017).

The two consultants have benefited from the monitoring and validation support of a group of thirteen individuals made up of leaders in cotton research, users (producers, cotton companies), and an expert. This group assisted the consultants during their time in the field, and with comments and reviews of the draft versions of the two reports produced.

The diagnosis of African cotton research has revealed both specificities and convergences among the cotton programmes of the National Agricultural/Agronomic Research Institutes (NARI). For example, these specificities reveal notable differences in terms of their sources of funding (public or private), their annual operating budgets, and the average number of researchers employed. But globally, beyond certain extreme deviations, the diagnosis underlines several common deficiencies: inadequate human resources (quantitative and qualitative) and funding (amounts and continuity), a less attractive status for researchers as compared to that in the universities, the absence of incentive measures for cotton research, few mechanisms for collaboration among national and international partners, a lack of scientific equipment, poor dissemination of research results, and an approach to research that is focused on disciplines rather than themes. At the same time, this cotton research is crucial to a cotton value chain, which faces common problematics in the different countries (loss of soil fertility, climate change, pest management, etc.).

This diagnosis leads to the formulation of recommendations for improving the performance of African cotton research. These recommendations address the security and continuity of scientific personnel and their activities, the diversification and sustainability of funding, the thematic focus needed to respond to the challenges facing cotton research, and the consideration of social concerns. One of the challenges is to mutualize resources (human, infrastructure, financial) through a more globally inclusive approach to research that includes regional centres and mechanisms, regional projects and programmes, and regional networks.

We have used these elements to develop a proposal for a detailed strategy to revamp African cotton research on a technical level, incorporating the strategic aim to “Revamp African cotton research and improve its contribution to the sustainability of cultivation, farm income, and the competitiveness of the cotton value chain”. This proposal focuses on four strategic objectives that envision the reinforcement of research capabilities, the adaptation of research themes and tools for sustainable production, the amelioration of
research efficiency in the cotton value chain, and the integration of African cotton research in the worldwide scientific community. These objectives are outlined in the following eleven operational objectives, which are in turn characterized by forty-three activities.

**Strategic objective n°1: Reinforce the capabilities of African cotton research.**
- Operational objective n°1.1: Ensure the optimum management of research skills.
- Operational objective n°1.2: Reinforce the technical means of research.
- Operational objective n°1.3: Ensure long-term and diversified funding sources for research.

**Strategic objective n°2: Adapt the themes and tools of African cotton research to contribute to sustainable production.**
- Operational objective n°2.1: Improve integration of the evolutions in environmental constraints.
- Operational objective n°2.2: Adapt research approaches to take account of the evolution in socio-economic constraints.
- Operational objective n°2.3: Open African cotton research to the world and the future.

**Strategic objective n°3: Make African cotton research more efficient in its relationship with other actors in the cotton value chain.**
- Operational objective n°3.1: Organize frameworks of exchange and cooperation between research and other actors in the cotton value chain.
- Operational objective n°3.2: Make research results more accessible and comprehensible.
- Operational objective n°3.3: Improve the connections between research, development, and production at the national and regional levels.

**Strategic objective n°4: Improve the dissemination of African cotton research within the global scientific community.**
- Operational objective n°4.1: Improve the relevance, visibility, and recognition of African cotton research at the international level.
- Operational objective n°4.2: Develop regional and international synergy that reinforces the mutualisation of resources, activities, and results.

This technical proposal should be shared with ensemble of concerned actors, validated in terms of policy, and adapted as a function of the opportunities and constraints inherent in the implementation of strategy. This implementation could be stretched over a period of five or six years.

At this point, considering the geographic range covering the African continent, the objectives and activities contained in this strategy proposal cannot be expanded into specific details for each of the twenty-four countries involved. Nevertheless, the elements of this proposal will be essential when the strategy advances to the stage of implementation. At that point, a more precise prioritization and phasing of the different activities and associated actions must be realized.

The proposed strategy was presented during the 22nd meeting of COS-cotton (Ouagadougou, Burkina Faso, March 31, 2017). Remarks and comments expressed in this frame are reported in the annex of this report. Some of them were integrated in the present proposal.
1. Introduction

1.1. Context and methods of conducting the Action

1.1.1. The Intra-ACP cotton programme
The action is conducted with funding from the Intra ACP 10th FED - Cotton facility, through the Support Programme for the Consolidation of the Action Framework under the EU-Africa Partnership on Cotton (or Intra-ACP Cotton Programme). The specific objective of this programme is that "actors in the African cotton value chain take concerted actions to implement cotton strategies for assuring the sustainable development of the African cotton sector". There are three expected outcomes for enabling its achievement:
Result 1: Regional cotton strategies are operational at the national level and coordinated in a continental approach.
Result 2: The capacities of professional associations in the sector are reinforced in terms of planning and monitoring the implementation of strategies.
Result 3: The internal competitiveness and viability of the African cotton value chains are improved.

1.1.2. The action
This study is entitled "State of the art of cotton research in Africa: diagnosis and proposals for a revamping strategy", and conducted in the form of a short-term expertise, under the management of the technical assistance and Programme Management Unit (TA / PMU). The study's global objectives aim to contribute to the level of cotton exploitation systems:
- to the reinforcement of the basic competitiveness of cotton value chains;
- to the sustainable intensification of African agriculture in social, economic, and environmental terms;
- and to growth in African agriculture’s appeal to new generations (modernity, professionalism, opportunity).

The specific objective is to use an in-depth and well-reasoned diagnostic of the state of the art of African cotton research to elaborate a proposal for a detailed strategy to revamp this research in a direction oriented towards the sustainable performance of field production, and to validate this strategy proposal from a technical perspective. Once validated technically, this strategy proposal will enable the initiation of a political validation process and ensure its dissemination.

The initiation of the study was subject to a delay inherent to administrative constraints, and the chronology of the five expected results as described in the terms of reference (February 2016) could not be respected. Therefore, the expected results were adapted, and are presented as follows in the study’s beginning report, validated in April 2016 by the TA / PMU:
R.1. A presentation and brainstorming workshop was organized for the study and a monitoring/validation unit was created;
R.2. An in-depth and well-reasoned diagnostic of the state of the art of African cotton research was produced, including thought-provoking approaches in the form of recommendations for the elaboration of a revamping strategy;
R.3. A proposal for a detailed strategy to revamp African cotton research was submitted at the technical level;
R.4. The proposal for a detailed strategy to revamp African cotton research was validated at the technical level;
R.5. A presentation of the proposal for a detailed strategy to revamp African cotton research, including elements of implementation and coordination, was organized to increase opportunities for political validation and ensure dissemination.
1.1.3. Cotton production in Africa and the World

Cotton is the world’s most used natural fibre, representing 27% of the global consumption of all fibres, and 78% of all natural fibres produced. In absolute terms, global consumption of cotton has risen from 10.4 million tons in 1960 to 24 million tons in 2015, but its share of the fibre market has considerably decreased. This decline can be explained primarily by growth in the consumption of other textile fibres, particularly polyester, the most important competitor of cotton.

On a global scale, the production of African cotton-fibre remains relatively modest. In 2014/2015, African cotton accounted for less than 7% of the 26.3 million tons of cotton-fibre produced globally. However, 90% of Africa’s 1.39 million tons of cotton production was exported, situating Africa in third place among exporters worldwide, behind the United States and India (ICAC, 2016). The majority of African cotton (70%) is produced in the "CFA franc zone" of West and Central Africa (Figure 1).

The statistics from the International Cotton Advisory Committee (ICAC) indicate that twenty-five African countries produced cotton in 2015/2016 (Figure 2). The production per country (Table 1 and ) ranges from more than 200,000 tons of fibre per year (Burkina Faso and Mali) to less than 10,000 tons (South Africa, the Central African Republic, Ghana, Kenya, Guinea, Niger, and Angola). The average yield ranges from 1,250 kg of fibre per hectare (South African irrigated crops) to less than 200 kg per hectare (Kenya, Mozambique and Zimbabwe).

The study’s reference terms reflect the major evolutions in African cotton from 1970 to 2015. African cotton crops flourished during this period until 2005 when they suffered a setback linked to the integrated industry model (with the State as the primary actor) predominant in West and Central Africa, and a financial and economic crisis that affected the African cotton industry between 2005 and 2010. There were both exogenous factors involved, such as global cotton prices (Figure 4), depreciation of the dollar, and political issues, and endogenous factors such as insufficient competitiveness, industry privatisation, and inadequate internal management. The visible consequence these factors was a strong decline in African cotton production during this period, passing from 2 million to less than 1 million tons of fibre per year. Although production appears to have increased since 2010, the volume remains relatively low as compared to that of the 1990s (Figure 5).

All the constituents of the African cotton value chain are concerned by this situation, particularly agricultural and agronomic research. This study seeks to clarify the prior and current roles of African cotton research with respect to its partners (other national and regional research structures, producers, cotton and sectoral organizations), and to propose a strategy at the technical level for revamping this research, enabling it to fully perform its scientific and technical role in the cotton value chain.
Figure 1. Worldwide distribution of cotton-fibre production in 2014/2015 (ICAC, 2017).

Figure 2. The twenty-five African cotton-producing countries in 2015/2016 (ICAC, 2016).
Table 1. Production statistics for 2015/2016 in African cotton-producing countries (ICAC, 2016).

<table>
<thead>
<tr>
<th>Country / Zone</th>
<th>Surface (x1 000 ha)</th>
<th>Fibre yield (kg/ha)</th>
<th>Production (P) (x1 000 t)</th>
<th>Import (x1 000 t)</th>
<th>Consumption (C) (x1 000 t)</th>
<th>Export (E) (x1 000 t)</th>
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<td><strong>2 658</strong></td>
<td><strong>370</strong></td>
<td><strong>983</strong></td>
<td><strong>0</strong></td>
<td><strong>18</strong></td>
<td><strong>982</strong></td>
<td><strong>2%</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>ANGOLA</td>
<td>3</td>
<td>302</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
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<td>0%</td>
</tr>
<tr>
<td>ETHIOPIA</td>
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<td>42</td>
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<td>50</td>
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<td></td>
</tr>
<tr>
<td>GHANA</td>
<td>12</td>
<td>366</td>
<td>4</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>KENYA</td>
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<td></td>
<td></td>
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<td>0%</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td>0%</td>
</tr>
<tr>
<td>MOZAMBIQUE</td>
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<td>181</td>
<td>20</td>
<td></td>
<td></td>
<td>3</td>
<td>9%</td>
<td>94%</td>
</tr>
<tr>
<td>NIGERIA</td>
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<td>205</td>
<td>52</td>
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<td>115%</td>
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<tr>
<td>SOUTH AFRICA</td>
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<td>1 250</td>
<td>9</td>
<td>17</td>
<td>21</td>
<td>10</td>
<td>233%</td>
<td>111%</td>
</tr>
<tr>
<td>TANZANIA</td>
<td>315</td>
<td>217</td>
<td>68</td>
<td></td>
<td>39</td>
<td>38</td>
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<td>56%</td>
</tr>
<tr>
<td>UGANDA</td>
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<td></td>
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<tr>
<td>ZAMBIA</td>
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<td></td>
<td>2</td>
<td>14</td>
<td>5%</td>
<td>35%</td>
</tr>
<tr>
<td>ZIMBABWE</td>
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<td></td>
<td>4</td>
<td>31</td>
<td>16%</td>
<td>124%</td>
</tr>
<tr>
<td><strong>East. &amp; South. Africa</strong></td>
<td><strong>1 322</strong></td>
<td><strong>240</strong></td>
<td><strong>317</strong></td>
<td><strong>31</strong></td>
<td><strong>148</strong></td>
<td><strong>213</strong></td>
<td><strong>47%</strong></td>
<td><strong>67%</strong></td>
</tr>
<tr>
<td><strong>Africa</strong></td>
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<td><strong>336</strong></td>
<td><strong>1 388</strong></td>
<td><strong>101</strong></td>
<td><strong>315</strong></td>
<td><strong>1 248</strong></td>
<td><strong>23%</strong></td>
<td><strong>90%</strong></td>
</tr>
</tbody>
</table>
Figure 3. Distribution of African cotton-producing countries by class of fibre production (top) and fibre yield (bottom) in 2015/2016 (ICAC, 2016).
Figure 4. Cotlook A Index, evolution of the average price of cotton-fibre on the world market (source http://www.insee.fr/fr/bases-de-donnees/bsweb/serie.asp?idbank=000455732).

Figure 5. Evolution of African cotton-fibre production from 1990 to 2015 (source ICAC, 2017).
1.1.4. Achievement of the Action

The study, which is organized in five phases and conducted by two experts, began a six-month provisional period in April 2016. It only includes the twenty-four African members of the ACP Group of States (thus excluding Egypt).

Phase 1 began in 2016 and consisted of five elements:

i) The conjoint work of the two experts to initiate the study (Montpellier, France, April 4-8);

ii) A documentary review;

iii) A presentation of the study by one of the experts (B. Bachelier) in the framework of the PR-PICA’s 9th Annual Assessment Meeting (Ouagadougou, Burkina Faso, April 13-15, 2016);

iv) The elaboration and distribution of questionnaires to the National Agricultural (or Agronomic) Research Institutes (NARI), to the Regional Agronomic Research Centres (RARC), and to the users of data from African cotton research (see the annex to this report for a list of correspondents that responded to the questionnaires); three distinct questionnaires were designed, one for each type of interlocutor, and each questionnaire was provided in French and English (see annex of the study’s initial report);

v) Editing and submission of the study’s Inception Report.

Phase 2 consisted of a presentation and brainstorming workshop (Cotonou, Benin, May 20, 2016). This workshop occurred back-to-back with the final workshop (Cotonou, Benin, May 18-19, 2016) presenting the results of the project ITK AID-cotton (“Technical Innovations and Africanization of Sustainability Indicators in cotton farming”, 2015-2016), which was also financed by the European Union (EU) in the framework of the Intra-ACP Cotton Programme. The phase 2 workshop included a presentation of the study and the initial elements of the diagnosis, a brainstorming session on the recommendations to be issued, and the creation of a monitoring unit. The original unit of twelve Francophone individuals was later joined by an Anglophone member (Dr Everina Lukonge, UARI, Tanzania). The report of this workshop was distributed in June of 2016.

Phase 3 included four circular missions (two per expert) which were undertaken in Africa with SNRRA and their partners in the cotton value chain. Time and budget constraints did not allow the experts to visit all of the twenty-four African cotton producing countries included in the study, therefore a selection of countries was made based on several criteria: responses to the questionnaires, volume of production, and inclusion of the three African sub-regions (West Africa, Central Africa, and East and Southern Africa). As a result, twelve countries were visited (Figure 6): Mozambique, Uganda, and Tanzania (B. Bachelier in July of 2016), the Central African Republic, Chad, and Cameroon (L. Seiny Boukar in July 2016), Senegal, Mali, Burkina Faso, and the Côte d’Ivoire (B. Bachelier in August of 2016), Togo, Burkina Faso, and Benin (L. Seiny Boukar in August of 2016). During these missions, one or more meetings were held in each country with most of the national actors involved in the cotton value chain. Both experts also met with the Cotton Focal Point of the UEMOA/WAEMU in Ouagadougou. These meetings enabled the experts to detail the study’s objectives, present the first elements obtained, and collect complementary information, opinions and suggestions from the actors in cotton research and its partners for use in refining the diagnosis and recommendations in the strategy to revamp African cotton research.

Phase 4 focused on two databases which were created for the storage and exploitation of the responses from the questionnaires (September). The data was then analysed and organized in tables and graphics (October - December). A preliminary slide show presentation of the diagnosis and initial recommendations was prepared and submitted to the monitoring-validation unit (October 20, 2016), and then presented by one of the experts (B. Bachelier) at the 5th Steering Committee of the Support Programme for the Consolidation of the Action Framework of the EU-Africa Partnership on Cotton (Brussels, Belgium, October 26, 2016). This presentation was conducted following the presentation assessing progress of the ITK AID-
Cotton project (see Phase 2 above). After being submitted to the monitoring unit for validation (December 2016 - January 2017), the report titled "Diagnosis and recommendations for the elaboration of a proposal for a revamping strategy of African cotton research" was released for dissemination. It is downloadable at this address: http://www.coton-acp.org/modules/docpool/files/etude320-967-diagnosisandrecommanagementsfinalreport.pdf. The responses to the questionnaires have been organized in an annex report (not disseminated). The monitoring unit validated the current report "Proposal of a detailed strategy for revamping African cotton research" (February 2017) before being disseminated.

**Phase 5**, the last phase of the study, consists of preparing the presentation of the proposal for a detailed strategy to revamp African cotton research, validated at the technical level by the monitoring-validation unit, and presenting it at the official closing of the “Support Programme for the Consolidation of the Action Framework for the EU-Africa Partnership on Cotton” (Ouagadougou, March 25 - April 1, 2017), in the meetings framework of the 22nd COS-Cotton and the programme Steering Committee. Remarks and comments expressed regarding the proposed strategy are reported in the annex of this report. Particular emphasis was placed on the important role of agricultural advisory and of research funding, leading to better integrate this questions in proposed activities.

![Figure 6. The twelve countries visited in the framework of this study (in green).](image)
1.1. Summary of elements from the diagnosis of African cotton research

The report "Diagnosis and recommendations for the elaboration of a proposal for a revamping strategy of African cotton research" was established from i) responses to the questionnaires addressed to the National Agriculture or Agronomic Research Institutes, the Regional Agronomic Research Centres (RARC), and the users of the results of African cotton research, and ii) the meetings and exchanges with actors from the cotton value chain in the twelve countries visited.

The "diagnosis of African cotton research" was approached through eight components. The principal elements of these components are outlined in the following.

<table>
<thead>
<tr>
<th>Component</th>
<th>Sub-component</th>
<th>Diagnostic element</th>
</tr>
</thead>
</table>
| 1. Human resources in African cotton research | Cotton researchers | • 168 research personnel work in 19 NARI  
• 10 work in two cotton companies  
• More than 8 in 10 work in public research organisms  
• 3 in 4 work in the National Agricultural or Agronomic Research Institutes (NARI)  
• 1 in 4 NARI researchers is over 50 years old & 1 in 2 is over 40  
• 1 in 5 NARI researchers is a woman  
• 1 in 4 NARI researchers with a degree, has a doctorate, and 1 in 10 has no university degree or advanced degree  
• In the NARI, more than half of the degrees in progress are doctoral |
| | Cotton technicians | • 3 for 4 researchers  
• 8 in 10 are less than 50 years old |
| | Support services | • Lack of statistical and computer services in almost 2/3 of the NARI  
• Lack of documentation services in almost 1/3 of the NARI |
| | Temporary staff | • 9 in 10 of the NARI make use of temporary staff |
| 2. Disciplines, themes, and activities in African cotton research | Disciplines actively involved | • Almost 3/4 of cotton researchers are concentrated in 3 disciplines: entomology, genetics, and agronomy (soil fertility, technical itineraries, cropping systems and production)  
• Agronomy, entomology, and genetics are the only disciplines actors consider as adequately represented in the NARI |
| | Principal research themes or activities | • 4 major types conducted by NARI and their partners: pest management, variety/seeds, technical itinerary (ITK), and direct seeding on cover vegetation (SCV)/conservation agriculture (CA)  
• 4 principal causes of delayed activities: lack of funding, equipment, personnel / capabilities, and access to land/laboratories |
| | Research themes from the PERFORMON workshop | • 5 priorities among NARI and Users: soil fertility, climate change, crop protection, cotton quality, and variety innovation (http://uraida.cirad.fr/actualites/performon) |
| 3. Scientific and technical | Experimental mechanisms in the field | • Limited or non-existent access, handicapping cotton research in the NARI |
### Component: Means of African Cotton Research

<table>
<thead>
<tr>
<th>Sub-component</th>
<th>Diagnostic element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental mechanisms in the laboratory</td>
<td>• Existing but sometimes limited access which needs to be improved</td>
</tr>
<tr>
<td>Technical means and tools</td>
<td>• Inadequate access to materials and basic software</td>
</tr>
<tr>
<td>Other support mechanisms</td>
<td>• Poor quality internet service and lack of small instruments/equipment</td>
</tr>
<tr>
<td></td>
<td>• When existing or accessible: partnership canvassing, innovation, data analysis, publication, fibre analysis, and biotechnology tools</td>
</tr>
</tbody>
</table>

### 4. Partners of African Cotton Research

| Scale | 
|-------|---|
| At the national scale | • Cotton companies, producer associations, and universities/agricultural training institutes |
| | • Conjoint actions: activity programming, conducting field work, dissemination of research, expertise, and management of students and interns |
| At the regional and international scale | • NARI from other countries, RARC, international agronomic research centres, and African Cotton Association |
| | • Conjoint actions: workshops, network management, project development, publication, and training |

### 5. Communication, Publications & Dissemination of Results from African Cotton Research

| 
| Visibility and integration of national cotton research in the global scientific community | • Strong lack of communication with the international scientific community and weak scientific production (0.1 - 2.5 documents on average per researcher per year) |
| | • Over 15 years: 1/2 in technical reports, approx. 1/5 in communication, and 1/10 in journal articles |
| | • Weak integration of national cotton research at the regional and national levels |
| | • Constraints in terms of funding, access to tools and training interfere with visibility and integration |
| Contribution to the diffusion of adapted solutions & impacts of cotton research | • Varied solutions and a contribution in phase with major NARI research themes and activities: production quality, pest management, conventional varieties, weed and fertility management, seed quality, cultivation system, sowing density, SCV/direct seeding, and disease management |
| | • A shared vision among NARI and Users on the solutions derived from cotton research, and their diffusion |

### 6. Organization of African Cotton Research

| 
| Actors in national cotton research | • Primarily conducted in the public sector (NARI and possibly universities) |
| | • Complemented by a mix of public-private actors: cotton companies, professional organization, producer organizations, and NGOs |
2. Strategic vision

The diagnosis of African cotton research has revealed specificities and convergences among the cotton programmes of the National Agricultural/Agronomic Research Institutes (NARI). Globally it underlines deficiencies in terms of human resources (quantitative and qualitative), scientific means (infrastructure, equipment) and funding (amounts and continuity). It also makes note of out-dated research tools and subjects, approaches based on disciplines rather than themes, and poor visibility or dissemination of results. It evidences insufficient exchanges with partners in the cotton value chain, and too few mechanisms for...
collaboration between regional, national and international partners, even though the different countries share common problematicas such as the loss of soil fertility, pest management, and climate change.

The recommendations formulated to improve the performance of African cotton research address issues of security and continuity for the activities of scientific personnel, diversification and sustainability of financial resources, and the adoption of themes relevant to the challenges of cotton research and related social requirements. One of the challenges involves the mutualisation of resources (personnel, infrastructure, funding) by a more global approach to research (regional centres and mechanisms, regional projects and programmes, and regional networks).

On the basis of the different elements found in this study, as well as those in the regional strategies of the UEMOA, the ECCAS/CEEAC and the COMESA (2011), and the PERFORMON framework (CIRAD, 2014), we propose the following strategic vision:

**Revamp African cotton research and improve its contribution to the sustainability of cotton cultivation, farm income, and the competitiveness of the cotton value chain.**

Beginning with this strategic vision and with the goal of enabling African cotton research to effectively contribute to the improvement of the competitiveness of the cotton value chain, specific actions should be taken in the framework of a revamping strategy. The strategy at the technical level as proposed by this report is organized into 4 strategic objectives, 11 operational objectives, and 43 activities. The four strategic objectives are outlined as follows:

- **Strategic objective n°1 (SO1):** Reinforce the capabilities of African cotton research.
- **Strategic objective n°2 (SO2):** Adapt the themes and tools of African cotton research to contribute to sustainable production.
- **Strategic objective n°3 (SO3):** Make African cotton research more efficient in its relationship with other actors in the cotton value chain.
- **Strategic objective n°4 (SO4):** Improve the dissemination of African cotton research in the global scientific community.

The further expansion of these strategic objectives into operational objectives and activities is detailed below. In terms of implementation priorities, the objectives are initially presented in a descending order of urgency from OS1 to OS4. However, even if they are associated with different strategic or operational objectives, several activities are interdependent and will not produce the anticipated effects unless they occur in the same period. The implementation could be stretched over a period of five or six years. At the end of this period, an update of the diagnosis would enable an evaluation of the evolution in the performance of African cotton research.

This technical proposal should be shared with the ensemble of actors concerned, validated though policies, and adapted to the opportunities and constraints inherent in the implementation of a strategy. At this stage, the geographic scale covering the African continent limits our ability to elaborate specific details of activities for each of the twenty-four countries involved. Nevertheless, this work will be essential for the strategy as it advances to a stage of implementation with a need for more localized proposals that are aimed at individual or smaller groups of countries, and specifically adapted to the various contexts of the cotton value chain, the constraints, and the state of cotton research and collaborations with other entities. Likewise, more precise phasing of the different activities and associated actions will thus be needed.
3. Strategic objectives and expected outcomes

3.1. Strategic objective n°1: Reinforce the capabilities of African cotton research

To successfully carry out its missions, African cotton research must have the scientific researchers, the technicians, and support personnel adapted to its needs. However, since 2005, a series of crises leading to structural adjustments and disengagement from the state of the cotton value chain have considerably reduced the human resources available for this research. Over the years, a freeze in hiring combined with departures for retirement has resulted in a drastic reduction in the number of scientific researchers, and the training and educational programs that form a path of reinforcement of capabilities have become rare. In addition, the status of active researchers, when it exists, is not always applied.

To meet this strategic objective, we propose the following twelve activities, organized into three operational objectives. The expected outcome is the reinforcement of the capabilities of African cotton research at the level of competency, technical means, and funding.

3.1.1. Operational objective n°1.1: Ensure the optimum management of research skills

3.1.1.1. Activity n°1.1.1: Pursue a voluntary recruitment policy, planned and adapted for achieving and maintaining the personnel necessary (number, type, training, education degree, age and gender) to conduct cotton research programmes

- To compensate for personnel who are already planning retirement, and to anticipate future departures for retirement given the existing age pyramid, it will be necessary in the short term to recruit young men and women researchers with advanced degrees. This recruiting should enable a more balanced ratio of women to men, which is currently around 20/80. To be efficient and permanent, the recruitment of young researchers should be planned cooperatively with the concerned research teams, and accompanied by integration mechanisms such as tutoring or apprenticeship (see n°1.1.2), either set up or improved if mechanisms already exist. These mechanisms should allow young researchers to benefit from the experience of their elders and accelerate their understanding of the realities and constraints of the work.
- Furthermore, it will be necessary to ensure that the level of recruitment is consistent with the periodic reinforcement needed in the capacities of personnel in the research teams.

3.1.1.2. Activity n°1.1.2: Reinforce the capabilities among scientific and technical staff

- Reinforcing capabilities of personnel is a priority, and it can be addressed by several actions:
  o Tutoring or apprenticeship among researchers, especially for encouraging the integration of young researchers, and the trans-generational transfer of knowledge.
  o Planning for continued education and training, individual and collective, both inside and outside of the NARI, that is managed scientifically by the cotton research teams (possibly requiring learning new management skills). This type of training should be anticipated and programmed regionally and periodically with sessions organized in the various African countries. This will provide one means of introducing and maintaining a regional dynamic in African cotton research, ensuring that each country is involved actively and as a beneficiary. Regional training and education programs will certainly benefit the largest number of individuals, but these programmes should also be complemented with training and education outside of the African continent.
  o Establishment of degree programmes (certificates, bachelor, master, doctorate, etc.).
Establishment of regional training programmes (modelling, biotechnology, technology, statistics, innovations, scientific editing, English, project development, etc.) that could certainly find funding.

- Internships in the international centres such as the West African Centre for Crop Improvement (WACCI), the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), or Wageningen University (WUR).

**3.1.1.3. Activity n°1.1.3: Secure the status of researchers by adopting the appropriate texts in accordance with the requirements of the CAMES**

- In order to avoid the loss of NARI researchers at the national level, their status should be made more attractive, particularly in comparison to the status of university teaching-research positions. The conditions for advancement, remuneration, and retirement should be consistent with those at the universities. As a complement, the categorization as found in the current procedures of the African and Malagasy Council for Higher Education should be taken into account, but adapted to the actual conditions in agricultural research.

**3.1.1.4. Activity n°1.1.4: Take inventory of the human resources available to the national programmes and projects of cotton research**

- In each African cotton producing country, take an inventory of the human resources related to or involved in the themes of cotton research: researchers, university teachers-researchers, cotton companies, etc. This information could lead to the creation and periodic updating of a human resource database, consolidated and decentralized.

**3.1.2. Operational objective n°1.2: Reinforce the technical means of research.**

**3.1.2.1. Activity n°1.2.1: Improve the operational capacity of the existing national research infrastructure (land, laboratories, and scientific equipment)**

- Define an itinerary of improvement for each country, capitalizing on the advantages and the current infrastructure, beyond that of the NARI alone. For example, in the Côte d’Ivoire, biosecurity infrastructures have already been established and exploited by the universities (at least one), suggesting that it is not necessary to reproduce them for the CNRA. However, it is still necessary to establish partnership links between these structures. This sharing approach should also be applied to cooperating countries: if something is already functioning in one country, links should be established for other countries, particularly those with few resources, to benefit.

- Improve the access of national research structures (NARI, universities, etc.) to adapted experimental mechanisms for terrains and laboratories (greenhouses; cold storage; laboratories for analysis of soil, plant material, seeds, fibre and thread; cotton gins; insect breeding; DL50; specific equipment and new technologies). The national structures of cotton research need access to these types of mechanisms in order to better identify the determinants of production in variable environments. Improving this access should be a priority.

- Provide appropriate and functional research equipment: the experimental stations are rarely equipped with material for characterizing climatic conditions other than a traditional pluviometer. This deficiency in equipment is also typical for characterization of cover plants (leaf surface area, nitrogen levels, etc.) and the availability of water and soil nutrients (tensiometers, probes). The lack of equipment means that experimental trials are rarely characterized according to agronomic standards, leaving the scientists who interpret them with little in the way of information or publishable results.

- Ensure that laboratories have the indispensable analytical tools necessary to characterise the impacts on fibre quality. The position of African cotton-fibre production on the cotton market depends on satisfying...
the quality criteria that fixes it exchange value, therefore the research must have access to these tools, either in the local laboratory, or by contracting the work elsewhere (involving a yearly budget for the cost).

3.1.2.2. Activity n°1.2.2: Provide African cotton research with appropriate work and communication tools

- This particularly includes the following:
  - Computer information system (computers, adapted software, printers, scanner, photocopier).
  - Agricultural vehicles and material.
  - Reliable internet access.
  - Access to technical and scientific information (TSI), see Activity n°4.1.3. The research centres in African countries can have free and easy access to TSI by taking the measures to access the AGORA platform: [http://www.fao.org/agora/en/](http://www.fao.org/agora/en/). AGORA access initiated by the cotton programmes in the following months will be a good indicator of the willingness in these countries to commit to improving the functioning of the NARI – a primary factor in attracting the attention of regional and international support.
- Video conferencing tools in the research centres to encourage exchanges and minimize the difficulties and cost of travel.

3.1.2.3. Activity n°1.2.3: Promote the regional mutualisation of existing experimental mechanisms based on their comparative advantages

- At the regional level, and particularly for regional projects, conjointly programme and conduct multinational trials that incorporate the synchronised mutualisation of mechanisms for similar situations and common themes. This effort could achieve important economies in time for the generation of credible, robust, and publishable results. It should be noted that several software tools exist for data treatment in the framework of multi-environment variety trials (particularly, the GGE biplot analysis).
- The mutualisation of mechanisms would also enable the establishment of a climate observation network, composed of weather stations installed in the cotton research stations of the various countries.

3.1.2.4. Activity n°1.2.4: Create and promote specialized research centres and/or centres of excellence in cotton research

- The regionalization of research and the underlying mutualisation of means also represent an optimization and integration in the form of shared infrastructures. This entails concentrating the material means on sites that offer a comparative advantage for a given theme: climate change, agricultural conservation, variety creation, mechanization, etc. These sites can become regional centres of specialized research, although there are limitations to be acknowledged in the available research means and the necessary globalisation of actions within the Regional Economic Communities (RECs). Furthermore, the specialised infrastructures organised around a particular theme do not respond to all the questions facing African cotton research. Nevertheless, a significant positive aspect of the integration in these shared structures lies in the improved position in terms of access to international funding and the creation of public-private partnerships (PPPs).
- In the absence of CGIAR cotton, we recommend the creation of a multi-theme and multi-disciplinary African centre of excellence in cotton research (Centre de Recherche Cotonnière pour l’Afrique / Cotton Research Centre for Africa, CRCA), or regional centres of excellence in cotton research (Centres Régionaux de Recherche Cotonnière / Cotton Research Regional Centres, CRRC). The choice of a unique centre would enable the maximum mutualisation of means, but its pertinence to the diversity and scale of Africa and the twenty-four cotton producing countries remains debatable. From a technical point of
view, it seems more logical to recommend the creation of several centres of excellence. These centres would have a number of missions:

- Create a “critical mass” enabling the metallization of resources (human, technical, financial, etc.) and optimize their use.
- Improve the targeting of sources and requests for funding (African Union, Regional Economic Communities, other public and private sources, PPPs, etc.).
- Address research questions at the scale of cotton cropping systems.
- Incorporate complete infrastructures (offices, analytical and breeding laboratories, cotton gins, cold storage, meeting rooms, lodging, etc.).
- Employ efficient equipment (information technology; internet; greenhouses; analytical equipment for soil, plant material, fibre, grains and threads; cotton gins; spinning; breeding; DL50, etc.).
- Ensure researcher training, particularly through the trans-generational transfer of knowledge.
- Encourage scientific exchange and international collaboration (develop networks, mount structurally ambitious projects, dissemination of results, etc.).
- House a unit to evaluate and conserve cotton genetic material.
- Conduct work in pre-breeding (crosses and first descendants) in order to provide genetic material for geneticists from African cotton producing countries; note however, in the framework of shared activities, the need to take into account the legal protection of varieties while adapting to a regional approach for their creation.
- Test motorized mechanization / agricultural motorization (rototillers, ploughs, seeders, spreaders, weeder, harvesters, etc.)
- Introduce and evaluate technical innovations within a short time frame (see project ITK AID – Cotton “Innovations cotonnières en Afrique de l’Ouest et du Centre2”).

- The option, “centres of excellence in cotton research”, relates to the transfer and diffusion of innovations. In the context of PPPs, this option seems more pertinent, with strong leverage (advantageous for upscaling best practices), but certainly complex to establish and manage. In any case, the implementation of specialized centres or centres of excellence can only be achieved through a progressive and collective effort. It should be noted that the UEMOA has pointed to regional centres and the CORAF / WECARD has identified centres of excellence. It would therefore be an opportune time to draw on these initiatives for efforts such as promoting one or several centres dedicated to cotton research, ensuring the participation of the countries concerned, allocating the means (human, technical, genetic resources, financial, etc.) and specifying their status, in order to conduct the activities (research, preservation, dissemination, training, transfer, etc.) with the results being shared between stakeholders.

3.1.2.5. Activity n°1.2.5: Preserve and disseminate the genetic resources of African cotton (germplasm and seeds)

- The “classic” creation of new varieties is a long and costly process (a dozen years) that requires anticipating the evolution in techniques and technology demanded by the clients. Each breeding selection has its advantages and disadvantages. The pooling of knowledge and results enables the detection of complementarities, the regionalization of recommendations, and the development of optimized hybridizations. However, it is evident that over last few years there has been a decline in the improvements resulting from new varieties. This is a notable indication of a reduction in the genetic base used for selection purposes, and occasionally a reduction in the seed quality (low rate of germination, mixture of varieties). There are several recommendations for improving the varietal response of African cotton research as it faces the problematics of farmers:

2 http://coton-innovation.cirad.fr/
• Improve genetic purity and sanitary quality of conventional seeds distributed to farmers (level of research and development).
• Encourage the exchange of healthy seeds between members of the network of African cotton researchers.
• Develop a programme creating isogenic varieties for various criteria (plant morphological characteristics, oil and protein levels in seeds, etc.)
• Provide access to a structure adapted to seed development and the preservation, rejuvenation, and dissemination of the germplasm in Africa. This could be accomplished through the centres of excellence in cotton research (see Activity n°1.2.4) or through an African Centre of Genetic Resources / Centre Africain de Ressources Génétiques (ACGR/CARG) intended to encompass the various species cultivated in Africa. This type of structure would act as a safeguard against the loss of genetic material, as has been the case in the past in several African countries (notably, following crisis situations).
• Enlarge the genetic base of African cotton through access to the cotton gene bank of the CIRAD, and other gene banks outside of Africa (Embrapa of the C4 countries, etc.) with the establishment of an experimental undertaking for shared rejuvenation, allowing better exploitation of genetic diversity.
• Implement modern tools to aid varietal selection that are available from biotechnology (marker-assisted selection, genomic selection, association genetics). This could be accomplished at the level of centres of excellence in cotton research (see above Activity n°1.2.4), grouping the necessary human and technical resources.

• The priority among these actions could correspond to the order in which they are presented above.

3.1.3. Operational objective n°1.3: Ensure long-term and diversified funding sources for research.

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<th>3.1.3.1. Activity n°1.3.1: Mobilise national funding</th>
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• For sustainable national research, the operating costs (salaries, water, electricity, communication, infrastructure maintenance, etc.) and expenses related to prospective research programs must be ensured by the State. Certain strategic continuing education or degree programmes should also be supported by public funds.
• The activities of applied research and the related costs incurred (including field logistics and certain laboratory equipment) are defined with the public and private users of the research results (such as producer associations, cotton companies, sectoral organisations) who fund them on a contractual basis. As mentioned for the regional centres (Activity n° 1.2.4), the search for funding in the framework of PPPs should be encouraged.
• In several cotton-producing countries, a national fund is available to finance all or part of research activities. In Africa, such a national fund for cotton research could be set up through a financing mechanism based on the annual amount of production (seed-cotton or fibre) and a set price par kg, set beforehand by the cotton sectoral organization. It would be responsible for the management of this fund and for making it available, based on priorities defined with all cotton stakeholders.

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<th>3.1.3.2. Activity n°1.3.2: Reinforce the researchers’ ability to develop projects and access competitive funding</th>
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• The Regional Agronomic Research Centres (RARC) are at the interface of national and international research institutions (scientific and funding). They are responsible for the management of regional funds. The reinforcement of researchers’ capabilities in the area of intervention to access these funds is part of their mission.
- At the national level, this section is implemented by the scientific management of the NARI. It can take the form of training researchers in the development of projects, arranging a tutor or mentorship (putting the necessary means in place) and giving researchers the means to access information on the different sources of funding.

**3.1.3.3. Activity n°1.3.3: Coordinate investigations and discussions on sustainable mechanisms of funding to maintain effective cotton research**

- The consideration of these mechanisms must be engaged in a coordinated manner at the national, regional, and international level. At the national level, it is necessary to convince the State and the sectoral organizations to commit contractually to the funding of cotton research as described in Activity n°1.3.1. This should also guarantee coherence between prospective or fundamental research and applied research. An implicit type of contract already exists (through automatic payments integrated in the mechanism fixing the purchase price of seed cotton). Experiments should be shared and adjustments defined to increase efficiency, or effectiveness, in promoting scientific and financial autonomy, and responsibility, in the NARI.

- At the regional level, the Regional Economic Community (REC) adds their political guarantee to the search for potential funding among regional or international institutions (such as AFD, World Bank, European Union, FRDA).

- African cotton research must take into account the questions related to the environmental evaluation of cotton cropping systems and to the effects of global changes on these systems. In order to respond to these questions, it will be necessary to mobilize national, regional and international funding, and form multidisciplinary consortiums (see Activity n°4.2.3).

**3.2. Strategic objective n°2: Adapt the themes and tools of African cotton research to contribute to sustainable production**

During the twenty-five years between 1980 and 2005 African cotton research produced results having an undeniable impact. The creation of varieties with strong characteristics, particularly in West and Central Africa (Burkina Faso, Cameroon, Togo, Chad), enabled growth in production and improvement in fibre quality. Effective methods of pest control were developed. Appropriate agronomic technical itineraries were established and made accessible. However, traditional production schemes have not been equipped to account for the profound institutional, technical, and biophysical transformations such as climate change, modifications in the pest complex, losses in soil fertility, a declining workforce, increases in costs, access to genetically modified cotton (GMC), and privatisations. In order to respond to this deficiency, African cotton research must centre its themes around these evolving challenges and issues, integrating the environmental, social and economic constraints that impact or are likely to impact the competitiveness of the African cotton value chains (production, yield, fibre and seed quality).

Numerous numerical simulation-models are now available in agronomic research, such as models of crop development, climate trends and forecasting, soil evolution, and hydraulic requirements. These tools have greatly influenced the evolution in research methods and approaches, by making the work more efficient and effective in the search for solutions that respond to new constraints. However, most of these tools were initially developed for more temperate crop zones and are still relatively unknown and under-utilized in the African NARI. Therefore, to better apprehend their research subjects, it is essential that researchers in the cotton programmes prioritize the appropriation these tools, and adapt and calibrate them for tropical crop zones.
This objective strategy can be approached through three operational objectives, which are extended here into thirteen activities. The expected outcome is the adaptation of themes and tools implemented in cotton research in order to contribute to sustainable production and respond to the new challenges, issues, and constraints facing the cotton crop, the farmers, and the cotton value chain.

3.2.1. Operational objective n°2.1: Improve integration of the evolutions in environmental constraints

- The professionals in Africa's cotton value chains experience the unfavourable manifestations of climate change through delayed onset and early or late cessation of rainy seasons, erratic amounts of rainfall, and dry spells or drought. Scientifically, climate experts have only been able to prove, globally and definitively, the rise in temperatures and levels of CO₂, and in certain zones the modifications in time and space of rainfall cycles. This reveals a gap between the perception of experience, and proven facts, that calls for the programming and realization of studies oriented towards the potential consequences of these changes on cotton cropping systems. Therefore, the necessary work on more localized changes falls more under the auspices of local teams than in a worldwide forum.
- The classical performance of plant materials and technical itineraries (ITK) that were valid and effective in the past are being challenged by these climatic disruptions. This context draws attention to the urgency and necessity of anticipating these effects of climate change, developing varieties adapted to the hydraulic stress, and creating rotation schemes that integrate the availability and optimisation of water. Under appropriate circumstances, occasional irrigation can be envisioned as a complement. Modelling tools for crop performance are used all over the world to anticipate and envision technical adaptations to global changes. The NARI cotton research programmes, impoverished and ill prepared to face this growing global issue, should be reinforced (see Activity n°1.1.1 et 1.1.2). These modelling tools are also helpful for organizing knowledge and distributing it among partners. Thus, the reinforcement of NARI capabilities in their use contributes an important educational aspect.
- New technical itineraries must be developed that are adapted to climate change, and more precisely to the variability of rainfall, and to cultivation techniques that reduce the impacts of climate changes.
- At the same time, acknowledgement of the poor capture of rainfall in cotton growing zones leads to the proposition for a change in this passive position. Concrete actions such as water retaining basins would be beneficial, particularly for changing the level of farmers' sensitivity to dry periods and input logistics.

3.2.1.1. Activity n°2.1.1: Adapt cotton research programmes to integrate the evolutions linked to climate change

- Several methods of pest control have been developed by cotton research. They are focused on the effectiveness of active materials and treatment methods. However, resistance to certain products has been observed (Helicoverpa to pyrethroids). Additionally, the cost of phytosanitary products continues to increase, and their toxicity to humans and the environment is continually confirmed, increasing the restrictions on the use of their active materials.
- For the sake of efficiency, the reduction of costs, human health, and respect for the environment, the recommendation is to turn to local materials (bio-pesticides, bio-herbicides), new generation molecules, and new techniques or methods. Several current or programmed actions can be cited: the Integrated
Production and Pest Management Programme (IPPM) in Africa\(^3\), threshold treatments, staggered seed-
cotton harvests (project GIRCOT-CORAF/WECARD), the use of trap crops, cotton topping (emissions from
volatile organic compounds have a repulsive effect on some pests), weed management, and research in
the management of weeds particularly affecting cotton crops.

- Following are several actions that should be undertaken by cotton research:
  - Accumulate and exploit knowledge on the evolution of the biocenosis.
  - Explore the feasibility of implementing an alert system (using new technologies) for pest
    management for cotton crops.
  - Follow the evolution of cotton diseases under pressure from cultivation practices and climate
    change.
  - Study the feasibility of producing and using organic pesticides on a large scale (virus, bacteria,
    fungus, plant extracts).
  - Follow the evolution of weed vegetation under the effect of cultivation practices (use of
    glyphosate in soil preparation) and under the effect of climate change.
  - Study the possibilities of offered by the management and exploitation of a mixed canopy,
    through crop rotation or association, under the economic constraints of diversifying economic
    products and food security.

- Take account of how landscape characteristics affect the dynamics of pest, diseases, and weeds.

3.2.1.3. Activity n°2.1.3: Consider new soil fertilization schemes that favour ways of increasing
their organic status (agroforestry, crop rotation, composting, cover plants, etc.)

- In spite of the numerous types of crop rotation that have been tested and increasing doses of expensive
  synthetic fertilizer, soil "fatigue" is often evident. Practices that increase the organic status of the soil
  (such as biofertilizers, SCV, agroforestry, mulching, associated crops) must be adopted in order to
  improve the effectiveness of these fertilizers and reduce the doses required.

- Tests of direct seeding (over cover crops) indicate that the technique is useful for soil and water
  conservation. However, it poses other problems such as weed management on smaller, family type
  farms, and there is still a need for studies on the availability of biomass, the identification of various cover
  plants and their impact on the evolution of soil carbon stock.

- For several years, there has been a decline in the efficiency of mineral fertilizers. This decline is the result
  of a combination of factors including economic constraints, the loss of soil fertility, and an acid pH in
  many of the cotton producing zones. Therefore, the formulas, the doses, and the application methods
  need to be reviewed, as well as the improvements needed to raise their level of efficiency (pH, organic
  status, and soil biological activity). The pertinence of leaf fertilization must also be studied.

3.2.1.4. Activity n°2.1.4: Adapt technical itineraries (ITK) to changing contexts

- The cotton crop is closely associated with the subsistence crops needed to satisfy the food needs of
  cotton farmers. In a context of soil degradation, growing risk of hydraulic stress, high input costs, and
  concerns about environmentally friendly practices, the traditional technical itineraries (ITK) have to be
  reconsidered. In addition, it would be too simplistic to adapt the ITK to a single crop such as cotton
  without integrating it in an exploitation where diverse crops interact. The priority must be placed on the
  search for alternative techniques that allow farmers to work towards the sustainable management of
  cotton cropping systems.

\(^3\) Conducted by the FAO and supported in the framework of the mechanism, «Support Programme for the Consolidation
of the Action Framework under the EU-Africa Partnership on Cotton”, see the innovation document AProCA available
Several axes of research and technical options should be considered, such as approaches through the techniques and practices of conservation agriculture (CA) and agroecology (see technical files of the ITK AID-Coton project on the site Coton-innovation): direct seeding, mulch based (SCV); sowing dates and density; twin row sowing; intensive cultivation; irrigated cultivation; motorized mechanization (see Activity 2.2.4); study of genotype interaction x environment x ITK for the design of ideotypes; organic cultivation / fair trade (see project Syprobio); associated or rotating crops; integrated cotton cropping systems with other crops such as cereals, corn, or soybean; association of agriculture-livestock; rotation integrating trees (agroforestry).

3.2.1.5. Activity n°2.1.5: Evaluate the value/usefulness of GMCs (Genetically Modified Cotton)

- At this point, farmers in three African countries have experimented with GMC: South Africa, Burkina Faso, and Sudan. Sudan is the only country currently pursuing a GMC crop. Nevertheless, other countries are interested (current trials or anticipated): the Côte d'Ivoire, Ghana, Nigeria, Cameroon, Ethiopia, Kenya, Uganda, Malawi, and Mozambique (source: ABNE, 2016).
- In Burkina Faso, cotton exploitations facing mono-specific parasite pressure reduced the number of insecticide treatments from 6 to 2 with GMC crops. This generates significant savings in terms of work time and production costs. The reduction in the number of treatments contributes to the farmers’ health and to respect for environmental regulations. In terms of economics, it has to be verified that reductions in treatments offset the cost of seeds. However, above all, taking note of the recent experience of Burkina Faso, it is vitally important to preserve the market quality of the cotton, particularly the fibre, in order to avoid negative impacts in terms of economics and reputation in the global market.
- The role of African cotton research in the question of GMC can be set on several levels:
  - Support for the definition of a national legislative framework and decision-making (see study Technoserve 2015 in Côte d'Ivoire)
  - Creation and/or evaluation of a network of transformed variety trials
  - Recommendations for adapted technical itineraries
  - Monitoring behaviour and production (quantity and quality) of GMC cultivated in real environments
  - Evaluating the environmental impacts of GMC

3.2.2. Operational objective n°2.2: Adapt research approaches to take account of the evolution in socio-economic constraints

3.2.2.1. Activity n°2.2.1: Improve the quality and market value of cotton products

- Continue the work of improving varietal fibre quality, which supports the global reputation of cotton production in numerous African countries.
- In a context of strong demand for food and animal feed, use selection techniques to improve the oil and protein content of cottonseeds.
- Study various means of promoting/improving cotton co-products (linters, seed, oil, and cottonseed cake), particularly in terms of food and energy values.

3.2.2.2. Activity n°2.2.2: Analyse the state and conditions of small family farms producing cotton

- Update knowledge on rural dynamics and family farms producing cotton.
- Update knowledge on the role of women and young people in cotton exploitations.

3.2.2.3. Activity n°2.2.3: Adapting to the reduction in family members working on farms
- Develop new production techniques that are less labour intensive.
- Examine weeding practices at the farm level for managing the labour required for hoeing.
- Introduce cultivation practices that reduce weed pressure.
- Analyse the experiments of chemically controlled weeds after the seedling stage.
- Study the feasibility of a fair credit system adapted to the labour needs of family farms.

### 3.2.2.4. Activity n°2.2.4: Conduct research on motorized mechanizations appropriate for cotton cultivation on family farms

- Develop new production techniques adapted to mechanization, particularly integrating the study of relationships between mechanization and weed control, in conjunction with Activity n°2.2.3.
- Study the technical, economic, and environmental feasibility of motorized mechanization in the various operations of cotton cultivation on small and medium sized family farms; the goal is to mechanize the largest number of cultivating operations while paying attention to equipment choices that disturb the soil and exclude the possibility of direct seeding; certain choices such as disc ploughs, seem to be a priori incompatible with CA.
- Implement the recommendations of the report « Cadre stratégique de référence pour le développement d’une motorisation durable dans les zones cotonnières en Afrique de l’Ouest » (Coton ACP, 2017)
- Keep track of developments in motorised mechanization in countries such as China, India and Pakistan for inspiration.
- Along with the technical aspects, study the social relationships involved in work exchanges in order to better characterize and consider schemes for developing motorization.
- Analyse the efficiency of manual tools for cotton harvesting (vacuum harvesters).
- Envision adapted mechanical harvesting equipment and determine the consequences in adjustments for commercialization and ginning.

### 3.2.2.5. Activity n°2.2.5: Implement R&D actions for coordinated management of space and natural resources

- Organize and accompany discussions and consultations with village communities.
- Take account of the new constraints brought about by technical changes (mechanization/motorization, water management, GMC, etc.).

### 3.2.3. Operational objective n°2.3: Open African cotton research to the world and the future.

#### 3.2.3.1. Activity n°2.3.1: Investigate and analyse innovations and important instances of evolution in technical itineraries of cotton production around the world

- Continue activities initiated in the framework of the ITK AID-Cotton project, particularly keeping track of innovations developed outside of Africa.
- Inform the African cotton network of the information and activities available on the internet site "Coton-innovation : Innovations cotonnières en Afrique de l’Ouest et du Centre ".
- Lead discussions and exchanges on the experiences in implementing land use policies in cotton zones.

#### 3.2.3.2. Activity n°2.3.2: Contribute to the understanding and improvement of indicators for sustainability in African cotton cultivation
The objective of the ITK AID-Cotton project was to promote inter-African exchanges on production techniques from a perspective of sustainability in cotton-based cropping systems and competitiveness within the cotton value chain. In this framework, the sustainability indicators for cotton cultivation as outlined by SEEP (Social, Environmental and Economic Performance of Cotton⁴), the panel of the ICAC on cotton innovations for Africa, were the subject of a selection process that enabled the identification of indicators well adapted to production conditions in West and Central Africa. We strongly recommend continuing, or initiating, among the ensemble of African cotton producing countries, the collection and transmission of information on these indicators.

Incorporating their research work, recommendations and innovations, it is now the responsibility of the ensemble of African cotton research organisms to encourage both the utilisation of these indicators by actors from the cotton value chain in each country, and the establishment of actions that enable their continued improvement.

3.2.3.3. Activity n°2.3.3: Explore new research themes and approaches for the future of African cotton

- Develop new software tools for the ex-ante evaluation of innovative techniques or to accompany the interpretation of agronomic trials.
- Develop modelling / diagnostics of cropping systems / production on the agro-socio-economic level.
- Prepare for the future by proposing innovations or recommendations for the long term.

3.3. Strategic objective n°3: Make African cotton research more efficient in its relationships with other actors in the cotton value chain

Research institutes and cotton programmes must take account of the immediate needs of the users of results, all the more so because these very users are often willing to support the research (particularly the cotton companies and the sectoral organizations). These partners should be integrated into the principle stages of the scientific process (programming, participatory trials, visits to trials at research stations, presentations of results, etc.). Research also has the mission of establishing a prospective vision, anticipating the problematics of development that fall within the domain of public authorities.

To reach this strategic objective, we are proposing three operational objectives and nine activities. These activities should enable more efficient results from African cotton research through improvements in the dissemination and popularization of its scientific production, in connection with its partners in the cotton value chain.

3.3.1. Operational objective n°3.1: Organize frameworks of exchange and cooperation between the research and other actors in the cotton value chain

- Use a framework of formal and regular meetings to systematically implicate the partners of the cotton value chain in the identification of research needs, the elaboration of research subjects, and the presentation of results. Avoid evaluations focused solely on short-term results.
- Develop agricultural advisory in each country, to improve technology transfer from research toward other stakeholders of the cotton value chain, in particular producers.

Consider new methods that favour mutual recognition among the actors. The existing forms of cooperation and exchange between research organizations and other actors in the cotton value chain are not always effective for explaining the constraints that prevent research from providing immediate results and benefits. The time required to understand certain phenomena could be long before knowing how to act. When this constraint is not apprehended or accepted, misunderstandings on the relevance of research work can endure.

3.3.1.2. Activity n°3.1.2: Establish sustainable, regional frameworks for dialogue and cooperation that bring together the ensemble of actors in the cotton value chain

- Establish and promote regional conferences on cotton research.
- Publish a technical newsletter on African cotton.

3.3.2. Operational objective n°3.2: Make research results more accessible and comprehensible.

3.3.2.1. Activity n°3.2.1: Institute mechanisms of sharing and cooperation between cotton research and other actors in the cotton value chain

- Create or develop mechanisms such as Farmer Field Schools for cotton producers.
- Organize "open house" (research stations, greenhouses and laboratories), trial visits and field demonstrations to encourage dialogue and sharing between researchers and users.
- Make frequent visits to farms, and take advantage of the opportunity for exchanges that can sensitize researchers to the perceptions and opinions of farmers vis-à-vis the innovations proposed.

3.3.2.2. Activity n°3.2.2: Contribute to technical training for other actors in the cotton value chain

- Cotton research should play a pedagogic role among the various actors in the cotton value chain, and the various subjects involved: risk analysis and management, the recognition of pest, diseases, and weeds and the damage they cause, utilisation of agro-socio-economic modelling results, production management and preservation of characteristics such as varietal purity, "contamination free" harvests, and intrinsic fibre and seed quality.
- Encourage the conception and design of training modules. NTIC development could eventually enable access to multimedia training modules on the internet (e-learning).

3.3.2.3. Activity n°3.2.3: Disseminate research results through diverse channels and mediums

- Use technical sheets, posters, audio-visual productions, and new technologies for information and communication (NTIC), etc.

3.3.3. Operational objective n°3.3: Improve the connections between research, development, and production at the national and regional levels (the sharing, transfer and popularization of knowledge and recommendations).

3.3.3.1. Activity n°3.3.1: Conduct conjoint, real-world tests of innovations proposed by research

- Research innovations that are developed in controlled environments are often less effective than anticipated when transferred to real-world use by farmers. Sometimes this loss can be attributed to the farmer who does not respect - or does not have the means to respect - the technical itinerary recommended. Nevertheless, this situation is also an effect of the interference with certain environmental parameters. Before popularizing innovations on a large scale among producers, it is
essential to conduct conjoint, real-world field tests and evaluate impacts in order to understand their behaviour, performance, and feasibility of actual use by farmers.

3.3.3.2. Activity n° 3.3.2: Involve producers in the research process (participation in varietal selection, identification of pest-repelling plants, organic fertilizer, and composting)

- The practical knowledge of farmers, particularly in the use of local products, should be taken into account in the research process. Involving the producers also helps reinforce their ability to master certain agricultural practices such as composting and pest management.

3.3.3.3. Activity n°3.3.3: Encourage direct exchanges between research organisms and development organisms

- Exchanges between research organisms and development organisms can take the form of mixed units of R&D or other forms of sharing information and services.
- Existing actions of differing types among the different countries should be examined to identify needed improvement.

3.3.3.4. Activity n°3.3.4: Develop new support structures adapted to the sharing of technical information with "connected" communication tools

- The modernization of farmers is associated with new means of communication. As internet service becomes progressively available in rural areas it will be used for sharing information (portable telephones and tablets).
- Nevertheless, considering the lingering difficulties and high costs of internet connections, more traditional communications must be maintained, such as radio emissions that can be accessed with a mobile telephone at the convenience of the listener.

3.4. Strategic objective n°4: Improve the dissemination of African cotton research within the global scientific community

The diagnosis of African cotton research underlined the low, or insufficient, level of international collaborations developed in the work and scientific production of African cotton researchers. Cooperation is a common practice in the scientific world, and occurs through both long term and formal mechanisms such as networks or research centres, and more intermittent or periodic forms such as conferences, seminars and workshops that are developed throughout the world. These mechanisms are excellent opportunities for sharing knowledge and know-how, planning conjoint studies, developing projects, and publishing results. They reinforce the capabilities of the researchers, and provide opportunities to disseminate results through publication in peer-reviewed journals (such as technical and scientific report on cotton or cotton zone in Africa) that are necessary for the recognition and careers of the researchers and essential for the visibility of African cotton research.

Two operational objectives and nine activities are aimed at this strategic objective. The expected outcome is the increased visibility of African cotton research, improved recognition and the development of more collaborations with the scientific global community worldwide.
3.4.1. Operational objective n°4.1: Improve the relevance, visibility, and recognition of African cotton research at the international level

3.4.1.1. Activity n°4.1.1: Develop internal mechanisms for communication and support within the research centres

- Hold regular (weekly or fortnightly), short (1 or 2 hour maximum), scientific meetings in the cotton programs (or on a larger scale of the NARI) that will allow researchers to present and discuss their work or projects, contribute to the integration of new staff members, and create an overall dynamic of scientific production.

3.4.1.2. Activity n°4.1.2: Plan for the participation of African cotton researchers at international cotton events (ICAC, ACA, SEA, etc.)

- Encourage the active participation (including presentations and posters) of cotton researchers at conferences, committees, and other opportunities for international exchange that involve the various actors in the cotton value chain. This might include event and platforms of exchange such as the plenary meetings of the International Cotton Advisory Committee (ICAC/CCIC), technical commissions of the African Cotton Association (ACA), and the Southern and Eastern African Cotton Forum (SEACF). This type of participation provides excellent opportunities for researchers: (i) to improve the understanding and integration of the questions and problematics of the various actors, (ii) to present research results and recommendations for the actors, (iii) to contribute the definition of major strategic orientations of the cotton value chain, and (iv) to build networks for exchange and partnerships.

3.4.1.3. Activity n°4.1.3: Incite and encourage scientific publication in peer-reviewed journals

- Develop African cotton researchers' capabilities to publish in peer-reviewed journals. Provide training for scientific writing, English language (for non-Anglophones) and biometric skills. Form a tutorial system, student supervision, and continuing education/degree programmes (a leading factor for doctoral programs).
- Facilitate publication by cotton researchers in recognized international journals, particularly peer-reviewed. Costs should be budgeted for each researcher (in the budget of his institute, for a project or a collaboration). Avoid "predatory publishers" even if they are tempting when publishing budgets are limited.
- Reinforce documentary services. These services are often treated as the poor relatives in the African research centres. This situation makes it difficult for researchers to access the scientific and technical documentation needed to be informed about current and historical work on the research themes relevant to their experiments and research projects. This difficulty concerns both the consultation of internal documentation (within their research centre), and access to external sources (particularly the journals available online). It is therefore important to (i) systematically update, organize, register, and archive the scientific and technical production, making it accessible both internally and externally, and (ii) facilitate the researchers' access to international scientific publications (budget subscription costs, internet access, etc.). As noted in Activity n°1.2.2, the AGORA programme, set up by the FAO of the United Nations, can be accessed without charge by African research institutions.

3.4.1.4. Activity n°4.1.4: Organize internal and/or external evaluations of cotton research (assessments and projects) and researchers
• Establish a systematic procedure for evaluating research results, both scientifically and in terms of their impacts at the level of the users. This evaluation will serve as an indicator of the effectiveness of the cotton research, a framework of exchange with the users, and a tool for guiding research activities.
• Involve socio-economists in the research process and in the monitoring of research impacts among the users.

3.4.2. Operational objective n°4.2: Develop regional and international synergy that reinforces the mutualisation of resources, activities and results

3.4.2.1. Activity n°4.2.1: Actions that encourage African cotton researchers to be involved in the existing international cotton networks

- National research institutions should facilitate their researchers' membership in international cotton associations such as the ICRA (International Cotton Researchers Association) or the ACA.
- Institutions should also allow researchers to participate in networks like the SEACF (Southern and Eastern African Cotton Forum) and the PR-PICA (Regional programme for the integrated protection of cotton in Africa).

3.4.2.2. Activity n°4.2.2: Create, or reinforce existing, extended geographical networks (WCA/AOC, ESA/AEA, and continent) in order to improve collaboration between African cotton researchers

- Since the dissolution of the WECARD/CORAF network, it is clear that the regional programme PR-PICA in West and Central Africa, and the SEACF of Eastern and Southern Africa, are the only formal networks of cotton researchers in Africa. Furthermore, in spite of the existence of FARA, which acts as the umbrella organization for WECARD/CORAF, the ASARECA, and the CCARDESA, there is no formal, global mechanism of exchange between African cotton researchers. This condition leads to the following recommendations for action:
  o Reinforce the SEACF network of cotton researchers in ESA/AEA to assure its sustained functioning and extend its capacities.
  o Support the transition of the PR-PICA from "Integrated Protection of Cotton in Africa" towards "Integrated Production of Cotton in Africa" in WCA/AOC, encouraging integration of the ensemble of disciplines and themes that can help improve cotton production and expand its activities in African cotton producing countries.
  o Use open access tools (CANTOOL http://www.cantool.net/, SLIRE http://www.slire.net/, etc.) to create a database of researchers and their activities.
  o Create an African Cotton Researchers Association / Association Africaine des Chercheurs Coton (A2C2/ACRA) with a web site, eventually associated with the ICRA.
  o Establish regular scientific meetings in Africa: the 1st African Cotton Research Conference, held in Lome, Togo in 1989, has never been repeated at the continental scale.
  o Expand collaborations with C4 countries, the WACIP, etc.

3.4.2.3. Activity n°4.2.3: Encourage African cotton researchers to develop and participate in regional and international projects and programmes

- Respond to calls for project proposals (African Union, etc.) and train researchers for this task.
- Develop multinational programmes on common themes of interest: varieties, fertilizers, pest management, SCV, climate change, ITK, agricultural mechanization / motorization, etc.

3.4.2.4. Activity n°4.2.4: Implement tools for sharing the results of African cotton research
• Provide accessible information on genetic resources of African cotton.
• Create a digital catalogue of African cotton varieties that covers the ensemble of African cotton producing countries.
• Share the results of trials on different research themes.
• We suggest that this information will be more accessible if it can be consulted on the internet, in a downloadable format (to be defined). In the beginning it could be hosted on the web site, "Coton-innovation - Innovations cotonnières en Afrique de l'Ouest et du Centre" which was created in the framework of the project ITK AID-Cotton. It could then move to the ICRA site or the site of the African Cotton Researchers Association (ACRA/A2C2), if that association were to be created (see above Activity n°4.2.2). In any case, it is necessary to add functionality to the databases on these sites, providing decentralized and shared sources of information.

3.4.2.5. Activity n°4.2.5: Encourage exchanges and visits between cotton researchers from the various organisms and research structures at regional and international levels

• These structures include the NARI, international centres, etc.
• Regional centres and/or centres of excellence in cotton research can also provide excellent opportunities for exchange among cotton researchers, and for hosting visiting researchers (see Activity n°1.2.4).

4. Domain of the strategy and its beneficiaries

This strategy proposal concerns twenty-four African cotton producing countries that are members of the ACP Group of States: South Africa, Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Uganda, R.C.A., Senegal, Sudan, Tanzania, Chad, Togo, Zambia, and Zimbabwe. In 2015-2016, they represent a collective surface of 4 million hectares of cotton cultivation and more than 1.3 million tons of cotton fibre.

There are no available statistics on the collective, continental African population that is involved in cotton farming, but we know that these exploitations are in large part, family farms. To have a better sense, we can look at figures available for West and Central Africa:

• In 2013, the Côte d'Ivoire counted 116,000 cotton farms, comprised on average of 7.6 individuals, 4.4 of which were active in the exploitation; this represents 510,000 agricultural workers and a global population of 880,000 (Technoserve, 2015).
• In 2014, Cameroon counted more than 200,000 cotton farmers working on 200,000 hectares of cotton.

Making an, a priori, realistic hypothesis of the surface area of African cotton cultivation, on the order of 1 hectare per exploitation, would suggest that there are approximately 4 million cotton exploitations on the continent. By extrapolating the figures from the Côte d'Ivoire, we can estimate that roughly 30 million people in Africa live on farms cultivating cotton. In addition, there are the individuals (and their families) directly implicated in other segments of the cotton value chain: researchers, developers, individuals involved in transformation, etc.

During the circular missions taken for this study in twelve countries (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Mali, Mozambique, Uganda, R.C.A., Senegal, Tanzania, Chad, and Togo), the experts met with participating actors to exchange ideas, opinions, and expectations concerning cotton research. These actors were from organisms such as the National Agricultural or Agronomic Research Institutes (NARI), universities, Regional Agronomic Research Centres (RARC), producer associations, cotton companies, sectoral
organizations, and NGOs. Opinions were also sought from political authorities such as Ministers in charge of agricultural or agronomic research, and representatives from Regional Economic Communities. All of these actors as well as those involved in transforming the products are either directly or indirectly linked to the cotton value chain at the national or regional levels, and constitute the potential beneficiaries of a revamping of African cotton research.

In terms of cotton research, the proposed strategy covers four key domains:

i.) institutional environment (human resources, experimental infrastructure and mechanisms, funding of activities);

ii.) research themes and tools, and the associated scientific disciplines;

iii.) collaborative mechanisms on a national level with local actors in the cotton value chain, the partnerships at the international level (networks, regional centres, centres of excellence);

iv.) international exchanges, and global visibility of the activities of African cotton research.

5. Connections with other actors in the cotton value chain

Research needs and their prioritization are defined in relation with all the national actors in the cotton value chain. In the field, in the real world, the research operations are performed in the farmers' fields with their active collaborations in subjects such as variety behaviour, monitoring the state of pests, or fertilization trials. This collaboration enables researchers to take account of other needs of the farmers, notably, the needs for subsistence crops that are integrated in the rotations of cotton cropping systems. The fibre yield and quality are also important to the people involved in ginning and spinning. This relationship is usually formalized through conventions that link the research with users of its results. These relationships also translate into funding for research activities by sectoral organisms, as seen in Burkina Faso and Cameroon in particular. Other actors also have links with the cotton value chain: the national and regional institutes, the lenders, suppliers of inputs and materials, the banks, etc.

6. Links to regional cotton strategies

The area of African cotton cultivation is covered by three official regional cotton strategies (RCSs) corresponding to the three African Regional Economic Communities (RECs):

- "Revised strategy for the implementation of the Agenda for competitiveness in the WAEMU cotton-textile industry 2011-2020" for the West African Economic and Monetary Union (WAEMU), applying to Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo;
- "Development strategy for the cotton-textile-clothing sector in Central Africa" (June 2011) for the Economic Community of Central African States (ECCAS); and
- "Regional strategy for cotton-to-clothing value chain” for the Common Market for East and Southern Africa (COMESA).

The actions of the "Support programme for the Consolidation of the Action Framework for the EU-Africa Partnership on Cotton" should have been coordinated with these RCSs. Unfortunately, over the last two years, and for various reasons inherent to the RECs, these regional organisms were not able to fully participate, thus slowing the implementation and monitoring of these regional strategies. The fact remains that these strategies exist and were adopted by each REC member country. These SRCs affect all the segments of the cotton value chain and highlight the role of cotton research in the points below. They have been addressed through the four strategic objectives (SO1, SO2, SO3, and SO4) proposed in this strategy to revamp African cotton research.
- Reinforce cotton research and promote the collaboration between research centres (SO1 and SO4).
- Develop and implement regional development programmes of research/technology (SO1 and SO4).
- Incorporate collaboration to address the transfer of competences between research centres for improvement of varieties, pest management, and agronomy (SO2).
- Reinforce the capabilities for exchange among agricultural research organizations, facilitating the mutualisation of resources and scientific and technological exchanges (provide laboratories with technical information, etc.) (SO1).
- Reinforce the partnership between research and producer organisations - popularization (SO3).
- Develop a regional programme for variety selection to improve field productivity, ginning yield, and technological characteristics of the fibre (SO2).
- Reinforce the capabilities of the researchers (SO1).

7. Consistency and relevance with respect to the evolutions in African agricultural policies

The common agriculture policies of the three regional institutions are closely associated with the framework of the Comprehensive Africa Agriculture Development Programme (CAADP) created in 2003 as part of NEPAD at the African Union. The global objective of the CAADP is to help African countries reach strong economic growth through the development of agriculture that contributes to the elimination of hunger, reduces poverty while improving food security and encourages the development of exports.

The regional cotton strategies listed above subscribe particularly well to three of the four thematic priorities (pillars) of the NEPAD⁵ (New Partnership for Africa's Development):
- Pillar 1, sustainable land management with reliable water control systems;
- Pillar 2, development of the private sector, rural infrastructure, improvements in commercial exchanges and market access;
- And pillar 4, agricultural research and popularization of new agricultural technologies.

The strategy for revamping African cotton research proposed here is rooted primarily in pillars 1 and 3, particularly through i) taking account of climate change effects and the loss of soil fertility, ii) the reinforcement of farmers' capabilities, and iii) the global improvement of the means, capacities, and efficiency of cotton research to respond to the issues of development.

8. Implementation framework

8.1. Outline of priority actions

The following tables outline priority actions for each of the strategic objectives, operational objectives, and activities (Table 3). The actions are presented with a list of the actors involved, the organisms or actors responsible for implementation, indicators of progress, envisioned technical support, and levels prioritized as high (1), intermediate (2), or low (3). At this stage, these elements are only indicative and will need to be identified more precisely and in function of future evolutions in this strategy proposal.

⁵ http://www.nepad.org/fr/programme/programme-definir-pour-le-developpement-de-la-culture-en-afrique-pddaa
### Table 3. Outline of priority actions in the proposed strategy to revamp African cotton research (in four parts)

<table>
<thead>
<tr>
<th>Operational objectives</th>
<th>Activities / Action leverage</th>
<th>Actors</th>
<th>Responsible for implementation</th>
<th>Progress indicators</th>
<th>Possible technical support</th>
<th>Priority (1 to 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Ensure the optimum management of research skills</td>
<td>1.1.1. Establish a voluntary recruitment policy, adapted to obtain and maintain the personnel necessary for conducting the cotton research programmes</td>
<td>Government Ministries</td>
<td>Directors of national research institutions</td>
<td>The number of researchers is maintained or augmented through recruitment of new personnel</td>
<td>Collaboration with national universities and cooperation with international research centres and scientific partners</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.1.2. Reinforce the capabilities of the scientific and technical personnel</td>
<td>Government Ministries, University</td>
<td>National research institutions</td>
<td>Increasing numbers of researchers with various education degrees; increasing number of scientific personnel benefiting from continuing education programmes</td>
<td>National and international training institutions, regional and international research centres, FIS</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.1.3. Secure the status of researchers by adopting appropriate texts that meet the requirements of the CAMES</td>
<td>Government Ministries</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>CAMES</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1.1.4. Inventory the human resources available for the national projects and programmes of cotton research</td>
<td>Universities, National research institutions</td>
<td>REC, National research institutions</td>
<td>Implementation of numerous projects of collaboration</td>
<td>RARC, International scientific partners</td>
<td>1</td>
</tr>
<tr>
<td>1.2. Reinforce the technical means of research</td>
<td>1.2.1. Improve the operational capacity of existing national infrastructures of research (land, laboratories, and scientific equipment)</td>
<td>Government Ministries; National and international scientific partnerships</td>
<td>National research institutions</td>
<td>Existence of field mechanisms (experimental research stations) and functional, well equipped laboratories</td>
<td>International scientific partners; Specialized laboratories</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.2.2. Provide African cotton research with adapted research and communication tools</td>
<td>Government Ministries; National research institutions</td>
<td>National research institutions; RARC</td>
<td>Improved communication between researchers at national, regional, and international levels</td>
<td>IARCs, RARCs, International scientific partners, funding partnerships</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.2.3. Re-engage in the regional mutualisation of existing experimental mechanisms as a function of their comparative advantages</td>
<td>Government Ministries, National research institutions</td>
<td>National hosting institutions, involved partnerships</td>
<td>New and functioning regional mechanisms</td>
<td>International partners</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.2.4. Create and promote specialized research centres and/or centres of excellence in cotton research</td>
<td>National research institutions</td>
<td>REC, RARC, ACA</td>
<td>Regional Centres and/or Centres of Excellence, created and functioning</td>
<td>IARCs, International scientific partners, Funding partnerships</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1.2.5. Preserve and promote the value of the genetic resources of cotton in Africa (gmo and seeds)</td>
<td>National research institutions</td>
<td>REC, RARC, ACA</td>
<td>African base or centre of cotton genetic resources, created and promoted</td>
<td>International scientific partners, CIRAD</td>
<td>2</td>
</tr>
<tr>
<td>1.3. Ensure long-term and diversified funding sources for research</td>
<td>1.3.1. Mobilise national funding</td>
<td>Government Ministries, Interprofessional organisations</td>
<td>National research institutions</td>
<td>Public funds regularly mobilised for research; Interprofessional organisations financially supporting applied research</td>
<td>Cotton companies, Interprofessional organisations</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.3.2. Reinforce the ability of researchers to develop projects and access competitive funding</td>
<td>Regional agricultural research centres, National research centres</td>
<td>National research institutions</td>
<td>Number of projects implemented with competitive funds</td>
<td>RARCs, FIS</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1.3.3. Coordinate the search for sustainable funding mechanisms that contribute to effective cotton research</td>
<td>ACA, RARC, Regional banks</td>
<td>Regional centres, National research institutions</td>
<td>Diversified funding, permanent funding</td>
<td>International funding partners, Regional banks, Interprofessional organisations</td>
<td>1</td>
</tr>
<tr>
<td>Operational objectives</td>
<td>Activities / Action leverage</td>
<td>Actors</td>
<td>Responsible for implementation</td>
<td>Progress indicators</td>
<td>Possible technical support</td>
<td>Priority (1 à 3)</td>
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<tr>
<td>2.1. Improve integration of the evolutions in environmental constraints</td>
<td>2.1.1. Integrate the evolutions linked to climate change with the cotton research programmes</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>Existence of a climate database; Inclusion of climatic constraints in the elaboration of cotton research programmes</td>
<td>IARCs, RARCs, Scientific partners, CIRAD, CRRA, AGRHYMET</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.1.2. Conduct studies on pests and diseases to adapt appropriate pest management schemes</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>Existence of a research programme on pest dynamics and biocenosis</td>
<td>IARCs, RARCs, International scientific partners, Crop protection companies</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.1.3. Consider new fertilization schemes that favour ways of increasing their organic status</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>Improvement in the organic status of soils; lower expenditures for chemical fertilizers</td>
<td>IARCs, RARCs, International scientific partners, Fertilizer companies</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.1.4. Adapt technical itineraries to changing contexts</td>
<td>Researchers, Producer organisations, Cotton companies</td>
<td>National research institutions</td>
<td>Visible innovations in agricultural practices</td>
<td>IARCs, International scientific partners, Manufacturers of agricultural machinery</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.1.5. Evaluate the value/usefulness of GMCs (Genetically Modified Cotton)</td>
<td>Researchers, Producer organisations, Cotton companies</td>
<td>National research institutions</td>
<td>Participative tests conducted on GMC</td>
<td>Regional and international scientific partners, Specialized companies</td>
<td>2</td>
</tr>
<tr>
<td>2.2. Adapt research approaches to take account of the evolution in socio-economic constraints</td>
<td>2.2.1. Improve the quality and value of cotton products</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>Improvement in the technological parameters of the fibre and the oil and protein content in seeds</td>
<td>International scientific partners, IARCs, RARCs</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.2.2. Analyse the state and condition of cotton production on family farms</td>
<td>National research institutions</td>
<td>National research institutions</td>
<td>Data on the functioning of existing family farms</td>
<td>Regional and international scientific partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.2.3. Adapt to the reduction of the familial workforce on family farms</td>
<td>National research institutions, Producer organisations</td>
<td>National research institutions</td>
<td>Data on the social dynamics in cotton-producing, family farms</td>
<td>International scientific partners</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.2.4. Conduct research on mechanization and motorisation for cotton cultivation on family farms</td>
<td>National research institutions, Cotton companies</td>
<td>National research institutions</td>
<td>Augmentation in motorized agricultural practices and operations</td>
<td>IARCs, International scientific partners, Manufacturers of agricultural machinery</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.2.5. Utilise R&amp;D actions for the concerted management of space and natural resources</td>
<td>Cotton companies, Farmers, Researchers</td>
<td>National research institutions</td>
<td>Better management of space and natural resources</td>
<td>International scientific partners</td>
<td>2</td>
</tr>
<tr>
<td>2.3. Open African cotton research to the world and the future</td>
<td>2.3.1. Identify and analyse the important innovations and evolutionary experiences, worldwide, that concern the technical itineraries of cotton production</td>
<td>Researchers, Farmers</td>
<td>National research institutions</td>
<td>Information sharing for existing innovations</td>
<td>CTA, International scientific partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.3.2. Contribute to the attention to and improvement of sustainability indicators in African cotton cultivation</td>
<td>Researchers</td>
<td>National research institutions</td>
<td>Creation and provisioning of national databases of sustainability indicators</td>
<td>RARCs, IARCs, CTA, International scientific partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.3.3. Explore innovative research themes and approaches for cotton’s future in Africa</td>
<td>Researchers</td>
<td>National research institutions</td>
<td>Development of research prospects</td>
<td>RARCs, IARCs, CTA, International scientific partners</td>
<td>2</td>
</tr>
</tbody>
</table>
### Objectif stratégique n°3 : Make African cotton research more efficient in its relationships with other actors in the cotton value chain

<table>
<thead>
<tr>
<th>Operational objectives</th>
<th>Activities / Action leverage</th>
<th>Actors</th>
<th>Responsible for implementation</th>
<th>Progress indicators</th>
<th>Possible technical support</th>
<th>Priority (1 to 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1. Organize frameworks of exchange and cooperation between the research and other actors in the cotton value chain</td>
<td>3.1.1. Establish national, long-term mechanisms for cooperative programming and the sharing of results from cotton research</td>
<td>National research institutions, Interprofessional organisations, Farmers, Cotton companies</td>
<td>National research institutions</td>
<td>Established and operational mechanisms (meetings held)</td>
<td>Interprofessional organisations</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3.1.2. Establish regional and sustainable frameworks of collaboration and cooperation that involve the ensemble of actors in the value chain</td>
<td>REC, RARC, ACA, Researchers, Interprofessional organisations</td>
<td>National research institutions</td>
<td>Functioning regional platforms of collaboration and cooperation</td>
<td>RARCs, REC, International organisms of multi-lateral cooperation</td>
<td>2</td>
</tr>
<tr>
<td>3.2. Make research results more accessible and comprehensible</td>
<td>3.2.1. Establish actions in cotton research that encourage sharing with other actors in the value chain</td>
<td>Researchers, Interprofessional organisations</td>
<td>National research institutions</td>
<td>Regular annual meetings where research results are presented</td>
<td>Private institutions, Local banks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3.2.2. Contribute to the technical training of other actors in the value chain</td>
<td>Researchers, Farmers</td>
<td>National research institutions</td>
<td>Annual training of actors from various parts of the value chain</td>
<td>Agricultural training institutions</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3.2.3. Dissemination of research results through diverse mediums and outlets</td>
<td>National research institutions, National media</td>
<td>National research institutions</td>
<td>Regular diffusion of radio and television programs consecrated to the results of research; the adoption of innovations</td>
<td>Government Ministry, Interprofessional organisations, ONGs, Media</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3.3.1. Conduct conjoint, real-world trials and experiments of research innovations</td>
<td>Cotton companies, producer organisations, researchers</td>
<td>National research institutions</td>
<td>Numerous participatory tests in farmers' fields</td>
<td>RARCs, Companies</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3.3.2. Involve farmers in the research process (participation in variety selection, identification of plants for organic pest management, organic fertilizer, composting, etc.)</td>
<td>Cotton companies, Producer organisations, researchers</td>
<td>National research institutions</td>
<td>Numerous participatory tests in farmers' fields</td>
<td>RARCs, Companies, International scientific partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3.3.3. Encourage direct exchanges between research and development organisations</td>
<td>Researchers, Farmers, ginners, spinners, etc.</td>
<td>National research institutions</td>
<td>Extent of exchanges</td>
<td>Cotton companies, related industry companies</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3.3.4. Develop new mediums and outlets adapted to the sharing of technical information on connected tools</td>
<td>Researchers, Farmers</td>
<td>National research institutions</td>
<td>Developed meetings for popularisation of results through multimedia tools</td>
<td>Specialized multimedia institutions</td>
<td>2</td>
</tr>
</tbody>
</table>
Objectif stratégique n°4 : Improve the dissemination of African cotton research within the global scientific community

<table>
<thead>
<tr>
<th>Operational objectives</th>
<th>Activities / Action leverage</th>
<th>Actors</th>
<th>Responsible for implementation</th>
<th>Progress indicators</th>
<th>Possible technical support</th>
<th>Priority (1 to 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1. Improve the relevance, visibility, and recognition of African cotton research at the international level</td>
<td>4.1.1. Develop the internal scientific management in the research centers</td>
<td>Researchers</td>
<td>National research institutions</td>
<td>Improvement in the scientific quality of research results</td>
<td>National universities</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4.1.2. Planning for the active participation of African cotton researchers in international cotton events (ICAC, ACA, SAGAF, etc.)</td>
<td>RARC, IARC, ACA, National research institutions</td>
<td>National research institutions</td>
<td>the number of national cotton researchers participating in international cotton events</td>
<td>RARC, CTA, International funding partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4.1.3. Encourage publication in peer reviewed scientific journals</td>
<td>RARC, CTA, National research institutions, Publishers</td>
<td>National research institutions</td>
<td>Increase in the number of publications in peer reviewed journals</td>
<td>CTA, RARCs, Publishers</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4.1.4. Organize internal and/or external evaluation of cotton research (activities and projects) and researchers</td>
<td>RARC, National research institutions, international funding partners</td>
<td>National research institutions</td>
<td>Evaluation report</td>
<td>Scientific committee, Funding partners</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4.2. Develop regional and international synergy that reinforces the mutualisation of resources, activities and results</td>
<td>4.2.1. Encourage the participation of African cotton researchers in the existing international cotton networks</td>
<td>RARC, IARC, C42 National research institutions</td>
<td>National research institutions</td>
<td>Number of national researchers participating in existing networks</td>
<td>CORAF/WECARD, ACA, ICAC</td>
</tr>
<tr>
<td></td>
<td>4.2.2. Create or reinforce active networks at the scale of large geographical regions (WCA, ESA, continent) to improve collaboration between African cotton researchers</td>
<td>RARC, IARC, National research institutions</td>
<td>National research institutions</td>
<td>Reactivated and operational cotton network of CORAF/WECARD</td>
<td>RARC, International partners</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4.2.3. Encourage African cotton researchers to develop and participate in regional and international research projects and programmes</td>
<td>IARC, RARC, ICRA, National research institutions</td>
<td>National research institutions</td>
<td>Effective and growing participation in the implementation of regional programmes</td>
<td>Regional banks, International funding partners</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4.2.4. Set up tools for sharing the results of African cotton research</td>
<td>RARC, ICAC, ICRA, ACA, National research institutions</td>
<td>National research institutions</td>
<td>Improvement in internet access to the IST</td>
<td>CTA, IARC, ICAC</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4.2.5. Encourage mechanisms for visiting researchers and the exchange of ideas and information among research structures at the regional and international level</td>
<td>RARC, ICAC, IARC, ACA, National research institutions</td>
<td>National research institutions</td>
<td>Number of researchers having spent time in regional or international laboratories</td>
<td>International scientific partners, Centres of excellence</td>
<td>2</td>
</tr>
</tbody>
</table>

8.2. Proposed mechanism of coordination

The outline of priority actions as presented in the previous tables shows that the actors implementing these actions are found at different scales of intervention (national, regional, continental and international). Therefore, the coordination mechanism must be organized as a function of these different levels of responsibility.

For the revamping strategy of cotton research, coordination of the implementation at the national level will be directed by a steering committee. This committee of no more than a dozen members should be made up of political representatives in charge of national agricultural research (Ministers), actors from the structures responsible for the implementation of the activities (National Agricultural or Agronomic Research Institutes), and from cotton companies or sectoral organizations, as the case may be. This committee will be accountable to the appropriate regional structures (RARC, REC).
At the regional level, the technical coordination will be ensured by each of the regional centres of agricultural research (WECARD, ASARECA, CCARDESA) regrouped in FARA. Coordination of policy or politics will be the responsibility of the regional Economic Commissions (ECCAS, WAEMU, and COMESA). The regional agricultural research centres represent the basic level of operational implementation for the strategy. They will be responsible for merging the national dynamics by initiating regional programmes, and facilitating the establishment of regional centres for cotton research.

The continental and international level is represented by the Forum for Agricultural Research in Africa (FARA). The FARA acts as the umbrella organization of the Regional Agricultural Research Centres (RARC). It implements the agricultural research policy of the African Union (AU), framed by NEPAD and the CAADP.

The steering committee, with its diverse composition, will ensure the coordination of the strategy’s implementation. It is responsible for the orientation, monitoring, and evaluation of this implementation:

- Oversee a successful implementation of the strategy
- Ensure synergetic and harmonious regional participation
- Research and mobilize the funding necessary to achieve planned activities
- Share the technical information from various interventions by partners among the actors of the implementation.

There is a technical secretariat in each Regional Economic Community (REC). It will centralize the information of the state of the strategy’s implementation at the regional level. The secretariat ensures the link between international partners and the regional centres of agricultural research.

9. Potential sources of funding

9.1. At the national level

- **Public funds**: to secure the basic functioning of the research structures by ensuring the basic infrastructure such as operating costs (water, electricity, communication), salaries of researchers and technicians, training, and prospects for research.
- **Users of research results**: (cotton sectoral organizations, producer associations, sellers of inputs and agricultural materials, etc.) can be a source of funding for cotton research (including materials such as specialized equipment and field logistics). In terms of modalities, this type of funding could be realised through a negotiated automatic assessment for production, as is seen in several countries with abundant research funds outside of Africa (particularly the USA). This type of system to provide funding for applied research already exists in certain African cotton producing countries, for example, Côte d’Ivoire’s Sectoral Funds for Agricultural Research and Advise (FIRCA⁶), and in Burkina Faso. The system of automatic assessment is particular to each country and is generally negotiated at the sectoral level. It is essential that the automatic assessment is not arbitrary (risk to competitiveness of the cotton value chain), but determined at a level shown to be justified by generated advantages.

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⁶ [http://firca.ci/](http://firca.ci/)
9.2. At the regional and international levels

- **Regional projects**: under the aegis of the regional research centres (FARA, WECARD, ASARECA, CCARDESA) and the Regional Economic Communities (ECOWAS, ECCAS, EAC, SADC), on common themes and according to the subsidiarity principle.
- **African Union**: the calls for project proposals, even if they are extremely competitive, offer good opportunities for funding research activities; transversal from a scientific and geographic perspective.
- **European Union**: learning from the "Support Programme for the Consolidation of the Action Framework under the EU-Africa Partnership on Cotton", new supports are to be defined and proposed, particularly in the framework of the 11th FED.
- **ACP Group of States**: idem, being careful to be relevant concerning the new approach on agricultural products that should become official in the near future.
- **South-South Cooperation**: developed in the last few years, particularly in support of the cotton value chains.
- **World Bank**: financing for the agricultural sector (in the form loans).
- **Regional Development Banks**: AfDB, BOAD, BDEA.
- **Agencies of national cooperation**: Agence Française de Développement (AFD), Swiss Agency for Development and Cooperation (DCC), German Agency for International Cooperation (GIZ), Japan International Cooperation Agency (JICA), etc.; they already fund support actions in several African countries, such as the « Projet d’Appui à l’Amélioration de la Gouvernance de la chaine de valeur coton dans sa nouvelle configuration institutionnelle et à la productivité et à la durabilité des Systèmes d’Exploitation en zone cotonnière” (PASE II), supported by the AFD.
- **Regional Scholarship and Innovation Fund (RSIF)**: administered by the Association of African Universities.
- **Common Fund for Commodities (CFC, http://common-fund.org/)**: numerous African cotton producing countries are members and thus eligible.
- **Public-Private Partnerships**: this will be the principle type of funding mechanism in the 11th FED, an approach that will probably be included in the next ACP Group of States strategy for agricultural products. In addition to the aspects of decompartmentalisation and shared vision, partnerships are based on association from the beginning, integrating research, private actors, producer associations, the State, banks and lessors. By nature they generate important leverage (which is sought for promoting good practices), balanced and accepted for divers type of funding (subsidies, loans, equity funding).
- **Specific funding (to be created)**: where researchers could apply for funding, on the model of that proposed by the World Bank through the APPSA (Agricultural Productivity Program for Southern Africa), which currently finances research on corn and legumes.

10. Mechanism for monitoring and evaluation

The monitoring and evaluation mechanism is aimed at the strategic and operational management of programmed activities. Results are judged based on defined objectives and anticipated outcomes. The evaluation applies to funding as well as technical aspects. The monitoring and evaluation functions are ensured by the Steering (coordination) Committee and rest on a specific mechanism. Like the mechanisms of coordination, this mechanism is functional at different scales: national, regional, and international.

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7 i.e. “Support Project for Improved Governance of the cotton value chain in its new institutional configuration and for the productivity and sustainability of farming systems in cotton zones”
At the national scale, a research and development committee, and a scientific committee will ensure the monitoring and evaluation of the strategy's implementation. The scientific committee, composed of scientists from universities, and the national and regional institutions of research. Development is also represented. The scientific committee reviews the relevance of the programming and the realisation of scientific activities, assessing the quality of the results obtained.

At the regional scale, the implementation of regional programmes, as well as the activities of the regional centres of cotton research are monitored and evaluated under the responsibility of the regional agricultural research centres. This evaluation is conducted in the form of circular missions to the partnering National Institutes, which constitute the core of these programs.

At the international scale, the responsibility of monitoring and evaluation of the strategy's activities falls to the Steering (coordination) Committee, placing the Technical Secretariat at the heart of the Regional Economic Communities.

11. **Hypotheses and risks**

The implementation of the strategy is strongly dependent on the involvement of the actors. Success is conditional (Hypotheses), but the strategy can also be compromised by malfunctioning in the system that has no relationship to the actors (Risks).

The hypotheses for success depend on certain conditions:

- The strategy for revamping African cotton research is adopted by the relevant parties.
- The management of capabilities in cotton research in the African institutions is effectively accomplished.
- The themes of cotton research are adjusted to the changing context in a timely manner.
- The national and regional actions are harmonized and regional centres of cotton research are created.
- The programming, dissemination, and popularization of research results is improved.
- African research is better integrated in the international scientific community.
- The strategic and operational objectives are translated into concrete actions through the mobilization of resources.
- There is efficient coordination between the implementation of programmed activities and their monitoring and evaluation.

If these conditions are met, then the results generated by cotton research will encourage the development of good agricultural practices that will then contribute to improvements in productivity, fibre quality, and the competitiveness of the African cotton value chain.

As to risks, they are related to an opposing set of conditions:

- The concerned parties do not adopt the strategy.
- Activities are not undertaken and thus the objectives are not accomplished.
- An absence of synergy and harmony between national and regional efforts.
- Failed efforts to secure funding.
- Activities are poorly coordinated.
- Political and economic crises dominate the partner countries.
12. Logistic framework of the strategy

The following logistic framework (Table 4) is presented according to the recommendations of the European Commission (2001). This proposal is situated well ahead of the activities proposed; certain cells in the table have not been filled (Costs) or only partially filled (Means) because sufficiently precise information is not yet available at this stage. As soon as this information is available, it could be incorporated.

Table 4. Logistical framework of the proposal for a strategy to revamp African cotton research (in three parts)

<table>
<thead>
<tr>
<th>Intervention logic</th>
<th>Objectively verifiable indicators</th>
<th>Sources of verification</th>
<th>Hypotheses</th>
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</thead>
</table>
| **Global objectives** | Contribute to the African cotton value chain:  
- reinforce competitiveness  
- aid the development of sustainable intensification in African agriculture  
- make agriculture more attractive to new generations of Africans (modern, professional, opportunity)   | Growth in African cotton production and market demand  
- Improvement in the environmental, social, and economic indicators of African agriculture  
- Growth in the average income of African cotton farmers  
- Reduction in the exodus of young, rural Africans  
- Development of agricultural exploitations by young African farmers | National statistics  
- Cotton companies  
- Producer associations | - A political will (national, regional and international) exists for revamping African cotton research  
- Independent of the research recommendations, the sustainability indicators of cotton cultivation are not degenerating  
- The farmers have the means (human, technical, financial, etc.) to implement the recommendations of research  
- External factors (world cotton market, value of the dollar, socio-political situations, etc.) do not affect the African cotton value chains |
| **Special objectives** | Revamp African cotton research and improve its contribution to the sustainability of cultivation, the income of farmers, and the competitiveness of the value chain | Sustainability indicators for African cotton cultivation (see ICAC/FAO & ITK AID-Cotton) are improved  
- Income of African cotton farmers is higher  
- African cotton value chains are more competitive on the world market (market price, product quality, supply/demand) | National statistics  
- Cotton companies  
- Producer associations  
- National agricultural/agronomic research institutes | - |
## Results

### Result 1
The capabilities of African cotton research are reinforced at the level of competency, technical means, and funding

- Number, age, and type of training of personnel (researchers, technicians, etc.) affected African cotton research
- Infrastructure and technical means (land, laboratory, office, etc.) available for cotton research personnel
- Number of regional research centers or centers of excellence in cotton research that are operating in Africa
- Long-term funding mechanisms for cotton research are implemented

**Intervention logic**
- National agricultural / agronomic research institutes
- Universities
- Cotton companies
- Lenders (public and private)

**Objectively verifiable indicators**
- Public research remains a priority for African governments
- Public research in Africa is attractive (status, salary, work conditions, continued education, etc.)
- The existing programme and means of training researchers in Africa are effective
- The national cotton programmes are willing to mutualise part of their means

**Hypotheses**
- The constraints of the value chain are correctly identified
- Visits to cotton zones on other continents are possible
- Each cotton producing country is willing to promote the value of indicators of sustainability in its cotton cultivation

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### Result 2
The themes of African cotton research are adapted to respond to new challenges, issues, and constraints for the crop, the farmers, and the value chain

- Environmental and socio-economic constraints are taken into account by the research
- Innovations from other continents are tested
- Sustainability indicators are improved by the work of research

**Intervention logic**
- Programmes and annual reports of cotton research
- Scientific production of cotton research
- Databases of sustainability criteria for cotton cultivation

**Objectively verifiable indicators**
- Programmes and annual reports of cotton research
- Scientific production of cotton research
- Databases of sustainability criteria for cotton cultivation

**Hypotheses**
- The political, economic, and organisational environment of the cotton value chains allow the programming of research activities, the dissemination of research results, and the implementation of recommendations by the users

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### Result 3
African cotton research is more effective with improved programming, and improved dissemination and popularization of results

- Number of conjoint meetings between cotton research and its partners in the value chain
- Number of innovations proposed by cotton research and adopted by the industry

**Intervention logic**
- Records of cotton research programming meetings
- Programmes and annual reports of cotton research
- Scientific production

**Objectively verifiable indicators**
- Records of cotton research programming meetings
- Programmes and annual reports of cotton research
- Scientific production

**Hypotheses**
- African cotton research has the human resources, technical means, and funding necessary to complete its missions (Result 1)

---

### Result 4
African cotton research is more visible and better recognized in the global scientific community

**Intervention logic**
- National agricultural / agronomic research institutes
- Universities
- Cotton companies
- Regional Economic Communities (REC)

**Objectively verifiable indicators**
- National agricultural / agronomic research institutes
- Universities
- Cotton companies
- Regional Economic Communities (REC)

**Hypotheses**
- African cotton research has the human resources, technical means, and funding necessary to complete its missions (Result 1)
<table>
<thead>
<tr>
<th>Activities</th>
<th>Intervention logic</th>
<th>Objectively verifiable indicators</th>
<th>Sources of verification</th>
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<td>1.1.1. Recruitment</td>
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<td>1.2.4. Regional centres of cotton research</td>
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<td>1.2.5. Genetic resources</td>
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<td>1.3.1. National funding</td>
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<td>1.3.2. Develop research projects</td>
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<td>1.3.3. Sustainable</td>
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<td>2.1.4. ITK</td>
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<td>2.2.2. State of familial prod.</td>
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<td>2.2.4. Mechanisation and motorisation</td>
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<td>2.2.5. Manage space &amp; nat. resources</td>
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<td>2.3.1. Worldwide innovations/evolution</td>
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<td>2.3.2. Sustainability indicators</td>
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<td>2.3.3. Innovative themes and approaches</td>
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<td>3.1.1. National mechanisms of exchange</td>
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<td>3.2.1. Actions of sharing</td>
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<td>3.2.3. Dissemination of</td>
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<td>3.3.1. Conjoint trials and experiments</td>
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<td>3.3.2. Involve the farmers</td>
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<td>3.3.3. Exchanges of R&amp;D</td>
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<td>3.3.4. New mediums and outlets</td>
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<td>4.1.1. Internal scientific management</td>
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<td>4.1.2. International participation</td>
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<td>4.1.3. Peer reviewed journals</td>
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<td>4.1.4. Evaluation of research / researchers</td>
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<td>4.2.1. International cotton network</td>
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<td>4.2.2. Network of active African researchers</td>
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<td>4.2.3. Projects and programmes</td>
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<td>4.2.4. Tools for sharing results</td>
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<td>4.2.5. Exchanges</td>
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**Means**
- Salary / function
- Training
- Official text (decree, etc.)
- Human resources
- Funding
- Policy decision / Funding
- Collaboration / Conservation mechanism
- Training / Sensitization

**Activities**
- Recruitment
- Capabilities
- Status
- Available HR
- Infrastructure
- Tools
- Mutualised
- Regional centres of cotton research
- Genetic resources
- National funding
- Develop research projects
- Sustainable
- Climate change
- Pests and diseases
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- Mechanisation and motorisation
- Manage space & nat. resources
- Worldwide innovations/evolution
- Sustainability indicators
- Innovative themes and approaches
- National mechanisms of exchange
- Frameworks of regional cooperation
- Actions of sharing
- Technical training
- Dissemination of
- Conjoint trials and experiments
- Involve the farmers
- Exchanges of R&D
- New mediums and outlets
- Internal scientific management
- International participation
- Peer reviewed journals
- Evaluation of research / researchers
- International cotton network
- Network of active African researchers
- Projects and programmes
- Tools for sharing results
- Exchanges

**Objectively verifiable indicators**
- Research work
- Research approach
- Management decision
- Travel budget
- Registration or participation
- Organisation
- Training / Access to information
- Collaboration / Internet site
- Network / Collaborations

**Sources of verification**
- Internet site
- List of indicators
- Conjoint meeting
- RARC
- Research approach
- Management decision
- Travel budget
- Training / Supervision / Collaborations
- Evaluation committees
- Organisation
- Collaboration / Internet site
- Network / Collaborations

**Hypotheses**

**Prior conditions**
Technical and political validation of the revamping strategy
13. Conclusion

This proposal for a detailed strategy to revamp African cotton research at the technical level has been developed within the framework of the "Support Programme for the Consolidation of the Action Framework under the EU-Africa Partnership on Cotton". It follows in response to an in-depth diagnosis of the state of this research and a set of recommendations. The diagnosis and recommendations were established through questionnaires and direct exchanges with the national and regional research organisms, as well as with the other actors in the cotton value chain and the users of the results of cotton research. This strategy proposal is aimed at revamping African cotton research and improving its contribution to the sustainability of cotton cultivation, the income of farmers, and the competitiveness of the African cotton value chain.

At this stage, being technical and relatively in advance of a future implementation, this proposition does not pretend to address an exhaustive list of the activities needed to revamp cotton research in Africa. However, the proposal is expressed through strategic objectives, operational objectives, and activities, judged realistic priorities for visibly contributing to the strategic goal within five to ten years.

This proposal should be shared with the ensemble of concerned actors in order to be validated at the technical and then political level, and adapted as a function of the opportunities and constraints inherent in the implementation of a strategy. Experience acquired through the "Support Programme for the Consolidation of the Action Framework under the EU-Africa Partnership on Cotton" has shown that support and appropriation needs must first be addressed at the national level before looking towards the regional level from a perspective of subsidiarity and added value. This approach must also be taken into account in the efforts to revamp African cotton research.

Beyond the expected impact on African cotton research itself, the influence of the proposed strategy extends to African cotton farmers in a context of small, family agriculture, to their families, and to millions of other Africans as well as the ensemble of actors from the cotton value chain. At this stage, with a geographical range covering the African continent, the objectives and activities contained in this strategy proposal cannot be expanded into detailed actions tailored to each country or group of countries. When this strategy, all or in part, reaches the phase of implementation, it will require further elaboration to develop and adapt specific actions to be taken at various regional, national, and local scales, prioritize those actions, and determine the appropriate timing for their execution.

The questionnaires and diagnostic elements developed and utilised in this study enabled the establishment of a baseline condition of African cotton research in 2016. Once a revamping strategy is launched, it would be useful to measure, inasmuch as is possible, the effects of the strategy through periodic updates of this diagnosis by examining the objectively verifiable indicators.
14. Bibliography

15. Annex

Report of the discussions held during the presentation of the study in the framework of the 22nd meeting of COS-cotton (Ouagadougou, Burkina Faso, March 31, 2017)

European Union:
In African cotton producing countries, the question of long-term funding for research is linked to the central question concerning the distribution of critical functions between Government services and the private sector. The warning cries concerning funding should be directed towards the national actors in the cotton value chains rather than exterior funding sources (EU, ACP secretariat, etc.). For example, systems of agricultural advisory should be the responsibility of each country and not simply provided by certain countries through the FAO, as it currently does through the IPPM programme. It is thus necessary to carry a strong message to the various national and regional authorities in order to ensure awareness of the situation confronting research.

Angola:
This study on the state of African cotton research would benefit from a complementary situational analysis of African textile companies that act as cotton consumers, and also face important functional problems.

Cameroon:
This study is limited to research at the level of agronomics and production. It should be complemented by an analysis of the state of research in cotton processing and transformation into products. In parallel, the political aspects are essential in order to ensure that the States take responsibility for the proper functioning of research operations.

WAEMU/UEMOA:
Responsibilities must be clarified and sovereign functions must be identified (such as the recruitment of researchers, particularly in the field of breeding). In the present study, the link between research and the transfer of technology should be examined more precisely. Research funding could also occur through the monetary valorisation of research results. It is important that new axes of research be developed (transformation, crop sustainability, etc.).

ECOWAS/CEDEAO:
An aging population of researchers is not only a problem in the domain of cotton research, it is a general problem in all of African research. What is the solution for ensuring a permanent and gradual replacement of researchers working in the NARI? In Mali and Burkina Faso, the recruitment of researchers is included in the budget. Among proposed solutions, the creation of a cotton CGIAR would not solve the funding problem (the majority of existing CGIAR programs face the same problem). It seems preferable to reinforce collaboration between the NARI and develop the aspect of agricultural advisory. Indeed, the transfer of technology is a major problem, which could be alleviated through the integration of organisms such as NGOs and producer organizations. A system of automatic assessment on cotton produced is needed to provide a permanent source of funding for research. In the Côte d'Ivoire, a similar system, managed by the FIRCA, enables the funding of agricultural research through the pooling of revenue generated by various sectors.
COMESA:
It is vital that both State governments and the actors in the cotton value chain appropriate the diagnosis of the state of cotton research. Directives should be coordinated with this diagnosis, and decisions should be taken at the national level in order to ensure research funding.

NEPAD:
The recommendations proposed in this diagnosis, along with the study's terms of reference, are primarily based on an agronomical approach and technical itineraries. The questions linked to issues such as the rural economy and the structure of the cotton system require research efforts in these cotton-producing areas.

ACA:
Can regional institutions support a revamping of cotton research with financial support? Concrete decisions must be made at a high political level. Systems of agricultural advisory depend on the research, the advisers that disseminate innovations resulting from the research, and the users of those innovations, all of which could be integrated in a research and development course of action. The funding of each national research program should be based on an obligatory assessment to offset difficulties of the State.

PR-PICA:
The proposed strategy's objective no. 2, which deals with the adjustment of research themes, must be organized according to the needs of the users in the cotton value chain. These include the producers, the cotton companies, and other actors in the transformation chain. It is thus necessary to have structures that enable a proper assessment of the needs of these users. In addition, considering the limits of human resources and funding, it is essential that the protocols, approaches, methodologies, and sharing of information and research results be coordinated. For example, this could happen at the level of the PR-PICA for work on thresholds in pest management. There are projects, without financing, for transmitting research results at the level of agricultural advisory.

FAO:
Two points need further development: i) the link between the diffusion of innovations and supporting council, and ii) the funding of research. As for the first point, there has been an evolution in the system of agricultural innovation: it begins with research and is then popularized or translated for use by farmers. Today, this process usually involves participatory systems of research and action, systems where all actors are at the table, from the beginning identification and prioritization of research questions to the execution and evaluation. Currently, the research is well integrated with the cotton companies, but much less so with the farmers. Many tests have been conducted: agricultural innovation platforms, field schools, and experimentation platforms at the farm level. In terms of pluralistic supporting council, there can be intermediary farmers, well trained to advise and train other farmers. As for the second point, it is necessary to find a balance between the public and private good. Research funding systems based on a tax assessment on cotton sales are interesting because they are economically neutral and enable self-financing of research for the cotton value chain. However, the allocation of funds collected should be decided collectively among the ensemble of actors. This point should be restated in the report.

MoZaZiMa:
The principal problems in our region are (1) understanding the low level of productivity in cotton cultivation and (2) the low wages paid by the governments. In order to improve the cotton situation, the recommendations of this study should be communicated to our governments. Zimbabwe is the only country in the group that currently has improved seeds. The situation is difficult in the other countries.
Zimbabwe:  
Since the 1990s, cotton research in our country has been financed, essentially, from exterior sources. The financing is very important for research. In addition, droughts negatively affect our cotton production, and irrigation is currently being considered as a solution to this problem.

C4:  
We are very interested in this study and hope to follow the results of its completion with COS-Cotton.

Response from the team-leading expert:  
- The study’s terms of reference involve the elaboration of a detailed strategy for revamping African cotton research, globally oriented towards a sustainable improvement in field production. However, it is clear that the necessary improvements involve the entire cotton value chain.
- In terms of the support council and the popularization of research results, this study proposes to develop a partnership within the value chain at the national and regional level for programming, follow-up and evaluation, and the dissemination of results, particularly with farmers. In Burkina Faso for example, the State ensures the basic operating expenses of research (salaries, infrastructure, etc.) as one of its sovereign responsibilities, while the actual functions of research operations depend on the needs of the cotton sectoral groups involved. These groups, in turn, secure funding for activities particular to their research. However, either of these sources do not address the funding of certain facets, such as continued education of researchers or the development of prospective research projects. The questions of partnership and sharing of responsibilities should be specifically addressed at both the national and regional levels (through the support of the REC/CER). The use of assessments on the value of fibre exports to create a fund that supports research is an approach that deserves to be explored.
- In terms of the relationship between research and the popularized dissemination of results and innovations, we note (in Togo, for example) an important distortion between the yields obtained at a controlled station and those of the farmers. It is essential that this distortion (yield gap) be explained. In questions linked to transformation, agronomic research occurs essentially prior, or upstream, through the consideration of criteria for the quality of cotton products (seed cotton, fibre and cottonseed). Beyond this, the questions fall in the province of industrial issues.
- It is important to reinforce the status of researchers, particularly as compared to that of university positions, in order to maintain and reinforce the human resources necessary for the implementation of the defined strategies.

Response of the UGP:  
Focused on field production, this study, like that on the Pan-African cotton road map, corresponds to a transversal theme, and was conducted in the framework of a short-term expertise with limited resources. Today it is not possible to extend this study beyond its terms of reference, but it is perfectly possible to integrate the final report and the mission leaders’ additional comments, which will be received following this meeting.

Conclusion of the European Union on behalf of the Steering Committee of COS-Cotton:  
In response to the request of the President of Burkina Faso, the following message is presented to the African Authorities and Heads of State:

1) A cry of warning that both the lack of investment in research and the problems of disseminating research results are endangering the productivity of cotton cultivation. This warning also points to the correlation
between insufficient support for the "package" of research - popularization - agricultural advisory, and the productive competitiveness of the African cotton value chain.

2) Solutions exist, but they depend on the actors in the chain. First in line are the national and regional Authorities through their regulatory role. Sustainable avenues of funding also exist (such as FIRCA in Côte d'Ivoire, or fibre assessment in Benin). This must be translated into concrete actions for financing research and systems for agricultural advisory.

Additional comments from the study's authors:
- Regarding the relationship between African cotton research and the transmission of results to farmers, the study's strategic objective n°3 proposes that the research could be made more effective with respect to other actors in the cotton value chain. This can be done through i) frameworks of cooperation and exchange, ii) activities that would popularize results, making them more accessible, and iii) improvements in the modes of interaction between research, development, and production at the national and regional levels.
- Regarding research funding, in light of the potential sources and based on an existing system in certain African cotton producing countries, the study proposes the implementation of an automatic assessment on each bale produced in order to establish a research fund. The choice of research activities funded through this assessment would necessarily depend on the priorities defined by the ensemble of actors in the cotton value chain.