

地球規模課題対応国際科学技術協力  
スーダン共和国  
根寄生雑草克服によるスーダン乾燥地農業開発  
プロジェクト  
終了時評価調査報告書

平成 27 年 3 月  
(2015年)

独立行政法人国際協力機構  
農村開発部

農 村
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## 序 文

独立行政法人国際協力機構は、2009年11月10日にスーダン共和国と締結した討議議事録（R/D）に基づき、2010年3月より地球規模課題対応国際科学技術協力（SATREPS）の枠組みによる「根寄生雑草克服によるスーダン乾燥地農業開発プロジェクト」を5年間の計画で実施しています。

当機構は、プロジェクト開始から約4年半が経過した2014年9月に、当機構農村開発部 専任参事 鍋屋 史朗を団長とする終了時評価調査団を現地に派遣し、スーダン共和国側のカウンターパートと合同でこれまでの活動実績並びにその結果について終了時評価を行いました。

本報告書は、同調査団によるスーダン共和国政府関係者等との協議及び終了時評価調査結果等を取りまとめたものであり、本プロジェクト並びに関連する国際協力の推進に活用されることを願うものです。

最後に、本調査にご協力頂いた内外の関係者各位に対し、心からの感謝の意を表します。

平成27年3月

独立行政法人国際協力機構  
農村開発部長 北中 真人

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## 現 地 写 真



圃場で指導する農業研究機構職員  
(ガダーレフ州)



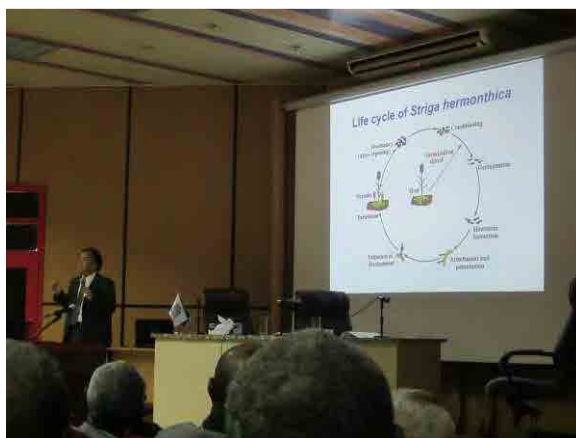
ポット試験のストライガ



ストライガのポット試験



ストライガのポット試験視察



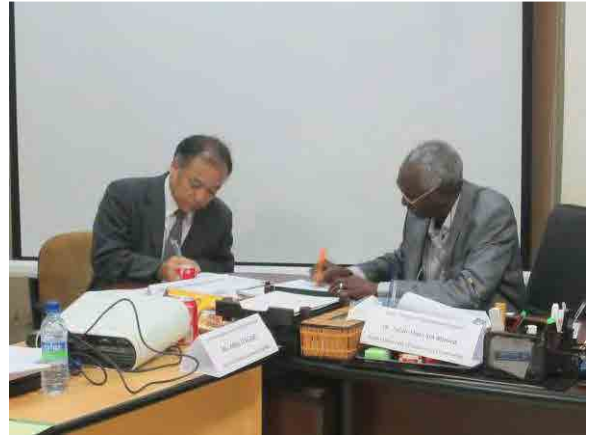
シンポジウムでの活動成果発表の様子



プロジェクト関係者との面談  
(スーダン科学技術大学)



終了時評価調査報告書の署名



ミニッツ署名



## 略 語 一 覧

	欧 文	和 文
ARC	Agricultural Research Corporation	農業研究機構
CAS	College of Agricultural Studies	農学部
COE	Center of Excellence	教育・研究・人材育成拠点機関
FFS	Farmers' Field School	農民圃場学校
GSMAI	Gedaref State Ministry of Agriculture and Irrigation	ガダーレフ州農業・灌漑省
IITA	The International Institute of Tropical Agriculture	国際熱帯農業研究所
JCC	Joint Coordinating Committee	合同調整委員会
JICA	Japan International Cooperation Agency	独立行政法人国際協力機構
JST	Japan Science and Technology Agency	独立行政法人科学技術振興機構
MFNE	Ministry of Finance and National Economy	財務国家経済省
MHESR	Ministry of Higher Education and Scientific Research	高等教育・科学研究省
MoAI	Ministry of Agriculture and Irrigation	農業灌漑省
MSC	Ministry of Science and Communication	科学コミュニケーション省
NCR	National Center for Research	国立研究センター
NERICA	New Rice for Africa	ネリカ（アフリカ米品種）
PCM	Project Cycle Management	プロジェクト・サイクル・マネジメント
PDM	Project Design Matrix	プロジェクト・デザイン・マトリックス
PDMe	Project Design Matrix for evaluation	評価用PDM
R/D	Record of Discussions	討議議事録
RDE	Research, Development and Extension	研究・開発・普及
SATREPS	Science and Technology Research Partnership for Sustainable Development	地球規模課題対応国際科学技術協力
SDG	Sudanese Pound	スーダンポンド
SUST	Sudan University of Science and Technology	スーダン科学技術大学
TOT	Training of Trainers	指導者研修

## 評価調査結果要約表

<b>1. 案件の概要</b>	
国名：スーダン共和国	案件名：根寄生雑草克服によるスーダン乾燥地農業開発プロジェクト
分野：農業開発（生物資源）	援助形態：技術協力プロジェクト
所轄部署：農村開発部 農業・農村開発第二グループ第四チーム	協力金額：約3億5,000万円
協力期間	2010年3月～2015年2月（5年間）
	先方関係機関：スーダン科学技術大学、高等教育・科学研究省、農業灌漑省、科学コミュニケーション省、ガダーレフ州農業・灌漑省、農業研究機構
	日本側協力機関：神戸大学、大阪府立大学、鳥取大学
	他の関連協力：特になし
<p><b>1-1 協力の背景と概要</b></p> <p>スーダン共和国（以下「スーダン」と記す）を含むサブサハラ地域において、根寄生雑草ストライガは、ソルガム、ミレット等の主穀の生産を阻害する最大の生物的要因であり、その損害は年間1兆円、被害人口は約3億人と推計される。スーダンでは、農村部貧困層の中核を成す小規模農家（小農）を担い手とした伝統的天水農業が、全耕作面積の約50%である700万haにおいて営まれている。乾燥条件下、低投入により同じ土地で主穀物を連作せざるを得ない状況が、ストライガの発生を助長しているとされ、経営状況の苦しい小農ほど生産が低下するという悪循環が形成されている。</p> <p>1994年以降、スーダン科学技術大学（Sudan University of Science and Technology：SUST）と神戸大学の共同により、ストライガの研究が進められ、その生理生態の解明に大きく貢献した。しかしながら、ストライガの生理生態はまだ科学的に解明されていない部分が多く、スーダンの食料安全保障、貧困問題に深刻な影響を与えていることから、効果的な防除方法確立のための研究能力の強化が求められている。</p> <p>このような状況のなか、これまでのストライガ研究の成果を踏まえ、科学的なストライガ防除のための知見蓄積を目的とした地球規模課題対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development：SATREPS）プロジェクトがスーダン政府より要請された。またそれに並行し、神戸大学より独立行政法人科学技術振興機構（Japan Science and Technology Agency：JST）に対しストライガ研究申請が行われたことを受けて、2010年3月より2015年2月までの5年間の協力が実施された。SUSTは、本プロジェクトの実施機関として他のカウンターパートである農業研究機構（Agricultural Research Corporation：ARC）や、ガダーレフ州農業・灌漑省（Gedaref State Ministry of Agriculture and Irrigation：GSMAI）とのストライガ防除研究を引導し、神戸大学は本プロジェクトの研究代表機関として、スーダン側研究者</p>	

や技術者に対するストライガ防除技術開発やデータ収集・機材管理に係る人材育成に努めた。

本プロジェクトでは、ストライガの発芽誘導物質の人工的抽出による防除や、選択的除草剤の検索、宿主からの養水分収奪機構の解明等の自然科学的研究と、伝統的な防除知識、防除の新技术に対する農民の受容性等の社会科学的調査を並行し、ストライガ防除に効果的な技術開発が進められた。また、ガダーレフ州の6カ村において農民圃場学校（Farmers' Field School : FFS）が組織され、農民やプロジェクト関係者の間で、防除技術や情報の共有が行われた。

## 1-2 協力内容

### (1) 上位目標

新たなストライガ対策の普及が進展する。

### (2) プロジェクト目標

スーダン科学技術大学（SUST）のストライガ対策にかかわる研究・開発・普及（Research, Development and Extension : RDE）能力が向上する。

### (3) 成果

成果1：革新的なストライガ防除技術が開発される。

成果2：農民のストライガ管理のための取り組みが改善される。

### (4) 投入（評価時点）

日本側：

専門家派遣：長期2名（業務調整）、短期57.6人月（複数回）

研修員受入れ（本邦）：カウンターパート研修及び大学等における研究活動：11名

機材供与：約1億1,000万円

ローカルコスト負担：約2,360万円

相手国側：

カウンターパート配置：延べ23名〔SUSTより13名、ARCより5名、GSMAIより3名、科学コミュニケーション省（Ministry of Science and Communication : MSC）及び財務国家経済省（Ministry of Finance and National Economy : MFNE）より各1名〕

プロジェクト運営費：約1,650万円

土地・施設提供：

SUST内のプロジェクト執務室、付帯資機材及び水道・電気設備

SUST及びガダーレフ州ARC内の実験圃場・用地の提供

SUST内ストライガ研究室拡張及び新研究棟用地の提供

<b>2. 評価調査団の概要</b>		
調査者	日本側 鍋屋 史朗 団長/総括 JICA 農村開発部 専任参事 花田 博之 協力企画 JICA 農村開発部 農業・農村開発第二グループ 第四チーム 専門囑託 板垣 啓子 評価分析 株式会社 国際開発アソシエイツ シニアコンサルタント スーダン側 Prof. Migdam E. 総括 Director, The National Center for Research, Ministry of Abdelgani Science and Communication	
調査期間	2014年9月6日～2014年9月22日	評価種類：終了時評価
<b>3. 評価結果の概要</b>		
<b>3-1 成果・目標の達成度</b>		
<p>&lt;成果1：革新的なストライガ防除技術が開発される&gt;</p> <p>本成果達成のために設定された6課題はいずれも研究成果が得られ、本成果の達成のめどが立っている。調査時における各課題の成果は以下のとおりである。</p> <p>課題1：新規自殺発芽誘導物質（T-010）が合成され、ポット試験・土壌試験において効果が検証された。</p> <p>課題2：土壌から多くの糸状菌と細菌を分離し、ストライガ防除効果をもつ微生物を特定した。</p> <p>課題3：根寄生雑草の発芽時に特徴的な炭素源・窒素源を特定し、それらの代謝阻害による発芽抑制効果を確認した。</p> <p>課題4：ストライガと宿主作物の気孔密度・開度の差異に基づく宿主養水分収奪機構が解析された。</p> <p>課題5：イネ・ソルガムのストライガ抵抗性試験が行われ、選定された6品種から環境適応性の評価を経て2品種が特定された。</p> <p>課題6：ストライガの寄生を抑制するゴマ品種を選抜したほか、コムギ・ミレット・ヒマワリ・ササゲ等の抵抗性/耐性を評価し、新規輪作体系を考案した。</p> <p>&lt;成果2：農民のストライガ管理のための取り組みが改善される&gt;</p> <p>本成果達成のための以下の2課題についても既に実施され、高い達成見込みが得られている。</p> <p>課題7：農家家計における経済的制約の軽減が新技術受容性の条件として特定された。生産者・消費者の嗜好について調査票調査が実施され、結果の取りまとめが最終段階である。</p> <p>課題8：ストライガ対処法の共有に向けたFFSが24回実施され、展示圃場でのストライガ防除効果と、それに起因する高い収量が報告されている。</p> <p>&lt;中間レビューにおける提言への対応状況&gt;</p> <p>中間レビューにおいて、運営管理面及び技術面に関する以下4項目の提言がなされ、本調査においてそれら提言への対応状況を確認した。</p>		

① プロジェクト・デザイン・マトリックス (PDM) の改訂

中間レビューで使用された評価用 PDM (PDMe) が 2012 年 12 月 25 日に行われた合同調整委員会 (Joint Coordinating Committee : JCC) において、PDM 第 2 版として承認された。

② 研究用機材の活用及び維持管理

SUST ストライガ研究室に勤める技術職員 (Technician) に本邦研修の機会 (2013 年 6～8 月) を提供した。帰国直後及び 3 カ月後、6 カ月後には日本側研究者が短期専門家としてスーダンを訪問し、スーダン側独自で活動を継続できるよう、ストライガ研究室の装置を使ってフォローアップを行った。

③ ストライガ研究室の若手研究者の能力育成

中間レビュー以降に、若手研究者 2 名の国外流出が起こったため、彼らの更なる能力向上には至らなかったが、他の研究員については理論と実践の充実した指導を通じて、自立した研究活動を支援する取り組みを行った。なお、スーダン人研究者が国際学会の一つである北米農村社会学会で農業経営経済学的調査の成果を発表した。

④ 成果 2 に係る活動の円滑な実施の推進

FFS の活動はスーダン国内でも注目されており、スーダン政府から、FFS 運営にかかわる助成金を受けるだけでなく、活動に理解を示した二つの銀行 (Bank of Sudan 及び Sudanese Agricultural Bank) からも助成金を獲得しており、FFS に係る活動が今後も円滑に進むことが期待できる。

<プロジェクト目標達成の見込み>

SUST 農学部ToStrाइガ研究室が設置されており、常勤の研究員 2 名、技術員 3 名が勤務しているほか、国立研究センター (National Center for Research : NCR)、ARC の研究員も研究活動に参加している。ストライガ研究室の年次予算計画はあるが、中期的な予算計画は策定されていない。ただし、SUST 農学部は、雑草研究のための新研究センター構想を有しており、学部内及び ARC 関係者から成る検討委員会を設置して具体的な計画内容の検討を開始した。同センター設立検討を通じて、長・中期的な予算についても検討が進むものと思われる。SUST 研究者の業績に関しては、これまでに 15 本の研究論文発表、17 本の学会発表がスーダン側の研究者により行われた。以上のことから、プロジェクト目標達成の見込みについては一定の期待がもてると判断された。

### 3-2 評価結果の要約

(1) 妥当性：高い

ストライガ被害はスーダン全土で農業生産に実害を及ぼしており、農民からのストライガ対策に関するニーズが高い。本案件実施機関 SUST を所管する高等教育・科学研究省及び農業灌漑省においても、ストライガは農業生産に被害をもたらす深刻な課題と認識され、本案件の成果に強い期待を抱いている。2012 年に策定されたわが国の対スーダン共和国国別援助方針は、貧困削減及び食料安全保障に貢献することを掲げており、本案件はスーダンの政策ニーズ、わが国の援助方針と照らして妥当性が高いといえる。

(2) 有効性：高い

各成果のための活動は着実に達成に向けて進捗しており、プロジェクト目標の達成に寄与している。協力期間終了時までには、プロジェクト目標は達成されると考えられる。

(3) 効率性：高い

スーダン・日本側双方からの投入は、スーダン人カウンターパートの頭脳流出の問題を除きおおむね適切であった。本プロジェクトのためにスーダン政府が支出したローカルコンポーネント（予算）は、ストライガ研究室の拡張工事、新研究棟（分子生物学）建設に利用された。

(4) インパクト：高い（正のインパクト）

本プロジェクトを通じて、多数の大学院生も、ストライガ防除の研究にかかわる機会を得た。ガダーレフ州のデモンストレーション農家では、ソルガムの生産性が大きく向上し、FFSは、ガダーレフ州の他のプログラムにも応用されつつある。FFSに参加した農家は、外部支援を得やすくするために、自ら農民組織化を図りつつある。負のインパクトは見当たらない。

(5) 持続性：中程度

スーダンの政策が農業の重要性をうたっていること、雑草研究センター構想が立ち上がっていることは、政策的・制度的な持続性を確保する要因となっている。一方で、予算面の持続性は、ひとえに雑草研究センターの具現化にかかっており、また、ストライガ防除の支援等を受けるための農民のグループ化には、GSMAIからの継続的な支援を必要としている。なお、プロジェクトに参加した研究員や普及員は、ストライガ防除に係る研究・普及を実践する能力を獲得しているが、農民レベルでは、肥料・除草剤・農業機械といったストライガ防除技術の導入に必要な投入資材の入手可能性が不透明なため、技術的持続性については中程度との判断となった。

### 3-3 効果発現に貢献した要因

(1) 計画内容に関すること：該当なし

(2) 実施プロセスに関すること：

一部のカウンターパートがプロジェクト以外の助成を受け研究活動を行った。また、ガダーレフ州のFFS活動に関しても、スーダン銀行・農業銀行からの資金的支援が得られた。これらの追加的な外部支援は、円滑な活動進捗と成果の産出に貢献した。

### 3-4 問題点及び問題を惹起した要因

(1) 計画内容に関すること：該当なし

(2) 実施プロセスに関すること：

2013年作期には早魃のため、FFSの展示圃場においても収量が低下した。収穫が皆無となった周辺圃場に比べ、展示圃場では収穫があり、技術の効果は確認されたものの、技術普及の効果には否定的な影響が及んだ。

### 3-5 結論

成果における各指標もほぼすべてにおいて協力期間内に達成見込みであり、ストライガ防除に係る SUST 及び協力機関の研究能力が、プロジェクトを通じて向上したことから、プロジェクトは、当初予定どおり 2015 年 2 月に終了が可能と判断される。ただし、ストライガ防除研究を継続するために、雑草研究センター構想の具現化が必要である。

### 3-6 提言

#### (1) 協力期間終了までに取り組むべき活動

##### 1) 雑草研究センター (Weed Research Center) 構想の具現化に向けた支援

SUST 農学部による雑草研究センター (仮称) 構想は、プロジェクトの各課題 (研究) の継続と発展のために重要な計画である。同構想の具現化に向けて、プロジェクトの日本側チームは、可能な限りの支援 (情報提供等) をスーダン側に対して行う。

##### 2) 実験機器の使用マニュアル

中間レビュー時の提言の一つに、「SUST ストライガ研究室に供与された実験機器の維持管理・保守のためのカウンターパート研修」がある。本編 4-2 (2) に記述のとおり、神戸大学で研修を受けた技術員 (Technician) が、今やストライガ研究室の実験機器管理 (分析から機器及び研究試薬等の保管管理) を一人で担えるまでになっている。一方、煩雑かつ使用上の注意を要する機材 (高速液体クロマトグラフ: 試料中の各成分を分離し含有量を測定する機器、ガスクロマトグラフ: 気化しやすい化合物の同定・定量分析に用いられる機器) もあることから、これら機材の使用マニュアルの作成が必要である。日本人専門家が、同マニュアルの作成を支援予定であり、プロジェクト期間内に作成し、カウンターパートへ引き継ぎを行う。

#### (2) 協力期間終了後、スーダン側関係機関に取り組むべき活動

##### 1) Center of Excellence (COE) の政府承認

中間レビューの際に期待されていた高等教育・科学研究省による SUST 農学部の COE (教育・研究・人材育成拠点機関) 政府承認 (農業部門) は、現在も省内で検討中である。高等教育・科学研究省へ表敬の折、COE 公認となった場合、優秀な学生の入学促進や授業料・生活費補助、研究者の海外派遣、スタッフの新規雇用、少額の資機材・消耗品購入費補助といった恩恵が生まれるとのことであった。早期の COE 承認を依頼した。

##### 2) 予算の確保

プロジェクト終了後は、ドナー国・機関及び当該国政府からの支援予算が少なくなり、往々にしてプロジェクト活動は大きく減じられるので、実施機関 (SUST) のみならず協力機関 (NCR、ARC、ガダーレフ州) もそれぞれでの予算確保を期待する。

### 3-7 教訓

(1) 研究施設・機材を整備することが困難な途上国にあつては、援助等によって整備された施設・機材の有効利用をいかに図るかが肝心である。その点において、他機関のストライガ研究者にも、SUST ストライガ研究室の門戸を開いている SUST 農学部の方針は、頭脳流出が頻繁なスーダンにおける大学、政府研究機関の研究者・学生に広く利用の機会を与

える意味で、有用な方針と考えられる。

(2) プロジェクトは、実施機関 SUST のみならず、NCR、ARC、GSMAI 等、複数の協力機関が関与するものであり、また、成果 1 と 2 のプロジェクトサイトが車で 6 時間の距離にあったことから、関係者のコミュニケーションが懸念された。しかし、関係者の調整努力により、大きな問題を生ずることなく、プロジェクトを成功に導くことができた。

(3) スーダン側及び日本側の研究代表者はストライガ防除研究において、20 年以上の関係を築いており、それは今後も継続するものと思料。本プロジェクトのような研究事業に限らず、共通の課題に取り組むなかで、強固な信頼関係の存在は、持続的な活動を行ううえで不可欠なものといえる。



## Summary of the Results of Evaluation Study

<b>I. Outline of the Project</b>	
Country: Sudan	Project Title: The Project on Improvement of Food Security in Semi-arid Regions of Sudan through Management of Root Parasitic Weeds
Issues/Sector: Agricultural Development (Biotic Resources)	Cooperation Scheme: Technical Cooperation Project
Division in Charge: Rural Development Department	Total Cost : 350,000,000 Yen
Period of Cooperation	March 2010 – February 2015
	Supporting Organizations in Japan: Kobe University, Osaka Prefecture University, Tottori University
Related Cooperation: Technical Cooperation Projects None in particular	
<b>1. Background of the Project</b> <p>Root parasitic weed which is known as “Striga” is one of the most serious biological factors that harm production of gramineous species such as sorghum, millet and rice within semi-arid regions of Sub-Saharan Africa including Sudan. Sorghum and millet, the main hosts of the parasite and the main staple food for Sudanese populace, are planted in millions ha. It is said that 300 million people's lives are affected by the weed; as a result, Sudanese government has faced serious food security issues. The need for simple, inexpensive methods which control Striga at the early development stage and suit for resource poor mostly illiterate, subsistence farmers is imperative.</p> <p>In order to exploit preventive methods against Striga, Sudan University of Science and Technology (SUST) and Kobe University, Japan have collaborated since 1994 and contributed to clarification of Striga's biological and ecological characteristics. Having said that, various aspects for controlling Striga have not yet scientifically been clarified; therefore, it is strongly required to develop innovative techniques to prevent damage by Striga for strengthening food security and poverty reduction in Sudan.</p> <p>To this end, “Project on Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds” (hereafter referred to as “the Project”) under the scheme of SATREPS (Science and Technology Research Partnership for Sustainable Development) has been implemented for five years from March 2010 to February 2015, following the signing of the Record of Discussions (R/D) on 10th November 2009.</p>	
<b>2. Project Overview</b> (1) Overall Goal Extension of new Striga control measures progresses. (2) Project Purpose	

Research, development and extension (RDE) capacity of Sudan University of Science and Technology (SUST) to manage Striga is improved.

(3) Outputs:

Output 1: Innovative technologies to control Striga are developed.

Output 2: Farmers' practice to manage Striga is ameliorated.

(4) Inputs (by the end of August 2014)

Japanese Side:

Dispatch of Experts: Long-term Experts (Coordinator): 2 persons

Short-term Experts : Total of 57.6M/M

Provision of Equipment: 1.06 million US Dollars

Bearing of Local Operation Cost: 0.2 million US Dollars

Training and Research Activities participated by Counterpart Personnel in Japan: 11 persons

Sudanese Side:

Counterpart personnel: 23 persons (SUST: 13 persons, ARC: 5 persons, GSMAI :3 persons, MSC: 1 person, MFNE: 1 person)

Operational Expenses: 159,000 US Dollars

Land and Facilities: Office spaces with office furniture and electricity at SUST

Facilities and experimental fields of the *Striga* Research Laboratory

**II. Evaluation Team**

Members of the Evaluation Team	<Japanese Team>	
	Leader	Mr. Shiro NABEYA Senior Advisor to the Director General, Rural Development Department, JICA
	Project Planning	Mr. Hiroyuki HANADA Project Officer, Rural Development Department, Team 4, JICA
	Evaluation	Ms. Keiko ITAGAKI
	Analysis	Senior consultant, International Development Associates Ltd.
	<Sudanese Team>	
Leader	Prof. Migdam E. Abdelgani Director, The National Center for Research, Ministry of Science and Communications	

Period of Evaluation: 6 – 22 September 2014

Type of Evaluation: Terminal Evaluation

**III. Results of Evaluation**

**1. Achievements**

1-1. Achievement of Outputs

(1) Output 1: Innovative technologies to control *Striga* are developed. (Most likely to be achieved)

To attain the output 1, the Project has carried out the researches on the six subjects. Experiments and verifications were conducted mainly at the *Striga* Research Laboratory in SUST. Achievements of each subject are as follows.

Subject 1: The Project has worked on the structural determination of strigolactone, and a *Striga* germination stimulant, T-010, was synthesized to induce suicidal germination.

Subject 2: The Project has isolated and identified microorganisms which have the potential to interfere and/or arrest early developmental stages of *Striga* through laboratory and pot experiments.

Subject 3: Based on the metabolic analysis, carbon and nitrogen sources for the germination of root parasitic weeds were identified and inhibition of sugar metabolisms was confirmed to have preventive effects on seed germination.

Subject 4: The differences in photosynthetic capacity, stomatal conductance and transpiration rate between *Striga* and host plants were analysed in terms of translocation mechanisms.

Subject 5: The *Striga* resistance of the selected varieties was examined through pot experiments two varieties (Umgar and NERICA 5) indicated high resistance.

Subject 6: A sesame variety with suppression effects on *Striga* was selected through evaluation using rhizotron method and hydroponic culture. Varieties of sunflower, wheat, cowpeas have also been evaluated as potential crop for rotation or mix cropping to mitigate *Striga* damage

(2) Output 2: Farmers' practice to manage *Striga* is ameliorated. (Most likely to be achieved)

Subject 7: Economical and technical capacities among the farmers were identified as factors that affect the degree of acceptance of the new technologies such as application of herbicide to control *Striga*. As for the preferences of sorghum varieties, data have already been collected from about seventy samples, which are at the final stage of processing and analysis.

Subject 8: The Project has organized 24 Farmer's Field Schools in 3 localities in Gedaref. Weekly meetings were conducted throughout the cropping season, and supervised by the extension department of GSMAI. The techniques to control *Striga*, together with other basic cultural management practices, are taught in these FFS.

1-2. Measures taken to address the Recommendations made at the Mid-term Review

(1) Revision of Master Plan

The revised Master Plan as summarized as PDMe was duly approved as PDM version 2 at the JCC meeting held on December 25, 2012.

(2) Utilization and maintenance of equipment for research

The Project has provided guidance on the basic operations and maintenance of the equipment. In addition to the researchers, one of the technicians of the Striga Research Laboratory participated in the training in Japan in 2013, which contributed to the further technology transfer particularly in this regard. These training in Japan were effectively augmented by the dispatch of a Japanese expert at three and six months after the training to provide follow-up guidance in the Striga Research Laboratory.

(3) Capacity Development for Output 1

One young researcher per year participated in the JICA training course on Integrated Pest Management (IMP) over the years from 2010 to 2013, upon which the young scholars had opportunities to be guided by the Japanese researchers in Japan. In Sudan, at the Striga Research Laboratory, many graduate students were also involved in the Project who could also be guided by the Project team members. By the time of the Study, 17 research papers were published and 17 presentations were made

by the Sudanese researchers. Unfortunately, two young researchers have left *Striga* Research Laboratory in 2012.

(4) Enhancement of smooth implementation of the activities for Output 2

There has been a Japanese researcher joined the research on Subject 7 since 2012, in close collaboration with the Sudanese researchers who had worked on the subject since the beginning of the Project. However, it should unfortunately be admitted that the activities on Subject 8 were mostly carried out by the Sudanese team members while the Japanese researcher who has been stationed in SUST for longer period of assignment occasionally took part in a part of the monitoring.

1-3. Prospect for Achievement of the Project Purpose

The *Striga* Research Laboratory of SUST is a formal institution of *Striga* research at SUST. There are two researchers and three technicians permanently assigned and some researchers from the National Center for Research (NCR) and ARC also participate in the activities. The annual budget planning has been exercised by *Striga* Research Laboratory, but no longer-term plan has yet been formulated. However, the College of Agricultural Studies (CAS) is planning to establish a new and independent research center on weed science, of which the current *Striga* research laboratory would become an essential part. A committee to discuss the detailed plan of the new center, composed of the researchers from relevant departments of the college and some representatives from ARC, has been organized and it is expected the mid- or long-term comprehensive plan would be formulated. By the time of the Study, 15 research papers were published and 17 presentations were made by the SUST researchers in various seminars, conferences and workshops. Hence the Team foresees a fair prospect for the achievement of the Project purpose.

## 2. Summary of Evaluation Results

### 2-1. Relevance: High

The Project is consistent to the policies of the Sudanese government, as well as to the ODA programs of Japanese government. The focus of the Project is appropriate response to the needs of beneficiaries.

### 2-2 Effectiveness: High

All of the expected outputs are steadily being achieved and most likely be attained by the end of the cooperation period. There is positive prospect for attainment of the Project purpose.

### 2-3 Efficiency: High

The inputs from both Japanese and Sudanese sides have duly been provided to produce the intended outputs. It should be noted with appreciation that the Sudanese government has provided considerable amount of “local component” which were utilized to renovate the existing laboratory facilities and to construct new building to be the base for future research activities.

#### 2-4 Impacts: High positive impacts

There are many graduate students were also involved in the research activities, whose experiences to work in the Project would be transferred to the relevant institutions in the future. GSMAI has started to apply FFS as effective extension tool to its own programs with a manual that they produce themselves. At the field level, positive impacts on the agricultural production and income are reported, though not all of the farmers could apply all of the techniques due to the affordability of some inputs. Some farmers have organized themselves into formal groupings to help each other as well as to obtain better access to external resources such as support from government programs and loans from banks. Farmers also enjoy closer relationship with extension officers, and some lead farmers have already disseminated what they have learned through the Project to other farmers in and around their communities.

#### 2-5 Sustainability: Moderate

Current policy directions that emphasize the importance of increase of agricultural productivity and food security are likely to continue. Organizational structures for research and extension may not change but financial sustainability would largely depend on the future efforts, to realize the Weed Research Center at SUST, as well as to secure resources for extension activities in Gedaref. A fair prospect is expected in terms of technical capacities of researchers and extension officers, while there may be financial and organizational constraints for continuous adoption of *Striga* control techniques among the farmers.

### 3. Factors that Promoted Realization of Effects

3-1 Factors Concerning the Planning N/A.

3-2 Factors Concerning the Implementation Process

Some research team members could avail additional fund from external sources. Also, additional financial supports were provided to conduct FFS in the field by the Sudan Bank and Agricultural Bank. These supports were found to have contributed to the smooth and effective implementation of the Project.

### 4. Factors that Inhibited Realization of Effects

4-1 Factors Concerning the Planning N/A.

4-2 Factors Concerning the Implementation Process

The drought in the cropping season of 2013 negatively affected the yield performances in some of the FFS demonstration plots. The incidence caused negative influences in terms of the effects of technology dissemination, although the Project could manage to proceed with its originally planned activities through the efforts of the relevant personnel.

### 5. Conclusion

The Team confirmed that the technical capability of staff of SUST as well as cooperating institutions for *Striga* research has surely been improved. Most of the recommendations by the Mid-Term Review Team have been addressed, and the necessary steps to continue *Striga* research activities are being taken through the plan of a special *Striga* research center or “the Weed Research Center”.

In accordance with the results of the comprehensive evaluation, it is concluded that the Project would be completed in February 2015 as planned. There are still several important issues to be addressed in order to have better outcomes of the Project. These issues are explained as recommendations in the following chapter.

## **6. Recommendations**

### **6-1 Recommendations for the remaining period of the Project**

#### **6-1-1 Support for planning of the proposed Weed Research Center of SUST**

As previously discussed in the section 4-5-2, the CAS is currently planning to establish a Weed Research Center, which would further enhance the research activities on Striga as well. The details of the plan are to be discussed from now on among the designated members of the planning committee that includes some research team members of the Project. This center would be one of the good ways to continue and further expand the achievement of the Project. It is thus important for the Project to monitor the progress of the formulation of the concrete plan, and to provide information and supports to the efforts to facilitate their planning activities by CAS.

#### **6-1-2 Preparation of operation manuals on equipment**

The Striga Research Laboratory of SUST has well been managed by virtue of efforts of the Project personnel with support of Japanese experts. It was observed by the Team that some operation manuals on usage of the laboratory equipment are indicated at the Laboratory, and operational manuals for GC (Gas Chromatography) and HPLC (High Performance Liquid Chromatography) are under preparation by a Japanese expert. However, for long-term technical sustainability, the Team recommends preparation of operational manuals for other equipment.

### **6-2 Recommendation for the Sudanese government for future (after completion of the Project)**

#### **6-2-1 Official Recognition of SUST as Center of Excellence**

The MHESR has been working to officially recognize the Striga Research Laboratory / CAS as the Center of Excellence (COE). As the authorization as COE may help SUST to further develop and enhance its research and educational capacities, it is recommended for the MHESR to accelerate the procedure to realize the authorization in an official manner.

#### **6-2-2 Efforts to secure financial support**

Along with the termination of the Project, the financial support such as local component from the MFNE and local expense borne by the Japanese side would cease. It is generally assumed that the fund allocation afterwards would inevitably been of much smaller scale. Thus the Team requests the participating institutions to continuously make their efforts to secure resources necessary to continue, further expand and scale up the accomplishments brought about by the Project, not only in terms of research activities at SUST, but also of the extension and demonstration activities by ARC and GSMAI.

## **7. Lessons Learned**

### **7-1 Open access to research facilities**

Universities and national research institutions are strongly expected to conduct research in order to solve the important problems in improving agricultural development. Universities are supposed to educate young students and researchers through research.

SUST has allowed Striga researchers from other institutions to utilize the Striga Research Laboratory equipment provided through the Project. This policy seems to have been very effective.

As most developing countries are not capable to furnish relevant institutions with necessary instruments for all research, it is desirable for universities and national research institutions to play a central role in generating wider impacts on the society by providing open access for academia and other stakeholders.

#### 7-2 Proper coordination among institutions

The Project was implemented in collaboration among several research institutions, who shared the common interests and commitment in Striga research. Efforts have been made to ensure close communications, and proper coordination made among these participating institutions seems to have contributed to smooth implementation of the Project, thus led to the success and fruitful achievement of the Project.

#### 7-3 Trust relationship

Representatives of the Striga research from both Sudanese and Japanese sides have been working for more than 20 years and there is a decisive confidential relationship between them. Such relationship is essential for not only a research project but also others to conduct sustainable activities with counterparts.

# 第1章 調査の概要

## 1-1 調査団派遣の経緯と目的

### 1-1-1 調査団派遣の経緯

スーダン共和国（以下「スーダン」と記す）を含むサブサハラ地域において、根寄生雑草ストライガは、ソルガム、ミレット等の主穀の生産を阻害する最大の生物的要因であり、その損害は年間1兆円、被害人口は約3億人と推計される。スーダンでは、農村部貧困層の中核を成す小規模農家（小農）を担い手とした伝統的天水農業が、全耕作面積の約50%である700万haにおいて営まれている。乾燥条件下、低投入により同じ土地で主穀物を連作せざるを得ない状況が、ストライガの発生を助長しているとされ、経営状況の苦しい小農ほど生産が低下するという悪循環が形成されている。

1994年以降、スーダン科学技術大学（Sudan University of Science and Technology : SUST）と神戸大学の共同により、ストライガの研究が進められ、その生理生態の解明に大きく貢献した。しかしながら、ストライガの生理生態はまだ科学的に解明されていない部分が多く、スーダンの食料安全保障、貧困問題に深刻な影響を与えていることから、効果的な防除方法確立のための研究能力の強化が求められている。

このような状況のなか、これまでのストライガ研究の成果を踏まえ、科学的なストライガ防除のための知見蓄積を目的とした地球規模課題対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development : SATREPS）プロジェクトがスーダン政府より要請された。またそれに並行し、神戸大学より独立行政法人科学技術振興機構（Japan Science and Technology Agency : JST）に対しストライガ研究申請が行われたことを受けて、SUSTを実施機関、神戸大学を研究代表機関とし、2010年3月より2015年2月までの5年間の協力が実施された。

本プロジェクトでは、ストライガの発芽誘導物質の人工的抽出による防除や、選択的除草剤の検索、宿主からの養水分収奪機構の解明等の自然科学的研究と、伝統的な防除知識、防除の新技術に対する農民の受容性等の社会科学的調査を並行し、ストライガ防除に効果的な技術開発が進められた。また、ガダーレフ州の6カ村において農民圃場学校（Farmers' Field School : FFS）が組織され、農民やプロジェクト関係者の間で、防除技術や情報の共有が行われている。

2014年9月をもって、本プロジェクト期間が残り6カ月となったことから、JSTと連携して終了時評価調査を実施し、JICAはプロジェクト運営監理の一環として相手国における人材育成、能力強化、及び開発課題に対する貢献の観点から、評価5項目（妥当性、有効性、効率性、インパクト、持続性）において評価を実施した。一方、JSTからは、研究成果及び科学技術水準の向上の観点から、日本国内及び相手国を含めた国際共同研究全体についての評価を得た。

以上の結果を踏まえて、残りプロジェクト期間で取り組むべき課題を抽出し、課題に対する対応策について検討した。

### 1-1-2 調査団派遣の目的

今回実施の終了時評価調査では、本プロジェクトの目標達成度や成果等を分析するとともに、プロジェクトの残り期間の課題及び今後の方向性について確認し、同結果を終了時評価調査として取りまとめたうえで、合同調整委員会（Joint Coordinating Committee : JCC）において内容を合意することを目的とした。



## 1-2 団員構成

### <日本側調査団>

団長/総括	鍋屋 史朗	JICA 農村開発部 専任参事
評価分析	板垣 啓子	株式会社 国際開発アソシエイツ
協力企画	花田 博之	JICA 農村開発部 農業・農村開発第二グループ 第四チーム 専門 嘱託

### <スーダン側調査団>

総括	Prof. Migdam E. Abdelgani	Director, The National Center for Research, Ministry of Science and Communication
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### <評価調査同行者>

独立行政法人科学技術振興機構 (JST)

科学技術計画・評価	浅沼 修一	JST プログラムオフィサー、 名古屋大学農学国際教育協力研究センター 教授
科学技術計画・評価	佐藤 雅之	JST 地球規模課題協力グループ 上席主任調査員

スーダン側プロジェクトカウンターパート

Dr. Salah-Eldin Sid Ahmed	Dean, College of Agricultural Studies, Sudan University of Science and Technology (SUST)
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## 1-3 調査日程

2014年9月6日～2014年9月22日（うち、官団員は9月12日～9月22日）

Day	Date	Evaluation	JICA	JST
9/6	Sat	Tokyo→		
9/7	Sun	→Khartoum Meeting and Interview @SUST, Meeting @JICA		
9/8	Mon	Interview with concerned		
9/9	Tue	organization staff/ Documentation		
9/10	Wed	Khartoum→Gedaref Field Survey		
9/11	Thu	Field Survey		
9/12	Fri	Field Survey Gedaref→Khartoum	Tokyo→	Tokyo→
9/13	Sat	Documentation	→Khartoum	→Khartoum
9/14	Sun	Courtesy call, Meeting, Making Draft and Report		

9/15	Mon	Courtesy Call to concerning organizations		
		Symposium (Presentation of the Project activities)		
9/16	Tue	Khartoum→Gedaref, Field Visit		
9/17	Wed	FFS, Interview, Gedaref→Khartoum		
9/18	Thu	Interview with researchers of SUST and other research institutes		
9/19	Fri	M/M and Report writing		
9/20	Sat	Joint Terminal Evaluation Discussion		
		Joint Terminal Evaluation Discussion		Khartoum→
9/21	Sun	JCC, Signing M/M, Q&A @SUST Khartoum→	JCC, Signing M/M, Q&A @SUST, Report to JICA Office Khartoum→	
9/22	Mon	→Tokyo	→Tokyo	→Tokyo

M/M : Minutes of Meeting (ミニッツ)

#### 1-4 対象プロジェクトの概要

プロジェクト目標、成果及び成果達成のために計画された活動は以下のとおりである。

##### (1) 上位目標

新たなストライガ対策の普及が進展する。

##### (2) プロジェクト目標

スーダン科学技術大学 (SUST) のストライガ対策にかかわる研究・開発・普及 (RDE) 能力が向上する。

##### (3) アウトプット

アウトプット 1 : 革新的なストライガ防除技術が開発される。

アウトプット 2 : 農民のストライガ管理のための取り組みが改善される。

##### (4) 活 動

アウトプット 1 : 革新的なストライガ防除技術が開発される。

課題 1. 新規自殺発芽誘導物質の開発

課題 2. ストライガ防除微生物の探索

課題 3. 選択的除草剤の探索

課題 4. 宿主養水分収奪機構の解析

課題 5. イネ・ソルガムの環境適応性とストライガ抵抗性の評価

課題 6. 抵抗性/耐性作物の選抜と新規輪作体系の考案

アウトプット 2 : 農民のストライガ管理のための取り組みが改善される。

課題 7. 新技術受容性と生産者・消費者の嗜好の調査

課題 8. ストライガ対処法の共有に向けた農民圃場学校の実施

(5) 投入（評価時点）

日本側：

専門家派遣：長期 2 名（業務調整）、短期 57.6 人月（複数回）

研修員受入れ（本邦）：カウンターパート研修及び大学等における研究活動：11 名

機材供与：約 1 億 1,000 万円

ローカルコスト負担：約 2,360 万円

スーダン側

カウンターパート配置：延べ 23 名〔SUST より 13 名、農業研究機構（ARC）より 5 名、ガダーレフ州農業・灌漑省（GSMAI）より 3 名、科学コミュニケーション省（MSC）及び財務国家経財省（MFNE）より各 1 名〕

プロジェクト運営費：約 1,650 万円

土地・施設提供：

SUST 内のプロジェクト執務室、付帯資機材及び水道・電気設備

SUST 及びガダーレフ州 ARC 内の実験圃場・用地の提供

SUST 内ストライガ研究室拡張及び新研究棟用地の提供

(6) プロジェクト期間

2010 年 3 月 1 日～2015 年 2 月 28 日（5 年間）

(7) 研究代表機関

日本側：神戸大学

スーダン側：スーダン科学技術大学（SUST）

## 第2章 評価の方法

### 2-1 評価設問と必要なデータ・評価指標

本終了時評価は、JICA 事業評価ガイドライン（第2版）（2014年）に基づき、プロジェクト・サイクル・マネジメント（Project Cycle Management：PCM）の評価手法を採用して、日本、スーダン双方の評価者から構成される合同評価調査団により実施された。実績及び実施プロセス、評価5項目に関する評価設問を設定した評価グリッド（付属資料1の英文合同評価報告書 Annex 4を参照）に基づき、プロジェクト・デザイン・マトリックス（Project Design Matrix：PDM）に掲げられた指標と照らしてプロジェクトの進捗及び成果達成状況を確認したうえで、合同評価調査団内で検討を行い、上記評価5項目の観点から調査結果の分析を行った。

### 2-2 データ収集方法

本終了時評価においては、以下のデータを収集・検討するほか、現地調査において、日本人専門家及びカウンターパートへの聞き取り、プロジェクト対象地域踏査及び受益農民へのインタビューなどを通じ、情報を収集した。

- (1) 討議議事録（Record of Discussions：R/D）、PDMなどプロジェクト計画資料
- (2) プロジェクト活動進捗報告書、短期専門家報告書
- (3) 日本側、スーダン側投入の詳細
- (4) プロジェクト活動進捗及び成果に関するプロジェクト作成資料

### 2-3 データ分析方法

本終了時評価にあたっては、以下の評価5項目の観点からの分析を行い、評価を実施した。

#### (1) 妥当性

妥当性は、プロジェクトが定めた上位目標とプロジェクト目標が、被援助国の開発政策やターゲットグループのニーズと一致しているか、また、これらの目標を達成するためのプロジェクトデザインが妥当であったかを検証するものである。

#### (2) 有効性

有効性とは、プロジェクト実施によって、ターゲットグループに対して所期の便益をもたらすことができたかどうかを評価するものである。そのためにはプロジェクト目標の達成度を分析するとともに、その内容について、プロジェクト活動によるアウトプット産出への貢献度を検証することが必要である。

#### (3) 効率性

効率性とは、プロジェクト実施過程における生産性のことであり、投入がアウトプットにどれだけ効率的に転換されたかを検討する。

#### (4) インパクト

インパクトとは、プロジェクト実施により生じた直接的及び間接的なポジティブ、ネガ

典型的な効果、影響のことである。

(5) 持続性

持続性とは、プロジェクト実施による効果が、プロジェクト終了後においても持続されるかどうか、それらの阻害及び貢献要因について、政策及び制度的側面、組織及び財政的側面、そして技術的側面から検証するものである。

#### 2-4 評価調査の制約・限界

本評価調査は限られた予算と調査期間をもって実施されたため、活動や実績のすべてを網羅するには至らず、受益農民やその他関係者へのインタビューについても対象が一部に限られた。また、評価団員の一部が、技術的な問題によりガダーレフ州の現地活動を視察できなかったため、日本人専門家及び SUST カウンターパートへのインタビュー、二次資料等を中心とした分析を行った。

## 第3章 プロジェクトの実績

### 3-1 投入実績、アウトプットの実績

#### 3-1-1 日本側投入

##### (1) 専門家派遣

本プロジェクトには、業務調整として計2名の長期派遣専門家が派遣されたほか、生物有機化学、作物生理学、植物生理学、文化人類学、有機合成化学等の分野の短期派遣専門家が、2014年8月末までに合計約57.6人月の期間派遣された。専門家派遣の詳細については付属資料1の英文合同評価報告書 Annex 5を参照されたい。

##### (2) 機材供与

プロジェクト活動の実施及び技術移転に必要な車両、コンピュータ等事務機器、試験器具等が要請され、総額約106万米ドル（約1億1,000万円<sup>1</sup>）相当の機材が供与された。これら供与機材の詳細については英文合同評価報告書 Annex 6に示すとおりである。

##### (3) 本邦における研修・研究への参加

スーダン側カウンターパート11名が本邦での研修及び研究活動に参加した。本邦におけるこれら研修・研究活動への参加については英文合同評価報告書 Annex 7に詳細を記す。

##### (4) 現地業務費支出

これまでに総計で約22万7,000米ドル（約2,360万円<sup>2</sup>）のローカルコスト負担が行われた。各年度の支出実績は下表3-1に示すとおりである。

表3-1 現地業務費支出実績

年 度	2009	2010	2011	2012	2013	2014 <sup>(*)1</sup>	小計	合計 (USD) <sup>(*)2</sup>
スーダンポンド (SDG)	1,0467.50	292,530.50	411,843.00	259,833.00	288,615.00	107,588.00	1,370,877.00	227,333.15
米ドル (USD)	0.00	5,541.00	7,238.00	939.00	1,559.00	1,152.00	16,429.00	

\*1：2014年8月末時点までの実績。

\*2：本終了時評価調査時の為替レート（USD 1.00 = SDG 6.011）による。

出所：プロジェクト作成資料（2013年11月）

#### 3-1-2 スーダン側投入

##### (1) カウンターパートの配置

スーダン側カウンターパートとして、これまでに延べ23名〔SUSTより13名、農業研究機構（Agricultural Research Corporation：ARC）より5名、ガダーレフ州農業・灌漑省（Gedaref State Ministry of Agriculture and Irrigation：GSMAI）より3名、科学コミュニケー

<sup>1</sup> 調査時点での為替レート（1米ドル=103.77円）に基づく概算値。

<sup>2</sup> 同上。

ション省（Ministry of Science and Communication：MSC）及び財務国家経済省（Ministry of Finance and National Economy：MFNE）から各1名]が配置された。カウンターパートの詳細は付属資料1の英文合同評価報告書 Annex 8のとおりである。

## (2) 予算の措置

スーダン側よりローカルコンポーネントとして、これまでに合計で約95万5,000スーダンポンド（約1,650万円<sup>3</sup>）の運営費が支出された。実施機関及び年度ごとの内訳は、下表3-2に示すとおりである。

表3-2 スーダン側の運営経費支出（SDG）

年度（*1）	2010	2011	2012	2013	2014 <sup>(*2)</sup>	合計
運営経費	116,680.00	125,843.00	371,210.00	325,371.19	16,100.00	955,204.19

\*1：スーダンの会計年度（1月～12月）による。なお、数字は予算額。

\*2：2014年8月末時点までの実績。

出所：プロジェクト作成資料

## (3) 土地、施設等の提供

プロジェクト開始当初から、スーダン側より、SUST 農学部内に専門家執務室と家具調度が提供されたほか、ストライガ研究室の施設、実験圃場用地が提供された。また、スーダン側予算により、ストライガ研究室の増築、新研究棟の建設が行われた。

## 3-2 成果及びプロジェクト目標の達成度

本プロジェクトにおいては、SUST のストライガ対策にかかわる研究・開発・普及（Research, Development and Extension：RDE）能力が向上することを目標として、研究機関における革新的なストライガ防除技術の開発、農民によるストライガ対策の改善という二つの成果が設定されている。各成果達成のために八つの課題が選定されており、それらに関する活動状況及び達成度は以下のとおりである。

### 成果1 革新的ストライガ防除技術開発

#### 課題1：新規自殺発芽誘導物質の開発

指標：

- 1-1 構造改編により発芽刺激物質の化学的安定性を高める
- 1-2 更なる化学修飾により発芽刺激活性を高める
- 1-3 対象発芽刺激物質の圃場での有効性が検証される

発芽誘導物質ストライゴラクトン類縁体の構造の最適化を進めてきた結果、その構造が決定され、世界に先駆けてソルガムより単離されたストライゴラクトン sorgomol が合成された（指標 1-1、1-2 達成）。自殺発芽誘導剤候補化合物として独自にデザイン・合成したカーバメート

<sup>3</sup> 調査時点での為替レート（1スーダンポンド=17.26円）に基づく概算値。

化合物の一つ（化合物コード番号 T-010）を合成し、T-010 の適用試験をポット試験、実験圃場で実施し、候補化合物によるストライガ防除効果を確認したことを受け、指標 1-3 は達成された。これにより、課題 1 は達成されたといえる。

#### 課題 2：ストライガ防除微生物の探索

指標：

- 2-1 ストライガの発芽を阻害または促進する可能性がある微生物を探索する
- 2-2 有効な微生物を発見する
- 2-3 当該微生物のストライガ防除剤としての有効性が圃場で検証される

土壌から多くの糸状菌と細菌を分離し、実験室、ポット試験で微生物を用いたストライガ防除の可能性を示し、その後立ち枯れしたストライガ個体から SUST 研究者により分離された *Fusarium* 菌株を、日本で同定した。*Fusarium* 菌株については、ポット試験でソルガムに対するストライガ抑制効果を確認した。なお、これはポット試験での結果であるが、協力期間終了までに圃場レベルでの検証を行うため、指標 2-3、及び課題 2 は達成見込みであるといえる。

この菌株の接種と窒素施肥あるいは堆肥施用を組み合わせることでより高いストライガ抑制効果が認められたことから、*Fusarium* 菌を単独に利用するのではなく、その他の技術と組み合わせた総合的なストライガ防除が有効であると考えられる。また、土壌由来細菌を利用することで、ストライガ出芽数を抑制するだけでなく、ソルガムの生育を向上させる可能性があることも分かった。

#### 課題 3：選択的除草剤の探索

指標：

- 3-1 特異的な代謝プロファイルが分かる
- 3-2 当該代謝がストライガの生存に必須であることが分かる
- 3-3 当該代謝を阻害する薬剤が発見される

指標 3-1 及び 3-2 について、メタボローム解析に基づき、根寄生雑草の発芽時に特徴的な炭素源として三炭糖、窒素源としてアラントインを見だし、これらの代謝を阻害することにより寄生雑草の発芽を抑制できることを確認した。これを受けて二つの指標は達成されたといえる。また、発芽種子に特異的な三炭糖の代謝をノジリマイシン（糖加水分解酵素阻害剤）によって阻害することでストライガの発芽を阻害することを見いだしたことにより、指標 3-3 は達成された。さらに、ノジリマイシンの発芽阻害活性の作用機構の解析を進めたところ、根寄生雑草の発芽にはプランテオース及びスクロースの代謝によって得られるグルコースが必要であることが示された。このことから、課題 3 は達成されたといえる。

#### 課題 4：宿主養水分収奪機構の解析

指標：

- 4-1 ストライガの水分生理特性が解明される
- 4-2 ストライガを抑制する水管理条件が解明される
- 4-3 ストライガを制御できる作物の栽培条件が解明される



ストライガは葉の気孔密度が高く、土壤乾燥により葉の相対含水率が低下しても気孔開度を高く維持し、宿主から養水分を収奪していることを確認した（指標 4-1 達成）。また、指標 4-2 について、湿潤であれば宿主の気孔開度が高いため、ストライガへの転流が抑えられることを確認した（指標 4-2 達成）。

これまでに、スーダン側共同研究者らの実験により、ガダーレフ州の展示圃場において、あぜの谷部に雨水を貯める集水技術の適用で、ストライガ被害が軽減されることが明らかとなった。協力期間終了までに、展示圃場で異なる土壤水分条件下でのソルガムとストライガの気孔応答、及びストライガ被害への影響について検証を行う。また、窒素施肥により、ストライガ汚染圃場での宿主作物（ソルガム、イネ）の生育阻害が軽減されることを実験圃場で確認した。協力期間終了までに、抵抗性品種、深耕、除草剤、施肥の組み合わせにより、ストライガ被害が軽減することを現地圃場で確認することから、指標 4-3、及び課題 4 は達成見込みであるといえる。

#### 課題 5：イネ・ソルガムのストライガ抵抗性と環境適応性の評価

指標：

- 5-1 イネ・ソルガムの遺伝子源を収集してストライガ抵抗性を評価する
- 5-2 ストライガ抵抗性の系統を選抜する
- 5-3 選抜した系統のうち環境適応性を有する系統を選抜する

ライゾトロン法を用い、NERICA18 品種とその親 4 品種、日本の陸稲 24 品種等を含む合計 52 種のイネ品種から、一次スクリーニングで 6 品種を選抜するとともに、ソルガムにおいても同法を用いて、抵抗性の一次評価を行い、圃場で二次評価を行った（指標 5-1 達成）。その結果、イネにおいては、スーダンの推奨品種である Umgar と NERICA5 が安定したストライガ抵抗性を示した（指標 5-2 達成）。特に Umgar について、スーダンの栽培環境にも高い適応を示したことから、指標 5-3 が達成された。しかし、環境によっては抵抗性を示さない可能性があることから、異なる環境下での調査を継続する。また、上記の試験は、ソルガム由来のストライガ種子を使用した結果であり、イネ由来もしくはミレット由来の種子では抵抗性に相違が発現することも分かった。また、ソルガムについては、野生種 90 系統をスーダン東部で収集し、ストライガ寄生の抵抗性試験を行っている。

#### 課題 6：抵抗性/耐性作物の選抜と新規輪作体系の考案

指標：

- 6-1 導入候補作物のインビトロ<sup>4</sup>でのストライガ抵抗性を評価する
- 6-2 導入候補作物の圃場でのストライガ抵抗性を評価する
- 6-3 選抜された作物を組み合わせた新規輪作体系を考案する

ライゾトロン法、水耕栽培法といったインビトロでの評価技術を習得し、ストライガの寄生を抑制するゴマ及びササゲ品種の選抜を行った（指標 6-1 達成）。また、輪作に組み入れられる可能性があるミレットやコムギについては、ポット試験でストライガへの感受性の評価を継続し、大学内の試験圃場での輪作試験で、ヒマワリ及びゴマ栽培によるストライガ発芽抑制効果

<sup>4</sup> 分子生物学の実験などにおいて、試験管内などの人工的に構成された条件下のこと。

の高さを確認した（指標 6-2 達成）。また、作物残渣（ざんさ）がもつストライガ種子発芽誘導活性を評価するために、ナイジェリアに本部をもつ国際熱帯農業研究所（The International Institute of Tropical Agriculture : IITA）から多数のササゲ品種を入手し、輪作あるいは混作物としての評価を行っている。協力期間終了までに輪作の効果を実証し、新規輪作体系を確立するため、ガダーレフ州の圃場において、ソルガム連作区とゴマ-ソルガム輪作区の比較が進行しており、指標 6-3 及び課題 6 は達成見込みである。

## 成果 2 農民のストライガ管理慣行改善

### 課題 7：新技術受容性と生産者・消費者の嗜好の調査

指標：

- 7-1 本事業で開発する防除技術の生産者の経済的・技術的な受容性を明らかにする
- 7-2 生産者・消費者の好むソルガム・コメ品種の経済性を含む特性を明らかにする
- 7-3 調査結果のうち有益な情報を現地語で提供する

ストライガ被害拡大の要因を検討した。ストライガ防除の新技術導入を図るうえで、農家家計における経済的制約の軽減が重要であり、農民が現金収入を確実に得ることを最優先し、ストライガ防除とは相反する行動を選択する可能性があることが確認された。例えば、ストライガを手作業で抜き取ることは高い寄生抑制効果が知られているが、農民はその時間を確実に現金収入が見込める農外での就業に振り向けている。また、新技術導入にはリスクへの補償に配慮し、女性農業者をインターフェースと位置づけることの重要性が見いだされた（指標 7-1 達成）。

ソルガムに関する生産者・消費者の嗜好については、アンケート調査を実施し、70 サンプルの回答を基に最終的な結果を取りまとめ中である。ソルガム・コメにおける嗜好調査は継続しており、一部の調査結果についてはアラビア語の報告書が作成され、協力期間終了までに農民を含む関係者に配布される予定であることから、指標 7-2、7-3 及び課題 7 は達成見込みである。

### 課題 8：ストライガ対処法の共有に向けた農民圃場学校の実施

指標：

- 8-1 農民圃場学校の運営・管理体制を強化する
- 8-2 農民圃場学校におけるカリキュラムを決定し、教材を準備する
- 8-3 普及活動を実施する

農民圃場学校（FFS）の運営・管理体制強化のため、ARC 職員 2 名と GSMAI 職員 2 名の合計 4 名で構成される FFS 実行委員会を組織した。2010 年には、FFS の運営を担うファシリテーターに任命された GSMAI 普及局職員 6 名及び ARC 職員 3 名に対する指導者研修（Training of Trainers : TOT）を行った。これらの GSMAI 及び ARC ガダーレフ支所の職員がこれまでに 24 回の FFS（各回 30 名程度の農民が参加）を運営したことを受け、指標 8-1 は達成された。FFS 実施の実績は表 3-3 に示すとおりである。

これら FFS においては、作期を通じてストライガ防除技術と基礎的な栽培管理技術の指導（普及活動）が行われた（指標 8-2 達成）。指導・導入されたストライガ防除技術の内容については表 3-4 のとおりである。協力期間終了までに、これら FFS で導入された一連の知見をアラビア語のパンフレットにまとめて配布する予定であり、指標 8-3 及び課題 8 は達成見込みで

ある。

### 3-3 FFS 開催実績

地区	村落	FFS 開催回数	実施年
Middle Gedaref	Tirfa	5	2010, 2011, 2012, 2013, 2014
	Umm Senabra	2	2010
West El Qalabat	Huriya	2	2013, 2014
	Kagara	4	2010, 2011, 2012, 2013
	Kasab	1	2014
	Wad Alsanosi	1	2014
	Ganan	3	2010, 2013, 2014
	Wad Al Halengi	1	2013
	Ziragah	1	2014
East El Qalabat	Tawarit	1	2010
	Allam	3	2010, 2011, 2012
合計		24	

出所：プロジェクト作成資料

表 3-4 FFS で指導・導入されたストライガ防除技術

技術コンポーネント	ストライガ防除効果
推奨品種（Wad Ahmad）の紹介と導入	より高いストライガ耐性をもつ品種の利用
深耕	土壌水分量を確保することによりストライガの成長を阻害
条播	栽培管理、特に除草作業を容易化する
窒素肥料の施肥	土壌養分を高め、ストライガによる養分収奪の影響を最小化
除草剤の使用	ストライガの成長を直接に阻害
ゴマとの輪作	ソルガム連作によるストライガ被害の軽減

出所：ARC ガダーレフ試験場職員からの聞き取りに基づき作成

### 3-3 プロジェクト目標の達成見込み

プロジェクト目標：スーダン科学技術大学（SUST）のストライガ対策にかかわる研究・開発・普及（RDE）能力が向上する。
指標： <ol style="list-style-type: none"> <li>1. SUST にストライガ研究のための常設チームが設置される</li> <li>2. SUST 内でストライガ研究のための中期的な予算計画が策定される</li> <li>3. SUST 研究者が国際的な場で研究成果発表（国際学会での発表、主要ジャーナルへの寄稿）を継続的に行うようになる</li> </ol>

SUST 農学部にストライガ研究室が設置されており、常勤の研究員 2 名、技術員 3 名が勤務しているほか、大学院生が論文研究を行っており、指標 1 は達成された。ストライガ研究チームには国立研究センター（National Center for Research : NCR）、ARC の研究員も参加している。終了時評価調査時点で、ストライガ研究室の中期的な予算計画は策定されていなかったが、SUST 農学部は、雑草研究のための研究センター構想を有しており、学部内及び ARC 関係者から成る検討委員会を設置して具体的な計画内容の検討が進められている。また、財務省による Weed Research Center 設置のための 5 年間の予算措置が計画されたことを受け、指標 2 は達成見込みであるといえる。

SUST 研究者の業績に関しては、これまでに 15 本の研究論文発表、17 本の学会発表がスーダン側の研究者により行われ、今後も研究成果が広く広報されることが期待できることから、指標 3 はほぼ達成見込みである。研究成果発表の詳細については付属資料 1 の英文合同評価報告書 Annex 9 に示すとおりである。

以上のことから、プロジェクト目標については達成見込みであると判断された。

### 3-4 実施プロセス

#### 3-4-1 意思決定とモニタリングのメカニズム

プロジェクトの最高意思決定機関である合同調整委員会（JCC）はこれまでに 5 回開催され、プロジェクトの活動進捗及び成果達成状況と次期活動計画内容の確認・承認等の機能を担ってきた。今般調査期間中に第 6 回 JCC が開催され、本評価調査結果及びそれに基づく提言が報告された。本プロジェクトの意思決定及びモニタリング体制は、プロジェクトの活動を円滑に進めていくうえで有効であった。

#### 3-4-2 プロジェクト関係者間の連絡調整

本プロジェクトにおいては、首都ハルツームに位置する SUST とガダーレフ州の展示圃場との物理的な距離、日本人専門家の比較的短期のシャトル型派遣、異なる組織に所属するカウンターパートの配置などの理由で、プロジェクト関係者間での会合を定期的に行うことは困難であった。しかしながら、カウンターパート及びその他プロジェクト関係者間には密接な連絡調整・コミュニケーションが図られており、プロジェクトの円滑な進捗が確保された。

## 第4章 評価結果

### 4-1 評価5項目による評価結果

#### 4-1-1 妥当性

以下の理由から、本プロジェクトの妥当性は高いと評価された。

##### (1) 対象地域・受益者のニーズとの合致

本プロジェクトは SUST のストライガ対策にかかわる研究・開発・普及（RDE）能力の向上を目的として実施されているが、ストライガはスーダンの穀物生産において、最大の阻害要因の一つであり、ガダーレフ州だけでも年間 30 万 t の被害が生じていると推定されている。農民を含め、今回インタビュー対象となった関係者は、食料安全保障及び農村経済の観点から、ストライガ対策が農業セクターにおける喫緊の課題であると認識している。よって、本プロジェクトの内容は対象地域及び受益者のニーズに対する適切な対応であったと考えられる。

##### (2) スーダン政府の政策との整合性

プロジェクト開始以来、国家開発の 25 年ビジョンである「Building of a United, Safe, Peaceful and Developed Sudanese Nation (2007-2031)」等の計画の方向性に大幅な変更はなく、農業灌漑省の第 2 次 5 年計画等のセクター開発政策においても、食料安全保障の重要性が依然として重要課題と認識されている。農業生産性の向上、特に小規模農民の生産強化は州レベルの計画においても重点課題とされている。以上のことから、本プロジェクトの内容及び方向性と、スーダン政府の開発政策、農業セクター計画との整合性は確保されている。

##### (3) 日本の開発援助政策との整合性

2012 年 12 月に策定された「対スーダン共和国国別援助方針」においては、平和の定着推進と基礎生活の向上及び貧困削減が大目標にうたわれており、農業開発は 3 重点分野の一つと位置づけられている。スーダンには農業開発の高いポテンシャルが存在する一方、貧困層の多くが農業に従事していることにかんがみ、貧困削減及び食料安全保障に寄与が見込まれる農業分野の開発を支援することが明記されている。事業展開計画においても、本プロジェクトは農業開発プログラムの重要なコンポーネントと位置づけられている。これらの点から、本プロジェクトの方向性とわが国の援助政策との整合性は依然として確保されていることが確認された。

##### (4) プロジェクト・アプローチの適切性

本プロジェクトのストライガ研究グループには、社会経済分野を含め、多様な専門分野の研究者が参画しており、マルチセクターの取り組みによって、ストライガ対策に対する包括的な研究が可能となった。特に、天然物化学、有機合成化学、植物生理学、作物生理学を専門とする優れた研究者の連携は、プロジェクト開始以前からの共同研究の経験によって培われたものであり、それら既往の強みを生かして総合的なストライガ研究を行う

本プロジェクトのアプローチは適切なものであったと考えられる。

#### 4-1-2 有効性

前章に記述した成果達成度の確認に基づき、本プロジェクトの目標が協力期間内に達成される見込みは高いと判断され、プロジェクト実施の有効性は高いといえる。

##### (1) プロジェクト目標達成の見込み

革新的なストライガ防除技術の開発、農民のストライガ管理慣行の改善という二つの成果のための活動はいずれも着実に進捗してきている。プロジェクト目標の指標に関してもおおむね達成が見込まれるところ、協力期間内のプロジェクト目標達成には高い期待がもてると考えられる。

##### (2) プロジェクト目標達成に対する成果の貢献度

本プロジェクトは、主として SUST のストライガ研究室における防除技術の開発と、ガダーレフ州における農民レベルでの防除慣行の改善という、研究と社会実装の両面を成果とするものであり、これらの達成が、ストライガ対策にかかわる RDE の能力向上というプロジェクト目標に結びつく論理性は依然として確保されている。また、前章で確認したとおり、これらの成果は適切かつ着実に達成されつつあり、プロジェクト目標の達成に等しく貢献するものと考えられる。

##### (3) プロジェクトの有効性に対する貢献要因

本プロジェクトの実施過程において、一部のカウンターパートがプロジェクト以外の助成を受け研究活動を行うことができた。また、ガダーレフ州の FFS 活動に関しても、関係者の努力によりスーダン銀行・農業銀行からの資金支援が得られたことは高く評価すべき事項である。プロジェクトからの投入に限りがある状況において、このような外部支援が得られたことは、円滑に研究活動を推進し、農民レベルでの活動を効果的に進めるうえで大きく貢献したと考えられる。

##### (4) プロジェクトの有効性に対する阻害要因

2013 年作期に早魃となり、FFS の展示圃場においても収量が低下した。収穫が皆無となった周辺圃場に比べ、展示圃場では収穫があり、技術の効果は確認されたものの、技術普及の効果に否定的な影響が及んだことは否めない。プロジェクトの活動自体に支障が出ることはなかったものの、このような気象条件等が、プロジェクト実施の潜在的な阻害する要因となり得ることには留意が必要である。

##### (5) 外部条件の変化による影響

本プロジェクトの外部条件のうち、農業資材や生産物価格の大幅な変動はなかったが、SUST 研究員の定着に関しては、日本研修を受けたカウンターパートも含め研究員の海外流出の事例が報告された。スーダンの社会経済的現状において、このような「頭脳流出」は、特に研究教育機関における恒常的な問題となっており、本プロジェクトにおいても、

本外部条件の変化は、持続性の観点からは否定的な影響をもたらしていると考えられる。

#### 4-1-3 効率性

本プロジェクトの運営において、日本・スーダン側双方の投入はおおむね適切に行われた。詳細は以下に示すとおりである。また、各成果を達成するための活動についても、双方の密な連携を通じて円滑に実施された。これを受けて、本プロジェクトの効率性は高いと判断された。

##### (1) 日本側投入

専門家の派遣はおおむね適切であり、カウンターパートやその他関係者との関係も良好である。プロジェクト活動に必要な機材の供与は当初計画どおり行われており、いずれの機材も良好な状態で維持管理され、活動実施及びプロジェクト運営管理業務のために有効活用されている。特に、ストライガ研究室に対する試験研究資機材の供与は、SUSTの研究能力強化に大きく貢献したと高く評価されている。本邦におけるカウンターパートの研究・研修についてもおおむね適切であったと評価されているが、一部の関係者からは、JICA予算の都合により1件の研修が実施できなかったことが遺憾と指摘された。

##### (2) スーダン側投入

本プロジェクトには、実施機関であるSUSTのみならず、協力機関であるNCR、ARC、GSMAIからも、活動に必要な分野のカウンターパートが配置され、成果の達成にあたり、活動は十分であったと考えられる。研究チーム内の役割分担は明確であり、多様な研究活動は適切に監理されていた。高等教育・科学研究省からローカルコンポーネントとして、プロジェクト活動経費が支出され、ストライガ研究室の拡張、新研究棟の建設などが行われたことは高く評価される。これらの投入はいずれも円滑なプロジェクト活動運営に貢献した。

#### 4-1-4 インパクト

本調査においては、プロジェクト活動のポジティブな効果、影響が確認され、ネガティブな効果、影響は特定されなかった。

##### (1) 上位目標達成へのインパクト

上位目標：新たなストライガ対策の普及が進展する
指標： ストライガ対策として開発された革新的な技術について、実用化に向けた具体的な提案や行動計画がSUSTからスーダン政府や農村に対して提示される。

本プロジェクトを通じて得られた研究成果は、ストライガ対策としての有効性に大きな期待がもてるものであり、それらの研究成果を基に、今後、革新的なストライガ対策技術が開発されていく見込みは高いと考えられる。一方で、現実的な技術開発・普及に関しては、実用化に向けた更なる科学的検証、一般に普及させるための商業ベースでの農薬等の開発、さらに、農家への支援を含む普及活動の一層の推進等、多くの課題が存在する。よって、本調査時点で上位目標そのものの見込みを判断するのは時期尚早であると判断さ

れた。

しかしながら、上述したように、SUST 農学部は、雑草研究のための研究センター構想を有しており、学部内及び ARC 関係者から成る検討委員会を設置して具体的な計画内容の検討が進められている。また、財務省による Weed Research Center 設置のための5年間の予算措置が見込まれ、本プロジェクトから得られた研究成果が、SUST 及び協力機関により更なる精査・検証を踏まえ、実用化に向けた取り組みに発展していくことが大いに期待できる。よって、上位目標達成への道筋は一定程度確保されていると考えられる。協力終了後の持続性については次節に後述する。

## (2) 協力実施によるポジティブ・インパクト

SUST のストライガ研究室においては、プロジェクトチームの研究者のみならず多くの大学院生が本プロジェクトの研究活動に参加する機会を得た。これらの学生は、プロジェクトにより供与された先進的な実験資機材を用いた研究に加わり、SUST、協力機関及び日本人専門家からの指導を受けた。SUST には、他の大学や農業関連組織に所属する学生がさまざまなストライガ研究分野に参加しており、これらの経験蓄積は、将来的に、他の関連組織に対するプロジェクト成果の移転に資するものと思われる。

GSMAI のレベルでは、普及手法としての FFS が高く評価され、他のプログラムにおいても FFS を導入する試みが始まっている。同省の普及局は、プロジェクトが TOT で配布した資料を基に、2013 年に独自の FFS 実施マニュアルを作成し、TOT に参加しなかった普及員にも配布し、同手法の普及に努めている。

プロジェクトの FFS 展示圃場においては、ストライガ防除技術や生産技術の共有により、ソルガムの収量増加がもたらされている。技術導入に必要な投入を入手することに制約があるため、FFS 参加農民すべてがこれらの技術を適用しているわけではないが、ソルガム自体の生産増と、飼料としての残渣利用の双方から、食糧確保のみならず追加収入の獲得などのポジティブ・インパクトが期待できる。FFS 参加農民の間では、銀行融資等、外部支援を得て技術導入に必要な投入を確保すべく、グループを組織する例も報告されている。さらに、これらの直接的な便益のみならず、プロジェクト活動を通じて農民と普及員のコミュニケーションが強化されたことや、自発的に他の農民への技術指導を行う先進農家の例も報告されており、これらもプロジェクトから得られたポジティブ・インパクトとして評価できよう。

## (3) 協力実施によるネガティブ・インパクト

今般調査の時点で、特段のネガティブ・インパクトは報告・確認されなかった。

### 4-1-5 持続性

本プロジェクトの持続性に関しては、若干の点について留保が認められ、今後の継続的な取り組みが必要であると考えられるため、持続性の見込みは中程度という判断となった。

#### (1) 政策・制度面

本プロジェクトは、スーダン政府の農業セクター開発計画の方向性に沿ったものであり、



農業生産性の向上、特に小規模農家の生産強化と食料安全保障の確保は今後も農業開発の主要な課題として重視されると考えられるところ、政策的支援の継続性は高いと判断される。また、プロジェクトの活動は実施機関である SUST、協力機関である NCR、ARC、GSMAI の業務所掌に合致しており、さらに、高等教育・科学研究省が SUST を教育・研究・人材育成拠点機関（Center of Excellence）と位置づけ、公的な認定の手続きを進めていることにかんがみ、本プロジェクトの制度的な持続性についても高い見込みが期待できる。

## (2) 組織・財政面

本プロジェクトの活動は SUST のストライガ研究室や協力機関の既存の組織体制に則って実施されており、プロジェクト終了後にそれらが大幅に変更される可能性は低いと考えられるが、各機関の活動に関する財政的な裏づけには不透明な面も多い。協力期間中はスーダン政府より相当額のローカルコンポーネント負担が行われていたが、SUST における研究活動と併せ、ガダーレフ州における普及活動に関しても、今後の予算確保には課題が残っている。

また、SUST に常設されているストライガ研究チームの人員の少なさも組織的な持続性に留保を残す要因となっている。2012 年に 2 名の若手研究者がストライガ研究室を辞して以降、彼らの後任となる研究者は配置されていない。ただし現在、SUST 農学部では、独立した雑草研究センターを設立する構想の検討が始まったところであり、設立検討委員会にはストライガ研究チームのメンバーも参加していることから、今後、同センターの陣容や活動内容、予算等に関して、包括的・中長期的な計画策定に向けた検討が行われ、適切な対応が取られるものと思われる。

農民のレベルでは、ストライガ防除技術導入にコストがかかる点が課題とされている。幾つかの地域では、組織化を通じて支援を得るための取り組みが報告されているが、組織・財務運営や外部支援獲得のための活動実施の経験がほぼ皆無であることから、これらの農民組織が持続的に機能していくためには、農業灌漑省等の普及関連組織による継続的な支援が不可欠であると思われる。

## (3) 技術面

本プロジェクトに参加した研究員は、ストライガ防除に係る研究を計画・実践する能力を獲得している。SUST においては研究者のみならずストライガ研究室の技官に対しても技術指導が行われ、研究資機材の利用・維持管理を学生や他機関の研究者に指導するに至っている。ガスクロマトグラフ、液化クロマトグラフ等の高度機材については現在日本人専門家を中心に、マニュアル作成が進められている。また、GSMAI においては、プロジェクトの TOT に参加した普及員のみならず、他の普及員に対しても FFS を通じた指導法が伝達され、プロジェクト活動以外のプログラムにおいても活用されている。よって、実施機関・協力機関レベルでは技術面での持続性が確保される見込みは高いと判断される。

一方、農民レベルでは、ストライガ防除技術の効果については、FFS 参加農民のみならず、周辺地域農民の間でも高い関心と評価が得られているが、深耕鋤や除草剤など、必要な農具や農業投入材の入手が困難であることが、農民のみならず普及員からも例外なく指摘されている。よって、農民レベルでの技術面の持続性確保のためには、将来的に必要な

追加投入に関する農民支援が必要であると考えられる。

#### 4-2 中間レビューの提言事項の進捗

##### (1) マスター・プランの改訂

中間レビューで使用された PDMe（評価用 PDM）を活動の進捗状況のモニタリングに活用できるよう、次回の JCC 会議において PDM 第 2 版として承認することを提案する。

⇒PDMe は 2012 年 12 月 25 日に行われた JCC において、PDM 第 2 版として承認された。

##### (2) 研究用機材の活用及び維持管理

多くの機材が JICA より供与されており、スーダン人研究者はその正しい使用法、メンテナンス及び管理についてトレーニングを受けている。その活用を促進するために、プロジェクトがカウンターパート (C/P) に対して更なるトレーニングの機会を準備することを勧める。

また、機材の維持管理については、スーダン側、特に SUST がプロジェクト終了後を見据え、機材用の予算を確保するとともに、研究活動を継続できるよう機材のメンテナンスや保守整備のためのメカニズムを確立するよう助言する。

⇒提言に従い、SUST ストライガ研究室に勤める技術職員（Technician）に本邦研修の機会（2013 年 6～8 月）を提供した。帰国直後及び 3 カ月後、6 カ月後には日本側研究者が短期専門家としてスーダンを訪問し、スーダン側独自で活動を継続できるよう、ストライガ研究室の装置を使ってフォローアップを行った。具体的には、機器の基本的操作方法のみならず、より効率的な測定プログラムの設定、測定データの取りまとめ方法、消耗品が不足した際の応急対応などの指導が行われた。結果、同技術職員がストライガ研究室での機器を用い、適切に実験・分析を行い、また機器・消耗品管理も行っており、この点で技術的な持続性は担保されている。

機器の保守管理メカニズムについては、SUST 学内には、一般的な電気技師しかおらず、学内の技術者による実験機器の修理は不可能であり、ストライガ研究室技術職員が対応できない具合・故障が確認されると、研究室主任の Babiker 教授に連絡したうえで、ほとんどの修理を外注する体制をとっている。ハルツーム市内に本邦実験機器メーカーの代理店があり、同代理店から技術者を派遣してもらうことになるが、複雑な故障への対応は難しい模様である。一方、機材のなかでよく損傷する部品や消耗品は限られており、スーダンである程度それらが入手可能であることは確認済みであるが、年内に日本人専門家による機材のメンテナンス法に係る指導が予定されている。

スーダン国内で入手が難しい部品（インキュベータのライトなど。年間 10 万～20 万円のメンテナンス代がかかっている）への対応については、プロジェクト内で検討中である。

ほとんどの試薬等消耗品は、ハルツーム市内で入手可能であることが、プロジェクトで確認済みである。

### (3) 成果 1 に係る能力の育成

スーダン人研究者が研究結果を科学論文など形のある成果へと結びつけられるよう、プロジェクトがより奨励する必要がある。また、日本人短期専門家が派遣前後に電子通信ツールなどを利用して研究活動に係る指導やフォローアップを強化することにより、スーダン側研究者の更なる能力向上に尽力されることを期待する。

⇒上記は、ストライガ研究室の若手研究者の能力育成を意図した提言であったが、中間レビュー以降に、それら若手研究者 2 名の国外流出が起こったため、彼らの更なる能力向上には至らなかった。他方、他の研究員については、提言にあるような指導・支援方法を取り、自立した研究活動を支援する取り組みを行った。

なお、スーダン人研究者が国際学会の一つである北米農村社会学会で農業経営経済学的調査の成果を発表した。

### (4) 成果 2 に係る活動の円滑な実施の推進

活動をモニタリングし、進捗を関係者間で共有するためのモニタリング・メカニズムが、その円滑な実施や予算の確保を容易にすると考えられる。課題 7 に係る活動を牽引するために新しくプロジェクトに加わる予定の日本人専門家が、課題 8 の FFS に係る活動についても支援することを期待したい。

⇒日本人専門家が派遣され、課題 7 の農民嗜好性調査の支援、スーダン人研究者の学会発表の切っ掛けをつくった。また、日本人専門家チームは、成果 2 の活動モニタリングを行っている。FFS の活動はスーダン国内でも注目されており、スーダン政府から FFS 運営にかかわる助成金を受けるだけでなく、活動に理解を示した二つの銀行 (Bank of Sudan 及び Sudanese Agricultural Bank) からも助成金を獲得しており、FFS に係る活動が今後も円滑に進むことが期待できる。

## 4-3 結論

成果における各指標もほぼすべてにおいて協力期間内に達成見込みであり、ストライガ防除に係る SUST 及び協力機関の研究能力がプロジェクトを通じて向上したことから、プロジェクトは、当初予定どおり 2015 年 2 月に終了が可能と判断される。ただし、ストライガ防除研究を継続するために、雑草研究センター構想の具現化が必要である。

## 第5章 提言及び教訓

### 5-1 提言

#### (1) 協力期間終了までに取り組むべき活動

##### 1) 雑草研究センター（Weed Research Center）構想の具現化に向けた支援

SUST 農学部による雑草研究センター（仮称）構想は、プロジェクトの各課題研究の継続のために重要な計画である。同構想の具現化に向けて、プロジェクトの日本側チームは、可能な限りの支援（情報提供等）をスーダン側に対して行う。

##### 2) 実験機器の使用マニュアル

中間レビュー時の提言の一つに、「SUST ストライガ研究室に供与された実験機器の維持管理・保守のためのカウンターパート研修」がある。4-2 (2) に既述のとおり、神戸大学で研修を受けた技術員（Technician）が、今やストライガ研究室の実験機器管理（分析から機器及び研究試薬等の保管管理）を一人で担えるまでになっている。一方、煩雑かつ使用上の注意を要する機材（高速液体クロマトグラフ：試料中の各成分を分離し含有量を測定する機器、ガスクロマトグラフ：気化しやすい化合物の同定・定量分析に用いられる機器）もあることから、これら機材の使用マニュアルの作成が必要である。日本人専門家が、同マニュアルの作成を支援予定であり、プロジェクト期間内に作成し、カウンターパートへ引き継ぎを行う。

#### (2) 協力期間終了後、スーダン側関係機関に取り組むべき活動

##### 1) Center of Excellence（COE：教育・研究・人材育成拠点機関）の政府承認

中間レビューの際に期待されていた高等教育・科学研究省による SUST 農学部の COE 政府承認（農業部門）は、現在も省内で検討中である。高等教育・科学研究省へ表敬の折、COE 公認となった場合、優秀な学生の入学促進や授業料・生活費補助、研究者の海外派遣、スタッフの新規雇用、少額の資機材・消耗品購入費補助といった恩恵が生まれるとのことであった。早期の COE 承認を依頼した。

##### 2) 予算の確保<sup>5</sup>

プロジェクト終了後は、ドナー国・機関及び当該国政府からの支援予算が少なくなり、往々にしてプロジェクト活動は大きく減じられるので、実施機関（SUST）のみならず協力機関（NCR、ARC、GSMAI）もそれぞれでの予算確保を期待する。

### 5-2 教訓

#### (1) 研究施設・機材を整備することが困難な途上国にあつては、援助等によって整備された施設・機材の有効利用をいかに図るかが肝心である。その点において、他機関のストライガ研究者にも、SUST ストライガ研究室の門戸を開いている SUST 農学部の方針は、頭脳流出が

<sup>5</sup> JCCに参加したスーダン財務省出席者からは、ローカルコンポーネントは、通常はドナー支援終了とともに拠出はゼロとなるが、本プロジェクトの成果にかんがみ、財務次官に継続拠出の申請中であり、2015年度拠出の可能性が残っている旨、発言があった。

頻繁なスーダンにおける大学、政府研究機関の研究者・学生に広く利用の機会を与える意味で、有用な方針と考えられる。

- (2) プロジェクトは、実施機関 SUST のみならず、NCR、ARC、GSMAI 等、複数の協力機関が関与するものであり、また、成果 1 と 2 のプロジェクトサイトが車で 6 時間の距離にあったことから、関係者のコミュニケーションが懸念された。しかし、関係者の調整努力により、大きな問題を生ずることなく、プロジェクトを成功に導くことができた。
- (3) スーダン側及び日本側の研究代表者はストライガ防除研究において、20 年以上の関係を築いており、それは今後も継続するものと思料。本プロジェクトのような研究事業に限らず、共通の課題に取り組むなかで、強固な信頼関係の存在は、持続的な活動を行ううえで不可欠なものといえる。

## 第6章 所感

### 6-1 JST所感

#### (1) 社会実装の現場での確認

共同研究の成果を社会実装に生かすことを目的とした SATREPS では、社会実装の現場に立ち、自らの目でその成果を確認することが評価の重要なポイントとなる。本プロジェクトでは、ソルガムのストライガに対する自殺発芽誘導物質（宿主植物が分泌する化合物からの人工合成）の効果確認（実験圃場）、ストライガ・コントロールの可能性を秘めた微生物の検索と無菌ポット土耕試験実施可能性の確認、乾燥条件下におけるソルガムと寄生ストライガの植物生理上の違いによる宿主植物からの養水分収奪機構の解明、NERICA 品種間のストライガ感染性の違いの確認など基礎的研究での成果は上がっている。その成果を実際の農家圃場でどのように適用して防除するかについては、ヒマワリ、ゴマ、カウピー（ササゲ）等の非宿主作物との輪作や間作の可能性等について、FFS の活動を通して農民への指導・普及を図った。その成果の確認のためガダーレフ州の現地圃場を訪問し、農民インタビューを行うことが重要であった。国内移動の制限を受けて、農民インタビューの時間が予定より減ぜられることになり、評価の面で制限があったことを明記したい。

#### (2) ストライガ研究グループ

本プロジェクトによって SUST のストライガ研究の資機材が格段に充実した。そのため、研究マネジャーを中心としたストライガ研究グループが、NCR、ARC や他の大学の研究者をメンバーとして形成され、国を挙げてこの難しい課題に取り組んでいることがみてとれた。本プロジェクトの終了に伴い、資機材や人材育成支援の面でこれまでと同様の活動を継続することは困難であるが、問題の重要性にかんがみ、研究から現場での技術普及まで広くカバーできるグループに成長し、現場の問題の解決に貢献することを強く期待したい。

### 6-2 調査団長所感

#### (1) スーダン側研究者の高いオーナーシップ

終了時評価調査を通じて、根寄生雑草である「ストライガ」の防除がスーダン農業開発上の重要課題の一つとして、同国内で長く研究課題として取り組まれてきたことが確認できた。このため、研究の重要性と必要性を認識するスーダン人研究者は、プロジェクト関係者（SUST、NCR、ARC）にとどまらず、Omdurman Islamic University といった他大学にも存在し、共同研究として広く取り組まれている。プロジェクトのスーダン側代表の A.G.E.Babiker SUST 農学部教授は、ARC に籍を置いていたこともあり、ストライガ防除研究の第一人者としてスーダン国内の研究ネットワークの中心におり、高いオーナーシップをもって、プロジェクトが進められているといえる。本プロジェクト終了に伴い、日本側からの財政支援は中止されるので、プロジェクト活動の維持に影響を及ぼすであろうが、これまでも長く独自で進めてきたスーダン側研究者の知恵とオーナーシップに期待したい。

## (2) SUST 研究者の人材育成

4-2 (3) で記述したように、ストライガ研究室の若手研究者の国外流出<sup>6</sup>もあり、成果 1 に係る SUST のストライガ研究者は、A.G.E.Babiker 教授及び Amani H.E.Hamad の 2 名のみである。後者は、将来を嘱望されているが、現在は農学科長 (Head, Department of Agronomy) の職にあることから、残念ながら研究に割ける時間が制限されている。組織的な能力向上を図る点からも、雑草研究センター (仮称) 構想が期待される。

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<sup>6</sup> 高等教育を受けた人材の国外流出は、SUSTにとどまらず、協力機関のNCRでも日常的にみられる事象である。NCR所長によれば、それら人材の多くが中東産油国に行くが、高等教育機関での教育を期待されるので、研究機関よりも大学関係者が望まれるとのこと。

## 付 属 資 料

1. M/M・合同評価報告書（英文）
2. 日本側・スーダン側課題担当分野リスト
3. スーダン科学技術大学（SUST）組織図



1. M/M・合同評価報告書（英文）

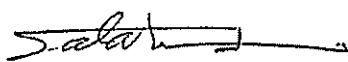
MINUTES OF MEETING  
ON  
THE TERMINAL EVALUATION  
ON  
JAPANESE TECHNICAL COOPERATION  
FOR  
THE PROJECT ON IMPROVEMENT OF FOOD SECURITY IN SEMI-ARID REGIONS  
OF SUDAN THROUGH MANAGEMENT OF ROOT PARASITIC WEEDS

Based on the Record of Discussions signed on 10<sup>th</sup> November, 2009, the Terminal Evaluation was conducted by the Joint Terminal Evaluation Team consisting of members from the Japan International Cooperation Agency (hereinafter referred to as “JICA”) and the National Center for Research, Ministry of Science and Communications from September 7<sup>th</sup> to September 21<sup>st</sup>, 2014 in order to evaluate the progress and achievements of the Technical Cooperation on the Project on Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds (herein after referred to as “the Project”).

After the intensive study and analysis of the progress and achievements of the Project, the Team prepared the Joint Terminal Evaluation Report (hereinafter referred to as “the Report”) attached and presented it to the Joint Coordinating Committee (hereinafter referred to as “JCC”) held on 21<sup>st</sup> September, 2014.

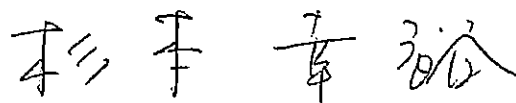
JCC discussed the major issues of the Project stated in the Report and agreed on the matters attached hereto.

Khartoum, 21<sup>st</sup> September, 2014



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Dr. Salah-Eldin Sid Ahmed  
Project Director  
Dean, College of Agricultural Studies, Sudan  
University of Science and Technology  
(SUST)



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Prof. Yukihiro SUGIMOTO  
Leader of Japanese Expert Team  
Professor, Graduate School of Agricultural  
Science, Kobe University

Main points of discussions based on the Report at JCC are as follows.

1. Approval of the Report

After the intensive discussion, JCC approved the Report and agreed to take necessary actions to each recommendation.

2. Others

The following issues were discussed at JCC. It is expected that necessary actions to be taken for better outcomes of the Project in the remaining project period and ensure effective utilization of the outcomes of the Project after the completion of project period.

(1) Support for planning of the proposed Weed Research Center of SUST

As previously discussed in the section 4-5-2, the CAS is currently planning to establish a Weed Research Center, which would further enhance the research activities on *Striga* as well. The details of the plan are to be discussed from now on among the designated members of the planning committee that includes some research team members of the Project. This center would be one of the good ways to continue and further expand the achievement of the Project. It is thus important for the Project to monitor the progress of the formulation of the concrete plan, and to provide information and supports to the efforts to facilitate their planning activities by CAS.

(2) Preparation of operation manuals on equipment

The *Striga* Research Laboratory of SUST has well been managed by virtue of efforts of the Project personnel with support of Japanese experts. It was observed by the Team that some operation manuals on usage of the laboratory equipment are indicated at the Laboratory, and operational manuals for GC and HPLC are under preparation by a Japanese expert. However, for long-term technical sustainability, the Team recommends preparation of operational manuals for other equipment.

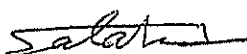
(3) Official Recognition of SUST as Center of Excellence

The MHESR has been working to officially recognize the *Striga* Research Laboratory / CAS as the Center of Excellence (COE). As the authorization as COE may help SUST to further develop and enhance its research and educational capacities, it is recommended for the MHESR to accelerate the procedure to realize the authorization in an official manner.

(4) Efforts to secure financial support

Along with the termination of the Project, the financial support such as local component from the MFNE and local expense borne by the Japanese side would cease. It is generally assumed that the fund allocation afterwards would inevitably been of much smaller scale. Thus the Team requests the participating institutions to continuously make their efforts to secure resources necessary to continue, further expand and scale up the accomplishments brought about by the Project, not only in terms of research activities at SUST, but also of the extension and demonstration activities by ARC and GSMAI.

Appendix: Joint Terminal Evaluation Report



THE JOINT TERMINAL EVALUATION REPORT  
ON  
THE PROJECT ON IMPROVEMENT OF FOOD SECURITY IN SEMI-ARID  
REGIONS OF SUDAN THROUGH MANAGEMENT OF  
ROOT PARASITIC WEEDS

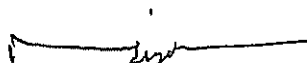
Khartoum 21<sup>st</sup> September, 2014

JOINT TERMINAL EVALUATION TEAM

鍋屋史朗

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Mr. Shiro NABEYA  
Leader  
Japanese Terminal Evaluation Team  
Senior Advisor to the Director General,  
Rural Development Department,  
Japan International Cooperation Agency



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Prof. Migdam E. ABDELGANI  
Leader  
Sudanese Terminal Evaluation Team  
Director, The National Center for Research,  
Ministry of Science and Communications

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### Acronym and Abbreviation

ARC	Agriculture Research Corporation
CAS	College of Agricultural Studies
COE	Center of Excellence
DAC	Development Assistance Committee
FFS	Farmers' Field School
GC	Gas Chromatograph
GSMAI	Gedaref State Ministry of Agriculture and Irrigation
HPLC	High Performance Liquid Chromatograph
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
MFNE	Ministry of Finance and National Economy
MHESR	Ministry of Higher Education and Scientific Research
M/M	Minutes of Meetings
MSC	Ministry of Science and Communications
NCR	The National Center for Research
NERICA	New Rice for Africa
ODA	Official Development Assistance
PDM	Project Design Matrix
R/D	Record of Discussions
RDE	Research, Development and Extension
SATREPS	Science and Technology Research Partnership for Sustainable Development
SDG	Sudanese Pound
SUST	Sudan University of Science and Technology
TOT	Training for Trainers

## 1. OUTLINE OF THE TERMINAL EVALUATION

### 1-1 Background of the Project

Root parasitic weed which is known as "*Striga*" is one of the most serious biological factors that harm production of gramineous species such as sorghum, millet and rice within semi-arid regions of Sub-Saharan Africa including Sudan. Sorghum and millet, the main hosts of the parasite and the main staple food for Sudanese populace, are planted in millions ha. It is said that 300 million people's lives are affected by the weed; as a result, Sudanese government has faced serious food security issues. The need for simple, inexpensive methods which control *Striga* at the early development stage and suit for resource poor mostly illiterate, subsistence farmers is imperative.

In order to exploit preventive methods against *Striga*, Sudan University of Science and Technology (SUST) and Kobe University, Japan have collaborated since 1994 and contributed to clarification of *Striga*'s biological and ecological characteristics. Having said that, various aspects for controlling *Striga* have not yet scientifically been clarified; therefore, it is strongly required to develop innovative techniques to prevent damage by *Striga* for strengthening food security and poverty reduction in Sudan.

To this end, "Project on Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds" (hereafter referred to as "the Project") under the scheme of SATREPS (Science and Technology Research Partnership for Sustainable Development) has been implemented for five years from March 2010 to February 2015, following the signing of the Record of Discussions (R/D) on 10<sup>th</sup> November 2009.

### 1-2 Background of the Terminal Evaluation

Based on the R/D, the Project has been implemented for five-year duration since March 2010. Since the Project reaches around half a year until the project is completed, the terminal evaluation was conducted by the Joint Terminal Evaluation Team (hereinafter referred to as "the Team") consisting of Sudanese and Japanese members.

### 1-3 Objectives of the Terminal Evaluation

- (1) To confirm the inputs, activities and degree of achievements of the outputs, and the prospect of achieving the Project purpose
- (2) To assess the Project in accordance with DAC's five evaluation criteria, namely "Relevance", "Effectiveness", "Efficiency", "Impact" and "Sustainability"
- (3) To make recommendations on the measures to be taken during the remaining period of the Project and beyond, and draw lessons learned from the Project
- (4) To confirm the results of the review above and agree on the minutes of meeting (M/M) with Sudanese authorities concerned

### 1-4 Members of the Joint Terminal Evaluation Team

#### 1-4-1 Japanese Terminal Evaluation Team

No.	Name	Position	Title
1	Mr. Shiro NABEYA	Leader	Senior Advisor to the Director General, Rural Development Department, JICA
2	Ms. Keiko ITAGAKI	Evaluation and Analysis	Senior Consultant / International Development Associates Ltd.
3	Mr. Hiroyuki HANADA	Project Planning	Project Officer, Rural Development Department, Team 4, JICA

#### 1-4-2 Sudanese Terminal Evaluation Team

No.	Name	Position	Title
1	Prof. Migdam E. Abdelgani	Leader/ Project Evaluation	Director, The National Center for Research, Ministry of Science and Communications

#### 1-4-3 Observers

No.	Name	Title
1	Prof. Shuichi ASANUMA	Program Officer, Japan Science and Technology Agency (JST) Professor, International Cooperation Center for Agricultural Education (ICCAE), Nagoya University
2	Mr. Masayuki SATO	Principal Researcher, Research Partnership for Sustainable Development Group, Japan Science and Technology Agency (JST)

#### 1-5 Schedule of the Terminal Evaluation

The Joint Terminal Evaluation was conducted from 7<sup>th</sup> to 21<sup>st</sup> September, 2014. The detailed schedule of the evaluation is shown in Annex 1.

#### 1.6 Outline of the Project

The outline of the Project is as follows, based on the Project Design Matrix (PDM) Version 2 (approved at the JCC on December 25, 2012).

##### (1) Overall Goal

Extension of new *Striga* control measures progresses.

##### (2) Project Purpose

Research, development and extension (RDE) capacity of Sudan University of Science and Technology (SUST) to manage *Striga* is improved.

##### (3) Outputs

Output 1: Innovative technologies to control *Striga* are developed.

Output 2: Farmers' practice to manage *Striga* is ameliorated.

##### (4) Activities

###### Under Output 1

Subject 1: Development of novel germination stimulants

Subject 2: Search for microorganisms with potential to manage *Striga*

Subject 3: Searching for selective metabolic inhibitors for *Striga*

Subject 4: Analysis of translocation mechanisms of host materials to *Striga*

Subject 5: Evaluation of susceptibility of rice and sorghum to *Striga* and adaptability to ecosystems.

Subject 6: Selection of *Striga*-resistant/tolerant crops and establishment of crop rotation system

###### Under Output 2

Subject 7: Field research on acceptability of new technologies and local producers/ consumers' preference

Subject 8: Implementation of farmers' field school (FFS) for sharing the *Striga* control measures

##### (5) Target Area

Khartoum (Campus, experimentation farm and other facilities of SUST outside campus), Farming communities for field research and experimentation

##### (6) Target Group (beneficiaries)

Direct Beneficiaries: Sudanese *Striga* researchers in SUST and other institutions

Indirect Beneficiaries: Farmers in Sudan and other countries

(7) Project Duration

The duration of the Project is 5 years (from 1<sup>st</sup> March, 2010 to 28<sup>th</sup> February, 2015)

(8) Responsible Organizations

Japanese side: Kobe University

Sudanese side: Sudan University of Science and Technology (SUST)

(9) Implementation Structure of the Project

Annex 2 shows the conceptual project implementation structure.

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*Handwritten signature*



## 2. Methodology of the Terminal Evaluation

### 2-1 Method of Evaluation

The Terminal Evaluation Study (hereinafter referred to as “the Study”) was conducted by the Team, composed of both Sudanese and Japanese evaluation team members indicated in the section 1-4 above. The Team reviewed the Project based on the materials showing the framework of the Project such as PDM (attached as Annex 3), and the R/D. The review activities include analysis on reports, field observations, and interviews with JICA experts, SUST researchers, officials of Agricultural Research Corporation (ARC) and Gedaref State Ministry of Agriculture and Irrigation (GSMAI), farmers participated in the Farmers’ Filed School (FFS) conducted by the Project, and other personnel concerned with the Project. Evaluation questions and indicators are as indicated in the Evaluation Grid attached as Annex 4, out of which the entire performances of the Project were assessed in line with the five evaluation criteria, each of which is defined in the following sub-section.

### 2-2 Data Collection

Following sources of information were used for this Study.

- 1) Project planning documents such as R/D, PDM, and M/M
- 2) Periodical reports of the Project
- 3) Interviews and discussions with the Japanese experts
- 4) Interviews and discussions with the counterpart personnel
- 5) Record of inputs and utilization, and other relevant documents
- 6) Project documents on the progress and achievements of the Project
- 7) Field visits to the target area and discussion with the beneficiaries
- 8) Discussions with other Sudanese authorities concerned

### 2-3 Data Analysis

The findings derived through the activities of the Study were analyzed along with the following five criteria which are the major points of consideration when assessing development projects. The results of the analysis are presented in chapter 5 of this report.

- |                   |   |
|-------------------|---|
| 1) Relevance      | The relevance is a measure for determining whether the outputs, the purpose and the overall goal of the Project are still in line with the priority needs and concerns at the time of Evaluation. |
| 2) Effectiveness  | The effectiveness is concerned with the extent to which the purpose of the Project has been achieved, or is expected to be achieved, in relation to the outputs produced by the Project.          |
| 3) Efficiency     | The efficiency is a measure for productivity of the implementation process: how efficiently the various inputs are converted into the outputs.  |
| 4) Impact         | The impact is any intended or unintended, direct or indirect, positive or negative change that has been brought about as a result of the Project.   |
| 5) Sustainability | The sustainability is a measure for determining whether or not the outcomes of the Project are likely to continue after the Project comes to an end.  |

### 2-4 Limitations and Constraints of the Study

There have been the following limitations and constraints in the conduct of the Study, which may have somewhat influenced the results.

- 1) The Study was conducted in a limited time, thus there may have been any aspects which were overlooked or could not thoroughly be reviewed.
- 2) The coverage of the interviewees was also limited to a part of the entire group of relevant personnel and beneficiaries of the Project, which implies the possibility that some information derived may be skewed, reflecting the personal opinions of the particular interviewees.
- 3) Due to the unprecedented problems, a part of the Team could not visit the sites of the field activities in Gedaref, thus the assessment on the field activities were basically based on the interviews and secondary source, with limited direct observations.

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### 3. Achievements and Implementation Processes of the Project

The Project has implemented its activities as per the plan stipulated in the PDM with approved modifications made at the time of the Mid-term Review. The Team reviewed the performance of the Project including inputs, the indicators for outputs and Project purpose as well as the implementation processes of the Project, the results of which are described underneath:

#### 3-1 Inputs

The Team has confirmed that the Project has availed the following inputs in accordance with the plan stated in PDM.

##### 3-1-1 Japanese Side

###### (1) Dispatch of experts

A cumulative total of seventy-two short-term experts has been dispatched to the Project, covering various fields of expertise such as bio-chemistry, crop physiology, plant physiology, cultural anthropology, pesticide science and so forth, who carried out research activities together with Sudanese researchers. The total duration of their assignments by the end of August 2014 has been about 57.8 man/months, the details of which are shown in the Annex 5. There have also been two Japanese long-term Project coordinators assigned all through the Project period.

###### (2) Provision of equipment and machineries

Equipment and machineries of the approximate total value equivalent to 1.05 million US Dollars were provided for the Project activities, including laboratory equipment and apparatus, vehicles, motorbikes, office equipment such as computers, printers and photocopiers, and so forth. The details of the machinery and equipment provided by JICA are listed in Annex 6.

###### (3) Participation of counterpart personnel in Training and Research in Japan

By the end of August 2014, eleven counterpart personnel were dispatched to Japan to participate in training and research activities on the subjects relevant to the scope of the Project. The details of these training of counterpart personnel are found in Annex 7.

###### (4) Bearing of local costs

A total sum equivalent to 0.2 million US Dollars was provided to supplement the operational expenses for the Project activities by the end of August 2014, as indicated in the following Table 3-1.

Table 3-1: Local Expenses borne by the Japanese Side

JFY		2009	2010	2011	2012	2013	2014 <sup>(*)</sup>	Sub-total	Grand Total (USD) <sup>(**)</sup>
Local Expenses	SDG	1,0467.50	292,530.50	411,843.00	259,833.00	288,615.00	107,588.00	1,370,877.00	227,333.15
	USD	0.00	5,541.00	7,238.00	939.00	1,559.00	1,152.00	16,429.00	

\*1: Figures are based on the account settled by the end of August 2014.

\*2: The figure is based on the exchange rate at the time of the Study (USD 1.00 = SDG 6.011).

Source: Documents prepared by the Project

##### 3-1-2 Sudanese Side

###### (1) Assignment of Sudanese counterpart personnel

By August 2014, a cumulative total of twenty-three counterpart personnel was assigned to the Project: thirteen persons from SUST, five persons from ARC, three person from GSMAI, and one person each from Ministry of Science and Communications (MSC) and Ministry of Finance and National Economy (MFNE ). A list of these counterpart personnel is found in Annex 8.

###### (2) Allocation of the operational costs

Sudanese side has allocated a total amount of 955,204 Sudanese Pounds (SDG) since the commencement of the Project up to the end of August 2014, including the cost for renovation and expansion of laboratory and for construction of new building, the details of which are indicated in the Table 3-2 below:

Table 3-2: Operational costs borne by the Sudanese side (SDG)

Fiscal Year <sup>(*)</sup>	2010	2011	2012	2013	2014 <sup>(**)</sup>	Total
Local components	116,680.00	125,843.00	371,210.00	325,371.19	16,100.00	955,204.19

\*1: Figures are based on the Sudanese Fiscal Year (January- December).

\*2: Figures are based on the account settled by the end of August 2014.

Source: Documents prepared by the Project

### (3) Provision of land and facilities

The necessary office spaces with office furniture and electricity have been provided for the Project at SUST since the beginning of the Project. Apart from the provision of offices, facilities and experimental fields of the *Striga* Research Laboratory and were used for the activities of the Project.

### 3-2 Achievement of the Outputs

During the Study, the performances of the Project were reviewed to assess the degree of achievements, the results of which are described in the following:

#### 3-2-1. Output 1

Description	Assessment
Innovative technologies to control <i>Striga</i> are developed.	Most likely to be achieved

To attain the output 1, the Project has carried out the researches on the six subjects. Experiments and verifications were conducted mainly at the *Striga* Research Laboratory in SUST to obtain the results summarized in the following.

#### < Subject 1: Development of novel germination stimulants >

##### Indicators:

- 1-1 Chemical stability of germination stimulants is improved by alternation of chemical structure.
- 1-2 Stimulant activity is elevated by further chemical modification.
- 1-3 Efficacy of the target stimulants is demonstrated in experimentation farms.

The Project has worked on the structural determination of strigolactones, and the world's first synthesis of sorgomol was achieved. A *Striga* germination stimulant, T-010, was synthesized to induce suicidal germination. In potted soil, T-010 displayed higher germination inducing activity than the common synthetic *Striga* germination stimulants (GR24), but with lower stability. Furthermore, the validation in experimental plots also showed that the application of T-010 increases the sorghum head dry weight through the reduction of *Striga* infection on the host plants.

Efforts would be continued for further improvement of application methods and/or formulation until the end of the Project period.

#### < Subject 2: Search for microorganisms with potential to control *Striga* >

##### Indicators:

- 2-1 Microorganisms with potential to inhibit or promote *Striga* germination are searched.
- 2-2 Effective microorganisms are found.
- 2-3 Effectiveness of the microorganisms is demonstrated at farm level.

The Project has tried to isolate and identify microorganisms which have the potential to interfere and/or arrest

early developmental stages of *Striga*. In a series of laboratory and pot experiments, various bacterial and soil born fungal isolates and strains were evaluated. One of the fungal isolates obtained from infected *Striga* diseased plants, isolated in Sudan and identified in Japan as *Fusarium brachygibbosum*, displayed high efficacy in reducing emergence of *Striga* in pot experiments. It was confirmed that combination of nitrogen and *Fusarium brachygibbosum* delayed emergence, reduced infestation and improved sorghum growth and dry matter yield.

It is planned for the remaining period of the Project to conduct validation in the experimental plots to further verify the efficacy of these microorganisms as promising candidates to control *Striga*.

**< Subject 3: Search for selective metabolic inhibitors for *Striga* >**

**Indicators:**

- 3-1 The specific metabolic profile is revealed.
- 3-2 The specified metabolism is proved to be necessary for *Striga* survival.
- 3-3 A chemical to inhibit the metabolism is found.

This subject aims at selective control strategy on metabolic requirements of germination of *Striga*. Based on the metabolic analysis, trisaccharide (gentianose was initially assumed as a candidate) and allantoin were identified as carbon and nitrogen sources, respectively, for the germination of root parasitic weeds. A galactosyl-sucrose, planteose, was identified as a distinctive metabolite as the storage carbohydrate for seed germination. It was confirmed that inhibition of sugar metabolisms has preventive effects on seed germination.

It was also found out that nojirimycin (NJ), a potent glycosidase inhibitor, selectively inhibited germination, and its inhibitory effect was circumvented by adding glucose. In case of *Striga*, NJ did not inhibit germination but caused a reduction in radical elongation. These findings suggests the possibility of developing parasitic plant specific herbicides based on further clarification of molecular mechanism of germination in parasitic plants.

**< Subject 4: Analysis of translocation mechanisms of host materials to *Striga* >**

**Indicators:**

- 4-1 The water relations characteristics of *Striga* are illuminated.
- 4-2 Water management conditions to inhibit *Striga* growth are adjusted.
- 4-3 Culture conditions to inhibit *Striga* growth are developed for the respective crops.

It has been revealed that the damages of *Striga* on the host plants become devastating under drought conditions. It is assumed that the differences in stomata response to water stress between *Striga* and host plants cause translocation of solutes and water from host to the parasite. Through the experiments, it was found out that photosynthetic capacity, stomatal conductance and transpiration rate were higher in *Striga* than in sorghum in dry conditions. *Striga* is less affected by water stress and exogenously applied abscisic acid (ABA) than sorghum.

So far, the experiments at the demonstration plots in Gedaref with rain-fed conditions have revealed that water harvesting technologies by chisling or constructing ridges and furrows in the farm reduced the damage of *Striga*.

In the remaining period, the differences of stomatal responses between *Striga* and sorghum as well as its effects on the damages on sorghum would further be examined in the experimental plots.

**< Subject 5: Evaluation of susceptibility of rice and sorghum to *Striga* and adaptability to ecosystems >**

**Indicators:**

- 5-1 Resistance of rice and sorghum against *Striga* is evaluated by analyzing genetic resources.
- 5-2 *Striga*-resistant breeds are selected.
- 5-3 The *Striga*-resistant breeds with adaptability to the local environment are developed.

Among fifty-two rice varieties including eighteen NERICA varieties, four of their parental varieties, and twenty-four Japanese upland rice varieties, six varieties were selected using rhizotron method. The *Striga* resistance of these selected varieties was examined through pot experiments. As the results, Umgar, a

recommended variety in Sudan, and NERICA 5 indicated high resistance. In further validation under artificial *Striga* infestation in greenhouse and field trials, the selected varieties consistently indicated low *Striga* emergence and negligible losses in dry weight and grain yield.

It should be noted, however, that these findings were derived from the experiments using the *Striga* seeds affecting sorghum, thus that different degree of resistance were indicated when the *Striga* seeds affecting rice or millet. It is essential in selection of *Striga* resistant varieties to evaluate various *Striga* that affect different crops, as well as to examine the crop history of the particular farm plots where the selected varieties are to be introduced.

As for sorghum, ninety lines of local varieties were collected from Eastern part of Sudan for evaluation. The differences in pre- and post-attachment resistance among these varieties have been tested, which would be continued by the end of the Project.

**< Subject 6: Selection of *Striga*-resistant/tolerant crops and establishment of crop rotation system >**

**Indicators:**

- 6-1 *Striga*-resistance of the candidate crops is evaluated *in vitro*.
- 6-2 *Striga*-resistance of the candidate crops is evaluated at experimental farms.
- 6-3 A crop rotation system with a combination of the selected crops is developed.

The Project has selected a sesame variety that has suppression effects on *Striga* through evaluation using rhizotron method and hydroponic culture. Other possible crops to be introduced in the crop rotation, such as millet and wheat have also been evaluated through pot experiments. In the experimental plots at SUST, experiments on rotation with sunflower and sesame were conducted, and effects of suppressing the *Striga* germination were confirmed. The Project also availed different varieties of cowpeas from Nigeria to conduct evaluation as potential crop for rotation or mix cropping to mitigate *Striga* damage.

On-farm experiments in Gedaref have also been in due progress, and it is planned to continue experiments in order to further confirm reproducibility of effectiveness of the selected crops and varieties in inhibiting *Striga* germination. It is anticipated that, by the end of the Project, new rotation, inter- and/or mix-cropping patterns would be identified and proposed as one of the measures to control *Striga*.

**3-2-2. Output 2**

Description	Assessment
Farmers' practice to manage <i>Striga</i> is ameliorated	Most likely to be achieved

There are two subjects to be studied for the Output 2, which have mainly been conducted in Gedaref, and the achievements are described in the following.

**< Subject 7: Field research on acceptability of new technologies and local producers/ consumers' preference >**

**Indicators:**

- 7-1 Producers' economical and technical capacity for the *Striga* control technologies developed by the Project is demonstrated.
- 7-2 Economical and other characteristics of the sorghum and rice breeds favored by consumers are identified.
- 7-3 The beneficial information included in the study results is provided in Arabic.

Major factors that cause the expansion of *Striga* damages attributable to the farmers' practices have been identified. The survey also reveals economical and technical capacities among the farmers that affect the degree of acceptance of the new technologies such as application of herbicide to control *Striga*.

As for the preferences of sorghum varieties, it was found out that about twenty varieties are grown in Gedaref, and a questionnaire survey has been conducted to detect the trend of preferences. The data have already been collected from about seventy samples, which are at the final stage of processing and analysis. It is anticipated that a comprehensive report would be prepared by the end of the Project.

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Some of the findings have already been compiled in the report in Arabic and been circulated among the research team members.

**< Subject 8: Implementation of Farmer Field School (FFS) for sharing *Striga* control measures >**

<p><i>Indicators:</i>          8-1 The administration and management systems of FFS are strengthened.          8-2 The curriculums of FFS are formulated and teaching materials prepared.          8-3 Extension activities are carried out.</p>
--

The Project initially organized the local management committee composed of members from ARC and GSMAI. It also provided equipment and machineries, such as tractors, planters, and motorcycles as well as the agro inputs necessary to carry out FFS activities.

Training of Trainers (TOT) for the extension officers to facilitate the FFS in Gedaref was organized in 2010. Six extension officers from GSMAI and three technicians of ARC attended the four-day TOT and trained on the methodology of FFS, the techniques of *Striga* control to be disseminate to the farmers, and field data collection methods. Basic teaching materials were also prepared and handed to the extension officers to facilitate the FFS.

The Project has organized twenty-four FFS in three localities in Gedaref as summarized in the Table 3-3 below. Weekly meetings were conducted throughout the cropping season, and supervised by the extension department of GSMAI. The techniques to control *Striga* as indicated in the Table 3-4, together with other basic cultural management practices, are taught in the FFS. It is reported that an average of thirty farmers attended each session.

Table 3-3: Record of the FFS organized by the Project

Locality	Village	No. of FFS	Year
Middle Gedaref	Tirfa	5	2010, 2011, 2012, 2013, 2014
	Umm Senabra	2	2010
West El Qalabat	Huriya	2	2013, 2014
	Kagara	4	2010, 2011, 2012, 2013
	Kasab	1	2014
	Wad Alsanosi	1	2014
	Ganan	3	2010, 2013, 2014
	Wad Al Halengi	1	2013
East El Qalabat	Ziragah	1	2014
	Tawarit	1	2010
	Allam	3	2010, 2011, 2012
Total		24	

Source: Documents prepared by the Project

Table 3-4: *Striga* control techniques taught in the FFS

Techniques	Implications
Introduction & recommendation of the sorghum variety, such as " <i>Wad Ahmad</i> "	Use of varieties with higher <i>Striga</i> resistance
Deep plowing	Improvement of the soil moisture content that contributes to suppress the growth of <i>Striga</i>
Row planting	Convenience in crop management, especially weeding
Application of Nitrogen fertilizer	Additional soil nutrients to minimize deprivation from the host plants
Application of herbicides	Direct measurer to suppress the growth of <i>Striga</i>
Introduction of crop rotation with sesame	Mitigation of <i>Striga</i> damage by avoiding continuous production of sorghum

Source: Interview with the Project personnel at ARC, Gedaref Station

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### 3-3 Prospect of Achievement of the Project Purpose

Description
Research, development and extension (RDE) capacity of Sudan University of Science and Technology (SUST) to manage <i>Striga</i> is improved.
Indicators: 1. A permanent team of <i>Striga</i> researches is founded in SUST. 2. A mid-term budgetary plan for <i>Striga</i> researches is formulated in SUST. 3. The researchers of SUST enable to present research outcomes continuously at international forums including international workshop and conferences, and research papers in international journals.

The *Striga* Research Laboratory of SUST is considered to be the formal institution of *Striga* research at SUST. There are two researchers and three technicians permanently assigned in the laboratory, as well as the graduate students who are working for their thesis. The *Striga* research team also includes some researchers from the National Center for Research (NCR) and ARC. As for the budgetary plan for *Striga* researches, the annual budget planning has been exercised as part of the routine budget planning at the college level, but no longer-term plan has yet been formulated.

In this relation, it should be noted that the College of Agricultural Studies (CAS) has recently initiated discussion to establish a new and independent research center on weed science to be under direct supervision by the dean of CAS, of which the current *Striga* research laboratory would become an essential part. A committee to discuss the detailed plan of the new center, composed of the researchers from relevant departments of the college and some representatives from ARC, has been organized and it is expected the mid- or long-term comprehensive plan would be formulated, encompassing research and managerial aspects, i.e. requirement of staffing, budget, facilities and equipment, as well as the possible themes of research and relevant activities to be undertaken in the center.

As for the presentation by SUST researchers in international forums and journals, continuous encouragement and some supports were provided by the Project, and by the time of the Study, fifteen research papers were published and seventeen presentations were made by the SUST researchers in various seminars, conferences and workshops, the details of which are found in the Annex 9.

Hence the Team foresees a fair prospect for the achievement of the Project purpose.

### 3-4 Implementation Processes of the Project

#### 3-4-1 Decision making and monitoring mechanism

The JCC, which is the decision-making authority of the Project has so far been held five times to review the progress of Project activities, to discuss the research findings in each subject, to endorse the plans for the upcoming period, and to make decisions on the issues related to the Project implementation. Another JCC meeting is scheduled to be held at the time of the Review. The decision-making and monitoring mechanism seem to have been functional and contributed to the effective coordination among the relevant stakeholders and thus to the smooth implementation of the Project.

#### 3-4-2 Communication among the relevant stakeholders of the Project

Despite the fact that the Project could not organize any regular meeting among the relevant personnel because of the physical distance between SUST and Gedaref, relatively short and intermittent assignments of the Japanese experts, involvement of researchers from different institutions, and so forth, the Project has been able to communicate well with counterpart personnel and relevant stakeholders.

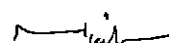
#### 3-5 Measures taken to address the Recommendations made at the Mid-term Review

At the time of the Mid-term Review conducted in September 2012, there were four issues raised as



recommendations for the Project to address in order to ensure smooth and effective implementation of the Project activities for the rest of the cooperation period, encompassing from technical to managerial aspects of the Project. The Team confirmed that the Project has made efforts to take appropriate measures to respond to most of these recommendations, the details of which are shown in the Annex 10.

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#### **4. Results of Review**

Through the Study, the relevance, effectiveness, efficiency, impact and sustainability of the Project were assessed, the major findings of which are described in the section below.

##### **4-1 Relevance**

The relevance of the Project is evaluated as high based on the following confirmations:

###### **4-1-1 Relevance to the needs of the target regions / societies**

The Project is aiming to enhance the research, development and extension capacity of SUST to contribute to effective control of *Striga*, which is one of the most serious pests for cereal production in Sudan. The annual loss caused by *Striga* in the State of Gedaref alone is estimated to reach about 300,000 metric tons (MT). All of the interviewed personnel unanimously emphasized that the search for the measures to control *Striga* is a pressing need in agricultural sector, particularly in view of food security and development of rural economy. It is therefore understood that the contents and focus of the Project have adequately addressed the needs in the rural communities in the country.

###### **4-1-2 Relevance to the development policies of the Sudanese Government**

The Project is still consistent with the policies of the government of Sudan as there has not been any notable change in the national development plans at higher level such as the country's 25 year vision, i.e. "Building of a United, Safe, Peaceful and Developed Sudanese Nation (2007-2031)", and the importance of food security has consistently been highlighted in the sector development policy such as the second five-year plan of the Ministry of Agriculture (2012-16). To increase the agricultural productivity, particularly among the smallholder farmers, still remains as one of the major thrusts of these plans. It is thus confirmed that the relevance of the Project to these policy directions of the government of Sudan is secured.

###### **4-1-3 Consistency with the Official Development Assistance (ODA) policies of the Japanese Government**

In the Country Assistance Policy for the Republic of Sudan of the Japanese government formulated in December 2012, agricultural development is regarded as one of its priority areas, with clear stipulation "to support to contribute to poverty reduction and food security. Accordingly, the Project is considered as one of the vital centerpieces of the Agricultural Development Program. From these viewpoints, it is assessed that the Project is still consistent with the Japanese aid policies.

###### **4-1-4 Appropriateness of the Project approach**

The research team of the Project is composed of Sudanese and Japanese researchers with different fields of expertise which has enabled the multi-disciplinary and comprehensive approach to *Striga* control. Especially in the plant science team of the Project, there are prominent scholars in natural resource chemistry, organic composition chemistry, plant physiology and crop physiology, some of whom have had already conducted joint research together prior to the Project. In view of these complementarities, the approach of the Project as a whole is considered appropriate.

##### **4-2 Effectiveness**

The effectiveness of the Project is assessed as high through the following analysis:

###### **4-2-1 Achievement of the Project purpose**

The Project purpose is to improve the research, development and extension capacity of SUST to control

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*Striga*. Through the joint research activities at the *Striga* Laboratory in SUST and in the fields in the State of Gedaref, various research findings have been revealed, which have high potential to contribute to develop innovative techniques to mitigate the effects of *Striga* damages in future. Through the FFS in Gedaref, some techniques to control *Striga* have been demonstrated and farmers started applying the learned techniques. The processes of these activities contributed to enhance the RDE capacities of Project personnel; hence, there are positive prospects that the Project purpose would satisfactorily be achieved by the end of the cooperation period.

#### **4-2-2 Contribution of outputs to the achievement of the Project purpose**

The Project purpose is to be achieved through two expected outputs; firstly the identification of innovative *Striga* control technologies through chemical, biological and physiological researches at *Striga* Laboratory in SUST, i.e. output 1; and the amelioration of farmers' practices to control *Striga* i.e. output 2. These outputs are being achieved as described in the previous section, and the research and development capacities of participating researchers and other stakeholders have enhanced through the process. Thus the Team considers that these outputs would adequately contribute to the achievement of the Project purpose.

#### **4-2-3 Analysis of factors**

##### **(1) Promoting factors**

It was fortunate that some of the research team members could avail additional fund from external sources during the Project, which augmented the limitation of Project funds allotted for relevant research activities. It should also be noted that, with appreciation of its effectiveness, financial supports were provided to conduct FFS by the Sudan Bank and Agricultural Bank. These additional supports were found to have contributed to the smooth implementation of the Project.

##### **(2) Hampering factors**

The drought in the cropping season of 2013 negatively affected the yield performances in some of the FFS demonstration plots. The incidence caused negative influences in terms of the effects of technology dissemination, although the demonstration plots produced a little harvest while the other farms in the vicinity could hardly produce any. The Project could manage to proceed with its originally planned activities through the efforts of the relevant personnel, but such climatic effects may need to be noted as potentially hampering factors for the Project implementation.

#### **4-2-4 Important assumptions**

There has not been any security problem or any drastic change of prices of agro-inputs and farm produces during the implementation of the Project. However, the Team noted that there have been some changes of research members; some quitted SUST and moved overseas. Although it is not quite manageable by the Project as the "brain drain" has been the common and chronic challenge in any research and educational institutions in the country, it still casts some reservation in terms of sustainability of the Project.

#### **4-3 Efficiency**

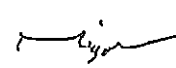
The efficiency of the Project is assessed as high based on the review of the inputs from both Japanese and Sudanese side as described in the following:

##### **4-3-1 Inputs by Japanese Side**

The Japanese experts in the relevant fields of expertise have properly played their expected roles in the course of the implementation of the Project, which is appreciated by the counterpart personnel.

The equipment and machineries required for the Project activities and technical transfer have duly been

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provided, fully utilized and kept in good conditions. Especially, the provision of the laboratory equipment and apparatus has highly been appreciated as considerable contribution to the enhancement of research capacities of SUST.

The timing, duration and subjects of the research visits and training under the arrangement of the Project are generally assessed as adequate. The ex-training participants unanimously appreciate that such opportunities could enrich their experiences and knowledge. It was however noted by some Project members with regrets that training of one project member was cancelled due to the JICA's budgetary problem.

#### 4-3-2 Inputs by Sudanese Side

The counterpart personnel were duly assigned not only from SUST, but also from other participating institutions such as NCR, ARC and GSMAI. There have been clear demarcations of responsibilities among the research members, and various research activities were properly supervised.

The operational costs of the Project have been granted by MHESR (Ministry of Higher Education and Scientific Research) as "local component". Some Project personnel admitted that there were minor and occasional problem in terms of timing of disbursement of the fund, which, however, did not cause any notable obstacle in the implementation of the Project. It should be noted with appreciation that the Sudanese government has provided, in addition to the operational costs of the Project, considerable amount of fund not only to renovate the existing laboratory facilities but also to construct new building to be the base for future research activities.

#### 4-4 Impact

Relatively high and positive impacts are expected from the implementation of the Project, as described in the following:

##### 4-4-1 Impacts on the Overall Goals

Description
Extension of new <i>Striga</i> control measures progresses.
<i>Indicator:</i> Specific suggestions and action plan on practical use of innovative technologies developed for <i>Striga</i> control are proposed to the Government of Sudan and farming villages

It was confirmed that various findings derived from research activities at *Striga* Research Laboratory are promising and that innovative technologies for *Striga* control would be developed utilizing these findings. However, the practical application may require further efforts, such as continuous scientific verification of the concrete effects, development of agro-chemicals on commercial basis for practical dissemination, as well as to strengthening of the extension services including tangible supports for the farmers. It is thus considered to be too early to assess the concrete prospects of the overall goal at this point of time.

However, the Team obtained positive impressions on the possibility of attainment of the overall goal, as the *Striga* researches would continuously and steadily be conducted, if not enhanced or expanded, and the innovative technologies would further be elaborated and disseminated through the future course of actions by SUST and other institutions participated in the Project. The continuity of *Striga* research and extension of technologies to the farmers are more relevant to the issues on the sustainability for the part of relevant institutions of the government of Sudan, which are separately discussed in the following section 4-5.

##### 4-4-2 Positive Impacts

There are some ripple effects in terms of research at the *Striga* Research Laboratory in SUST, as many

graduate students were also involved in the research activities of the Project. They had opportunities to work closely with SUST and Japanese researchers and had exposed to experiments and verifications with improved laboratory facilities. Some of them are from other universities or the agriculture-related government institutions, thus it is anticipated their experiences to work in the Project would also be transferred to the relevant institutions in the future.

As for the methodology of FFS, the GSMAI has started application of the method, with recognition of its effectiveness as extension tool, to its agricultural programs and projects other than the Project. The extension department has already compiled by its own a manual on FFS for extension officer in Arabic in 2013, and distributed it to the extension officers who did not take part in the TOT conducted by the Project.

At the field level, the Team presumed positive impacts from the Project on the agricultural production and income. With introduction of new techniques through FFS, considerable increases in yield performances have been observed in demonstration plots, though not all of the farmers participated in the FFS could apply all of the techniques due to the affordability of some inputs. Increase of income is also expected since the farmers' gain would not be limited to those derived from the increase of grain yield but also from far larger volume of residues that can be sold as fodders. Another impact is that some farmers who participated in the FFS have organized themselves into formal groupings to help each other as well as to obtain better access to external resources such as support from government programs and loans from banks.

Aside from these tangible impacts, some of the interviewed farmers shared with the Team that they enjoy closer relationship with extension officers, and some lead farmers have already disseminated what they have learned from the Project to other farmers in and around their communities. Such opportunities have made them feel proud of themselves, or feel that they are gaining respects from other farmers. Although these are not always the case for all of the FFS participants, such improvement in terms of social linkages and self esteem should also be appreciated as positive impacts derived from the undertaking of the Project activities.

#### **4-4-3 Negative Impacts**

There has not been any negative impact observed or reported at the time of the Study.

#### **4-5 Sustainability**

The sustainability of the Project is assessed as moderate, as there are aspects that need further reinforcement, while a fair sustainability is expected in a few other aspects as described in the following:

##### **4-5-1 Policy and institutional sustainability**

The Project was designed in alignment with the current development plan of the agriculture sector of the Sudanese government. It is generally anticipated that the improvement of agricultural productivity, especially among the smallholders, will continue to be a key strategy, and that food security will remain as one of the primary objectives of the agricultural plans and programs. It is thus assumed that the policy support would continuously be secured for the coming years.

As all of the activities of the Project have been carried out in line with the mandates of the SUST as well as of NCR, ARC and GSMAI, thus the institutional sustainability is also assessed as high. It should also be noted that the MHESR regards SUST as one of the Centers of Excellence in education and research and provides support for SUST in receiving researchers and students from other academic and research institutions, although the formal issuance of official documents in this regard has yet been in process through the respective committee.

##### **4-5-2 Organizational and financial sustainability**

The activities of the Project have been carried out in line with the existing organizational structure of SUST and other participating institutions, continuity of which seemed to be assured, yet the operational functions of these organizations tend to be hampered by insufficient resource allocation. Although the considerable financial resource as "local component" were provided to the Project, it has repeatedly been pointed out that there are chronic resource constraints in government funding in research and extension under general conditions. The strong need for mobilization of additional financial supports was raised by the Project personnel from Gedaref ARC Station and GSMAI to continue FFS activities to cover all of the localities in the State.

Another concern in terms of organizational sustainability is the small number of researchers in the permanent team for *Striga* researches. After two young researchers have left *Striga* Research Laboratory in 2012, those number are not filled until now. However, the Team came to learn that the College of Agricultural Studies in SUST has just started to take initiatives to establish a special research center, the Weed Research Center<sup>1</sup>, i.e. directly supervised under the Dean's auspices, of which the *Striga* research laboratory would be an integral part. The members of founding committee including some of research team members of the Project have been appointed to prepare a concrete plan of the center, including organizational set-up and structures, activities, staff allocations, financial and other requirements for the operations in mid- or long-term perspectives, and so forth. It is thus assumed that the financial and organization sustainability would largely depend on the feasibility of the plan of the Weed Research Center to be formulated from now on.

For the part of the smallholder farmers, there seem to be various challenges for them to apply the innovative techniques of *Striga* control in full scale, since they are generally suffering from the insufficiency of production capital. Some of the farmers have recently organized themselves into the form of farmers' groups, in search of supports to avail necessary inputs, but their management capacities would also further be enhanced, as proper organizational and financial management within the group should be the key to sustainable application of effective technologies. It is thus considered that the organizational and financial sustainability at the farmer's levels may not be secured without continuous future supports to the groups, such as guidance, supervision and consultation in terms not only of production technologies but also of organizational management through the extension services.

#### 4-5-3 Technical sustainability

The participating researchers have already acquired enough technical competence to plan and conduct various researches on *Striga*. In SUST, researchers as well as technicians have already mastered the use of equipment and apparatus introduced by the Project, and they transfer their experiences to other members of the *Striga* Research Laboratory. The Team was informed that operation manuals for Gas Chromatograph (GC) and High Performance Liquid Chromatograph (HPLC) are under preparation by a Japanese expert.

As for the extension officers in GSMAI, not only the extension officers participated in the initial TOT conducted by the Project, but also the other extension officers are provided with a manual to conduct FFS, and the FFS as the extension method has already been applied in some of the programs of GSMAI. Thus a fair prospect is expected in terms of technical sustainability for the part of extension department in GSMAI.

The Team confirmed that the demonstration plots under FFS have achieved increase in the yield by applying the technologies to control *Striga*, which has also drawn attention and interests of other farmers in and around their communities, resulted in the spontaneous diffusion of the technologies. Nonetheless, the uncertainty of availability and affordability of agricultural inputs and machineries such as deep plow and planters were unanimously raised by the interviewed farmers as well as by the extension officers as most critical issue for continuous adoption of the technologies. It is thus assessed that further support from GSMAI or other relevant

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<sup>1</sup> There are two proposed names of the center at this point of time, i.e. Weed Research Center, and Weed Science Center.

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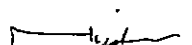
institutions to farmers' production activities is one of the essential conditions to secure the technical sustainability for the part of the farmers.

#### 4-6 Conclusions

The Team confirmed that the technical capability of staff of SUST as well as cooperating institutions for *Striga* research has surely been improved. Most of the recommendations by the Mid-Term Review Team have been addressed, and the necessary steps to continue *Striga* research activities are being taken through the plan of a special *Striga* research center or "the Weed Research Center".

In accordance with the results of the comprehensive evaluation, it is concluded that the Project would be completed in February 2015 as planned. There are still several important issues to be addressed in order to have better outcomes of the Project. These issues are explained as recommendations in the following chapter.

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## **5. Recommendations**

### **5-1 Recommendations for the remaining period of the Project**

#### **5-1-1 Support for planning of the proposed Weed Research Center of SUST**

As previously discussed in the section 4-5-2, the CAS is currently planning to establish a Weed Research Center, which would further enhance the research activities on *Striga* as well. The details of the plan are to be discussed from now on among the designated members of the planning committee that includes some research team members of the Project. This center would be one of the good ways to continue and further expand the achievement of the Project. It is thus important for the Project to monitor the progress of the formulation of the concrete plan, and to provide information and supports to the efforts to facilitate their planning activities by CAS.

#### **5-1-2 Preparation of operation manuals on equipment**

The *Striga* Research Laboratory of SUST has well been managed by virtue of efforts of the Project personnel with support of Japanese experts. It was observed by the Team that some operation manuals on usage of the laboratory equipment are indicated at the Laboratory, and operational manuals for GC and HPLC are under preparation by a Japanese expert. However, for long-term technical sustainability, the Team recommends preparation of operational manuals for other equipment.

### **5-2 Recommendation for the Sudanese government for future (after completion of the Project)**

#### **5-2-1 Official Recognition of SUST as Center of Excellence**

The MHESR has been working to officially recognize the *Striga* Research Laboratory / CAS as the Center of Excellence (COE). As the authorization as COE may help SUST to further develop and enhance its research and educational capacities, it is recommended for the MHESR to accelerate the procedure to realize the authorization in an official manner.

#### **5-2-2 Efforts to secure financial support**

Along with the termination of the Project, the financial support such as local component from the MFNE and local expense borne by the Japanese side would cease. It is generally assumed that the fund allocation afterwards would inevitably been of much smaller scale. Thus the Team requests the participating institutions to continuously make their efforts to secure resources necessary to continue, further expand and scale up the accomplishments brought about by the Project, not only in terms of research activities at SUST, but also of the extension and demonstration activities by ARC and GSMAI.



## 6. Lessons Learned

### 6-1 Open access to research facilities

Universities and national research institutions are strongly expected to conduct research in order to solve the important problems in improving agricultural development. Universities are supposed to educate young students and researchers through research.

SUST has allowed *Striga* researchers from other institutions to utilize the *Striga* Research Laboratory equipment provided through the Project. This policy seems to have been very effective.

As most developing countries are not capable to furnish relevant institutions with necessary instruments for all research, it is desirable for universities and national research institutions to play a central role in generating wider impacts on the society by providing open access for academia and other stakeholders.

### 6-2 Proper coordination among institutions

The Project was implemented in collaboration among several research institutions, who shared the common interests and commitment in *Striga* research. Efforts have been made to ensure close communications, and proper coordination made among these participating institutions seems to have contributed to smooth implementation of the Project, thus led to the success and fruitful achievement of the Project.

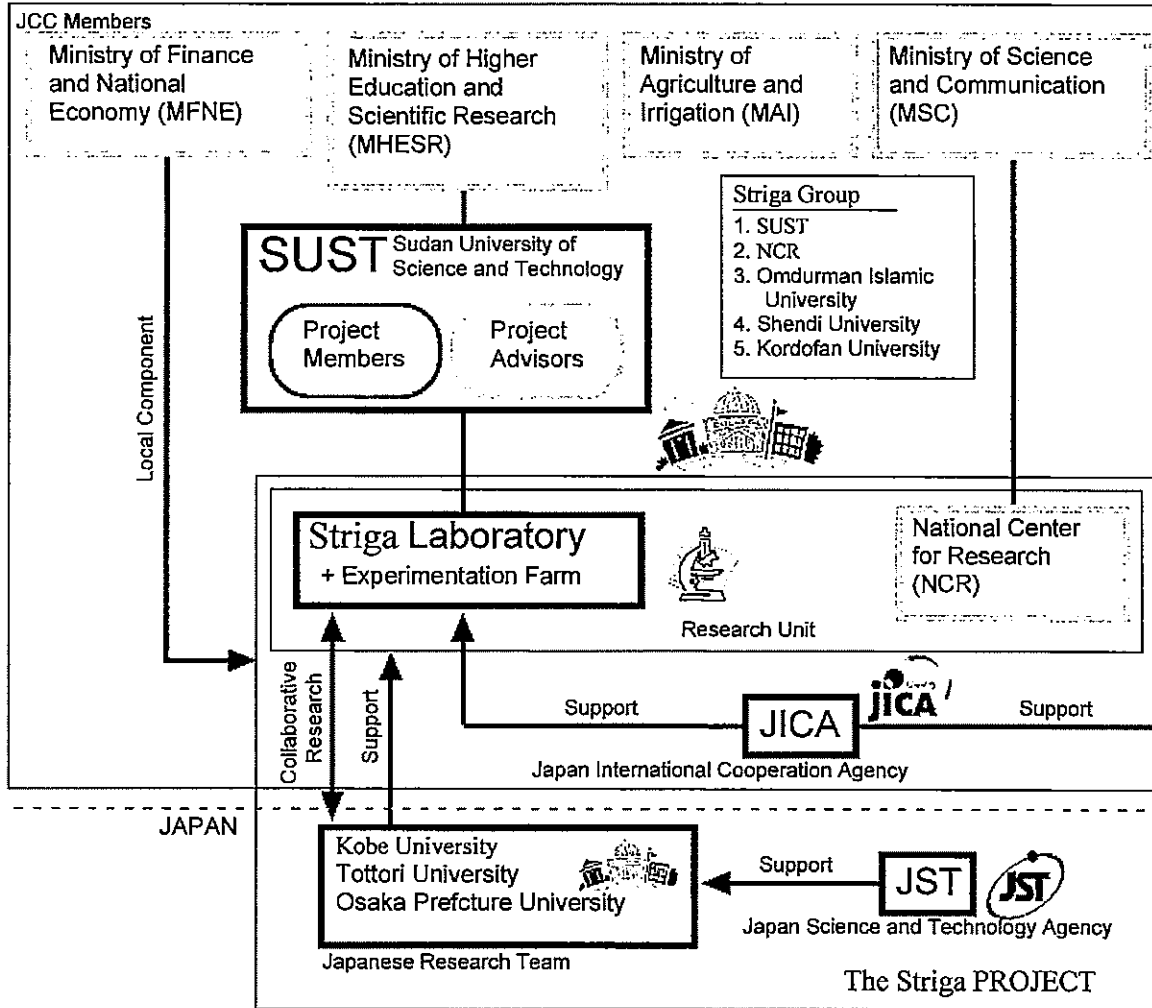
Annex 1: Schedule of the Terminal Evaluation

		Evaluation Team on Japan side				Kebe Univ.						SUST		Evaluation Team on Sudan side	Accommodation			
		JICA		JST		Consultant Ms. Itagaki	Prof. Sugimoto	Associate Prof. Kuse	Prof. Okazawa	Prof. Iba	Dr. Samejima	Dr. Inoue	Prof. Babiker	Dr. Salah-Eldin Sid Ahmed (Dean, SUST)		Prof. Nigdem Abdelgani (The National Center for Research)		
		Mr. Nobeya	Mr. Manada	Prof. Asenawa	Mr. Sato													
Sep. 6	Sat	/				22:30 Departing Tokyo OR887	/	/	/	/	/	/	/	/	/	/		
Sep. 7	Sun					10:55 Arrival in Khartoum OR1329											Lab	Lab
Sep. 8	Mon					M/G w/ JICA, SUST, others												
Sep. 9	Tue																	
Sep. 10	Wed																	
Sep. 11	Thu	Field visit Khartoum ↔ Al Qadafif	Departing Osaka EK317 23:40	Departing Osaka EK317 23:40	Departing Osaka EK317 23:40	/	/	/	/	/	/	/	/	/				
Sep. 12	Fri	22:30 Departing NARITA OR 807	11:55 Departing Tokyo TK051	Arrival in Khartoum EK733 17:40	Arrival in Khartoum EK733 17:40										Departing Osaka EK317 23:40			
Sep. 13	Sat	10:55 Arrival in Khartoum OR1329	01:30 Arrival in Khartoum TK680	Documentation	Lab										Lab	Arrival in Khartoum EK733 17:40	07:50 Osaka 11:55 TK051 NST	
Sep. 14	Sun	Courtesy call, Meeting, Making draft of MM and Report													Lab	Lab	Lab	Arrival in Khartoum 01:10 TK680
Sep. 15	Mon	Symposium/ Report writing	Symposium/ Report writing	Report writing	Symposium													
Sep. 16	Tue	Report Writing				Lab			Departing Khartoum 02:25 TK691	/	/	/	/	/	/			
Sep. 17	Wed	Report Writing				Lab			Arrival in Osaka 17:55 Osaka TK646									
Sep. 18	Thu	Interview with researchers of SUST and other research institutes				Lab	Lab	Lab/ Khartoum EK734 19:10	/	/	/	/	/	/	/			
Sep. 19	Fri	MM and Report writing				Lab	Lab	Arrival in Osaka EK316 17:10										
Sep. 20	Sat	Joint Evaluation Meeting (Drafting Joint Evaluation Report)				Joint Evaluation Meeting (Drafting Joint Terminal Evaluation Report)										Joint Evaluation Meeting (Drafting Joint Terminal Evaluation)	/	/
Sep. 21	Sun	Joint Evaluation Meeting (Drafting Joint Terminal Evaluation Report)	02:25 Departing Khartoum TK691	Joint Evaluation Meeting (Drafting Joint Terminal Evaluation Report)	JCC (Presentation of the result of Terminal Evaluation from the Mission, M/M signing)			Joint Evaluation Meeting (Drafting Joint Terminal Evaluation Report)										
Sep. 21	Sun	JCC (Presentation of the result of Terminal Evaluation from the Mission, M/M signing)		JCC (Presentation of the result of Terminal Evaluation from the Mission, M/M signing)	JCC (Presentation of the result of Terminal Evaluation from the Mission, M/M signing)			JCC (Presentation of the result of Terminal Evaluation from the Mission, M/M signing)	/	/	/	/	/	/				
		20:15 Departing Khartoum OR1328		20:15 Departing Khartoum OR1328														
Sep. 22	Mon	17:55 Arrival in Narita OR806	Rice field visit (Gezira)	10:25 Arrival in Narita TK050	17:55 Arrival in Narita OR805	Morning: Lab	Morning: Lab	Departing Khartoum EK734 19:10	Departing Khartoum EK734 19:10	/	/	/	/	/	/			
Sep. 23	Tue		Gezira - Khartoum Khartoum 20:15 OR1328			Arrival in Osaka EK316 17:10	Arrival in Osaka EK316 17:10											
Sep. 24	Wed		Arrival in Narita 17:55 OR805															

# Annex 2: Conceptual Project Implementation Structure

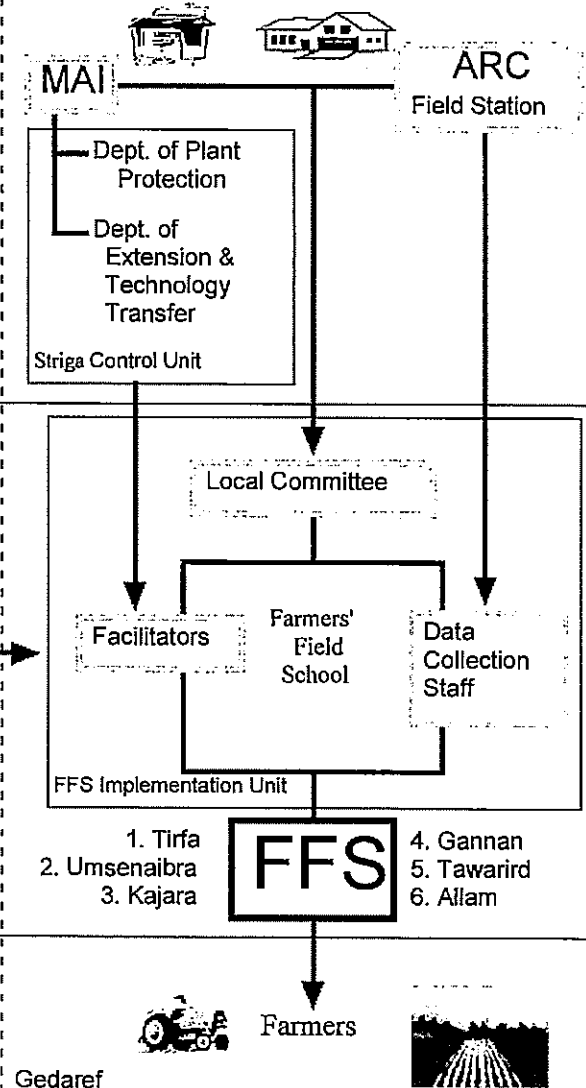
Output 1. Innovative technologies to control Striga are developed.

Federal



Gedaref

Output 2. Farmers' practice to manage Striga is ameliorated.



SUDAN: Project on "Improvement of food security in semi-arid regions of Sudan through management of root parasitic weeds (SATREPS)"

**Project Purpose**  
Research, development and extension (RDE) capacity of SUST to manage Striga is improved.

Gedaref

### Annex 3: Project Design Matrix (PDM)

Prepared on 25th December 2012 Version: PDM2

Project Title: Improvement of food security in semi-arid regions of Sudan through management of root parasitic weeds (5 years from 1st March 2010 to 28th February 2015)

Target Area: Khartoum (Campus, experimentation farm and other facilities of SUST outside campus), Farming communities for field research and experimentation

Target Group: Direct Beneficiaries: Sudanese *Striga* researchers in SUST and other institutions, Indirect Beneficiaries: Farmers in Sudan and other countries

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
<p><b>Overall Goal</b> Extension of new <i>Striga</i> control measures progresses.</p>	<p>• Specific suggestions and action plan on practical use of innovative technologies developed for <i>Striga</i> control are proposed to the Government of Sudan and farming villages</p>	<p>• Specific suggestions, Action plan, Seminars, etc.</p>	
<p><b>Project Purpose</b> Research, development and extension (RDE) capacity of Sudan University of Science and Technology (SUST) to manage <i>Striga</i> is improved.</p>	<p>1) A permanent team of <i>Striga</i> researches is founded in SUST. 2) A mid-term budgetary plan for <i>Striga</i> researches is formulated in SUST. 3) The researchers of SUST enable to present research outcomes continuously at international forums including international workshop and conferences, and research papers in international journals.</p>	<p>• SUST Documents on foundation of a permanent team for <i>Striga</i> researches • SUST documents on Budget • Proceedings of Meetings • Published scientific papers</p>	<p>• Cooperation between SUST, governmental institutions and farming villages is maintained.</p>
<p><b>Output</b> 1. Innovative technologies to control <i>Striga</i> are developed.  2. Farmers' practice to manage <i>Striga</i> is ameliorated.</p>	<p><b>Output 1. Development of innovative technologies for <i>Striga</i> control</b> <b>Subject 1: Development of novel germination stimulants</b> 1-1 Chemical stability of germination stimulants is improved by alteration of chemical structure. 1-2 Stimulant activity is elevated by further chemical modification: 1-3 Efficacy of the target stimulant is demonstrated in experimentation farms. <b>Subject 2: Search for microorganisms with potential to control <i>Striga</i></b> 2-1 Microorganisms with potential to inhibit or promote <i>Striga</i> germination are searched. 2-2 Effective microorganisms are found. 2-3 Effectiveness of the microorganisms is demonstrated at farm level. <b>Subject 3: Search for selective metabolic inhibitors for <i>Striga</i></b> 3-1 The specific metabolic profile is revealed. 3-2 The specified metabolism is proved to be necessary for <i>Striga</i> survival. 3-3 A chemical to inhibit the metabolism is found. <b>Subject 4: Analysis of translocation mechanisms of host materials to <i>Striga</i></b> 4-1 The water relations characteristics of <i>Striga</i> are illuminated. 4-2 Water management conditions to inhibit <i>Striga</i> growth are adjusted. 4-3 Culture conditions to inhibit <i>Striga</i> growth are developed for the respective crops. <b>Subject 5: Evaluation of susceptibility of rice and sorghum to <i>Striga</i> and adaptability to ecosystems</b> 5-1 Resistance of rice and sorghum against <i>Striga</i> is evaluated by analyzing genetic resources. 5-2 <i>Striga</i>-resistant breeds are selected. 5-3 The <i>Striga</i>-resistant breeds with adaptability to the local environment are developed. <b>Subject 6: Selection of <i>Striga</i>-resistant/tolerant crops and establishment of crop rotation system</b> 6-1 <i>Striga</i>-resistance of the candidate crops is evaluated <i>in vitro</i>. 6-2 <i>Striga</i>-resistance of the candidate crops is evaluated at experimental farms. 6-3 A crop rotation system with a combination of the selected crops is developed.</p>	<p>• Proceedings of Meetings • Published scientific papers • Bulletins • Handouts • Syllabuses of joint seminars</p>	<p>• The research members of SUST do not often change.</p>

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	<p><b>Output 2. Amelioration of farmers' practice to manage <i>Striga</i></b>          Traditional knowledge on <i>Striga</i> management is systematically compiled.  <b>Subject 7: Field research on acceptability of new technologies and local producers/ consumers' preference</b>          7-1 Producers' economical and technical capacity for the <i>Striga</i> control technologies developed by the Project is demonstrated.          7-2 Economical and other characteristics of the sorghum and rice breeds favored by consumers are identified.          7-3 The beneficial information included in the study results is provided in Arabic.  <b>Subject 8: Implementation of FFS for sharing <i>Striga</i> control measures</b>          8-1 The administration and management systems of FFS are strengthened.          8-2 The curriculums of FFS are formulated and teaching materials prepared.          8-3 Extension activities are carried out.</p>				
<p><b>Activities</b>  <b>Under Output 1</b>  <b>Subject 1:</b> Development of novel germination stimulants  <b>Subject 2:</b> Search for microorganisms with potential to manage <i>Striga</i>  <b>Subject 3:</b> Searching for selective metabolic inhibitors for <i>Striga</i>  <b>Subject 4:</b> Analysis of translocation mechanisms of host materials to <i>Striga</i>  <b>Subject 5:</b> Evaluation of susceptibility of rice and sorghum to <i>Striga</i> and adaptability to ecosystems  <b>Subject 6:</b> Selection of <i>Striga</i>-resistant/tolerant crops and establishment of crop rotation system  <b>Under Output 2</b>  <b>Subject 7:</b> Field research on acceptability of new technologies and local producers/ consumers' preference  <b>Subject 8:</b> Implementation of farmers' field school (FFS) for sharing the <i>Striga</i> control measures</p>	<p style="text-align: center;"><b>Inputs</b></p> <table border="1" style="width: 100%;"> <tr> <td data-bbox="622 619 1263 1238"> <p><b><u>Japanese side</u></b></p> <p>[Experts]            • Long-term expert: 1 Project Coordinator            • Short-term expert: 9 Researchers</p> <p>[Materials and Equipment]            • Materials and equipment necessary for research            • One 4WD vehicle</p> </td> <td data-bbox="1263 619 1809 1238"> <p><b><u>Sudanese side</u></b></p> <p>[Counterpart personnel]            • 1 Leader            • 13 Researchers</p> <p>[Materials and Equipment]            • A part of materials and equipment necessary for research</p> <p>[Facilities]            • Project Office            • Laboratories            • Experiment farm plots</p> </td> </tr> </table>		<p><b><u>Japanese side</u></b></p> <p>[Experts]            • Long-term expert: 1 Project Coordinator            • Short-term expert: 9 Researchers</p> <p>[Materials and Equipment]            • Materials and equipment necessary for research            • One 4WD vehicle</p>	<p><b><u>Sudanese side</u></b></p> <p>[Counterpart personnel]            • 1 Leader            • 13 Researchers</p> <p>[Materials and Equipment]            • A part of materials and equipment necessary for research</p> <p>[Facilities]            • Project Office            • Laboratories            • Experiment farm plots</p>	<p>• The security in the study areas does not deteriorate.          • The prices do not soar.</p> <p><b><u>Pre-conditions</u></b>          • The security of Sudan is stable.</p>
<p><b><u>Japanese side</u></b></p> <p>[Experts]            • Long-term expert: 1 Project Coordinator            • Short-term expert: 9 Researchers</p> <p>[Materials and Equipment]            • Materials and equipment necessary for research            • One 4WD vehicle</p>	<p><b><u>Sudanese side</u></b></p> <p>[Counterpart personnel]            • 1 Leader            • 13 Researchers</p> <p>[Materials and Equipment]            • A part of materials and equipment necessary for research</p> <p>[Facilities]            • Project Office            • Laboratories            • Experiment farm plots</p>				

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Annex 4: Evaluation Grid

Evaluation Criteria	Evaluation question		Basis of judgment	Data needed	Data source	Data collection method
	Main question	Sub question				
Achievement	Were the input made as planned?	Have the Japanese experts dispatched as planned?	Comparison with the planned figures	Records on Japanese experts	Project records	Document review, interviews
		Has the counterpart training conducted as planned?	Comparison with the planned figures	Records on counterpart training	Project records	Document review, interviews
		Have the equipment and machinery provided as planned?	Comparison with the planned figures	Records on equipment provision	Project records	Document review, interviews
		Have the counterpart personnel assigned as planned?	Comparison with the planned figures	List of counterpart personnel	Project records	Document review, interviews
		Have the physical facilities provided as planned?	Comparison with the planned facilities	Information on the facilities	Project records, opinions of experts	Interviews, ocular visit
		Have the budgets to cover operational costs allotted as planned?	Comparison with the planned figures	Records on budgetary allocation	Project records	Document review, interviews
	Have the outputs been produced properly?	Have the novel germination stimulants been developed?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the microorganisms with potential to control striga been sought?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the selective metabolic inhibitors for striga been sought?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the translocation mechanisms of host materials to striga been analysed?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the susceptibility of rice and sorghum to striga and adaptability to ecosystems been evaluated?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the striga-resistant/tolerant crops been selected and crop rotation system been established?	Degree of achievement against the indicators	Research results	Project records and personnel	Document review, interviews
		Have the field research on acceptability of new technologies and local producers/consumers preference been conducted?	Degree of achievement against the indicators	Research results	Project records and personnel, Agricultural officers	Interview, discussion
		Have the FFS for sharing striga control measures been implemented?	Degree of achievement against the indicators	FFS implementation records	Project records and personnel, Agricultural officers	Document review, interviews
	Is the Project purpose likely to be achieved?	Has the permanent team on striga researches been founded in SUST?	Status of the permanent team	Information on the striga research team	Official documents of SUST	Document review, interviews
		Has the mid-term budgetary plan for striga researches been formulated in SUST?	Status of the budgetary plan formulation	Information on the budgetary plan for striga research	Official documents of SUST	Document review, interviews
		Have the researchers of SUST been able to present research outcomes continuously at international forums including international workshop and conferences, and research papers in international journals?	Degree of achievements	Record of academic presentations by SUST researchers	Records of SUST	Document review, interviews
	Have the activities been	Have the activities been timely implemented?	Comparison with the PO	Actual implementation schedule	Project personnel, Project records	Document review, interviews

Evaluation Criteria	Evaluation question		Basis of judgment	Data needed	Data source	Data collection method	
	Main question	Sub question					
Implementation processes	implemented as scheduled?	Has there been any change in the activities and schedule of implementation from the original PO?	Comparison with the PO	Information on the changes that took place	Project personnel, Project records	Document review, interviews	
	Have there been any problem related to the management of the Project?	Have the Project activities been properly monitored?	Frequency and contents of monitoring	Monitoring mechanism, frequency, monitoring results	Project personnel, Project records	Document review, interviews	
		Has the decision making mechanism of the Project been functional?	Problems faced and the countermeasures	Information on the JCC and other decision making mechanisms	Project personnel, Project records	Interview, discussion	
		Has the communication among JICA HQ, JICA country Office, implementing agencies and the Project been smooth?	Existence of problems and countermeasures	Way and contents of the regular transactions	Project personnel, Project records	Interview, discussion	
		Has the communication among the Project personnel been smooth?	Existence of problems and countermeasures	Ways and contents of the daily and regular transactions among the Project personnel	Project personnel, Project records	Interview, discussion	
		Has there been any other problems encountered in the Project implementation?	Problems faced and the countermeasures	Information on the JCC and other decision making mechanisms	Project personnel, Project records	Interview, discussion	
		What are special measures taken in terms of the managerial aspects of the Project?		Information on the managerial measures taken by the Project	Project personnel, Project records	Interview, discussion	
		Are the implementing agencies well aware of the Project?	Do the implementing agencies understand the objectives and approaches of the Project?	Levels of understanding among the decision makers	Information on the understanding of the Project purpose, discussion & meeting records	Project personnel, Project records	Document review, interview, discussion
	Have appropriate counterpart personnel been assigned?		No. and suitability of their expertise	Information on the qualification / background / experiences of the assigned personnel	Project personnel, Project records	Interview, discussion with Project staff	
	Have the counterpart personnel been involved actively in the Project activities?		Degree of participation	Examples of the activities that were mainly conducted by the counterpart personnel	Project personnel, Project records	Interview, discussion	
	Are the target groups well aware of the Project?	Have the beneficiaries well recognize the Project activities?	Levels of understanding	Information on their understanding of the Project, records of explanatory efforts made by the Project	Project personnel, Project records, cooperative officials, sample beneficiaries	Interview, discussion	
		Have the beneficiaries participated actively in the Project activities?	Degree of participation	Information on their participation in the Project activities	Project personnel, Project records, agricultural officers, sample beneficiaries	Interview, discussion	
	Were there any special measures taken to ensure the smooth implementation of the Project?	Have there been any special measures taken in terms of implementation mechanism?		Information on the measures taken by the Project	Project personnel, Project records	Document review, interview, discussion	
		Have there been any special consideration given in terms of dealing with the target groups?		Information on the measures taken by the Project	Project personnel, Project records	Document review, interview, discussion	
	Has the Project still been in line with the priorities in the development plans and program of the country and the sector ?	Does the Project address the needs of the target area and the target groups?	Is the Project still in line with the needs of the target area and society?	Confirmation on the current needs			
			Is the Project still in the line with the needs of the target group?	Positive response from the target group	Baseline information, opinion of Project personnel	Project reports and personnel	Document review, interviews
		Is the Project consistent with the development plans of Sudanese Government?	Is the Project consistent with the development plans of Rwanda?	Existence of the consistent stipulation in the document	Development plans and programmes of Rwanda	Policy documents	Document review
			Is the Project consistent with the plans and programs of SUST?	Existence of the consistent stipulation in the document	National and district policies and programs on agricultural development	Policy documents	Document review
			Does the Project address the needs and context of MAI and ARC?	Existence of the consistent stipulation in the document	Plans and program of implementing agencies (MINAGRI & Districts)	Policy documents, MAAIF officials, district officials	Document review, interviews

Evaluation Criteria	Evaluation question		Basis of judgment	Data needed	Data source	Data collection method
	Main question	Sub question				
Relevance	Is the Project priority in the Japan's foreign assistance policy and JICA's country programs?	Is the Project relevant to the Japan's Aid Policies ?	Existence of the consistent stipulation in the document	Priority directions in Japan's Aid Program	Japan's Foreign Assistance Policy	Document review
		Is the Project relevant to the JICA's Program?	Existence of the consistent stipulation in the document	JICA's Program	JICA's Rolling Plan	Document review, discussion with JICA staff
	Has the Project been adequate means to address the development issues in the country and the sector?	Does the Project appropriately address the issues of agricultural development sectors?	Existence of the consistent stipulation in the document	National policies & programs related to the local government and water sector	Policy documents	Document review
		Does the Project properly address the needs and context of implementing agencies?	Existence of the consistent stipulation in the document	Plans and program of implementing agencies	Policy documents, staff of implementing agencies	Document review, interviews
		Has there been any synergy effects through cooperation with other donors?	Positive response from the target group	Baseline information, opinion of stakeholders	Project reports and personnel, sample beneficiaries	Document review, interviews
	Has the selection of target groups been appropriate?	Has the size of the target group been appropriate?		No. and area of coverage, No. of beneficiaries	Project personnel	Document review, interviews
		Has the Project equitably brought about the benefit?	Distribution of the Project benefits	Project benefits for different strata of target groups	Project records and personnel	Document review, interviews
		Has the cost been equally shared by the stakeholders?	Cost sharing ratio	Expenditure and source of funds	Project records and personnel	Document review, interviews
	Has the Project applied appropriate approach?	Is there any advantage of Japanese technologies?		Technologies transferred through the Project	Project personnel, Project records	Document review, interviews
	Has there been any changes in the environment of the Project?	Has there been any changes in the social, political and other conditions assumed prior to the commencement of the Project?		Information on the environment of the Project	Project personnel, Project records	Document review, interviews
Effectiveness	Is the prospect of achieving the Project purpose considered to be high?	Has the Project purpose been specific enough?	Existence of commonly shared definitions of Project purpose	Definition, understanding on the Project purpose among the Project personnel	Project personnel, Project records	Interview, discussion with Project personnel
		Will there be any potential obstacles that may hinder the achievement of the Project purpose?	Potential obstacles	information on the potential risks and obstacles and possible countermeasures	Project personnel, Project records	Interview, discussion with Project staff
	Have the outputs been appropriate to achieve the Project purpose?	Has there been any factors contributing to the achievement of the Project purpose other than the outputs?	Confirmation on the factors	Information on the related events, programs/projects by other organizations in the target area	Project personnel, Project records, relevant documents	Interview, field visit, discussion with Project staff
		Is the logical sequences between outputs and Project purpose still secured?	Confirmation on the logical sequence	Information on the results of activities that indicate the cause-effect relationship	Project personnel, Project records	Interview, discussion with Project staff
	Has there been any influence of important assumptions?		Conditions of important assumptions	current status and past events related to the important assumptions	Project personnel, Project records	Document review, interviews
	Has there been any other hindering or contributing factors?		Confirmation on the factors	Information on any relevant events in the course of Project implementation	Project personnel, Project records	Interview, discussion with Project personnel
Have the Project activities properly been appropriate to produce the expected outputs?	Are the activities contributing to achieve the outputs?	Co-relation between the outcomes of the activities and outputs	Logical sequence between activities and outputs, progress of activities and levels of achievements	Project personnel, Project records	Document review, interviews	
	Has there been any obstacle for the achievement of the outputs?	Existence of obstacles	Information on any relevant events in the course of Project implementation	Project personnel, Project records	Interview, discussion with Project staff	



Evaluation Criteria	Evaluation question		Basis of judgment	Data needed	Data source	Data collection method
	Main question	Sub question				
Efficiency	Have the inputs been appropriate to produce the outputs?	Have the timing, number, duration, and fields of Japanese experts dispatched been appropriate?	Comparison with the planned figures	Records on Japanese experts	Project records	Document review, interviews
		Have the timing, duration, contents of counterpart training been appropriate?	Comparison with the planned figures	Records on counterpart training	Project records	Document review, interviews
		Have the timing, volume, and specification of provision of equipment been appropriate?	Comparison with the planned figures	Records on equipment provision	Project records	Document review, interviews
		Have the timing, number, fields and competency of the counterpart personnel been appropriate?	Comparison with the planned figures	List of counterpart personnel	Project records	Document review, interviews
		Were the physical facilities sufficient to implement the Project activities?	Comparison with the planned figures	Information on the facilities	Project records, opinions of experts	Interviews, ocular visit
		Has the scale of Project cost been appropriate for the planned inputs?	Comparison with the input costs	Budget and expenditure, local cost borne by Japanese and Sudanese sides	Project record and personnel, JICA staff	Interview, discussion with Project personnel and JICA staff
		Will the degree of the Project achievements be enough to compensate the costs of inputs?	Comparison with the input costs	Budget and expenditure, local cost by Pakistani side	Project record and personnel, JICA staff	Interview, discussion with Project personnel and JICA staff
		Are there any outputs that were realized by cooperation with other JICA schemes or other donors?	contribution by other interventions	Information on other interventions	Project record and personnel, JICA staff	Interview, discussion with Project personnel and JICA staff
	Have there been any factors hindering or contributing to the efficiency of the Project?	Has there been any influence from important assumptions?	Conditions of important assumptions	Information on the security conditions, researchers turnover, cooperation among SUST, governmental institutions and farming villages	Project personnel, Project records	Interview, discussion
		Have there been any other factors affecting the efficiency?	Confirmation on the factors	Information on any relevant events in the course of Project implementation	Project personnel, Project records	Interview, discussion
Impacts	Is the prospect of achieving the overall goal assumed to be high?	Will the the suggestions and action plan on practical use of innovative technologies developed for striga control be proposed to the Government of Sudan and farming villages?		Prospect of formulation of suggestions and action plans	Project personnel, Project record, research results	Document review, interview, discussion with Project personnel
		Has any method or mechanism been suggested to achieve the overall goal?		Future plan of the government, opinion of the Project staff	Staff of the implementing agencies, Project personnel	Document review, interviews, discussion
		Will the achievement of the overall goal contribute to the bring positive impacts to the policies of Sudanese government?	organizational commitment, existence of relevant programs	Current program, future plan of the government, opinion of the Project staff	Staff of the implementing agencies, Project personnel	Document review, interviews, discussion
		Is there any possible factors that hinder or contribute to the achievement of the overall goal?		Information on any relevant events in the course of Project implementation	Project personnel, Project records	Document review, interviews
	Is the project purpose still appropriated to achieve the overall goal?	Is the logical sequences between the Project purpose and the overall goal still secured?	Confirmation on the logical sequence	Information on the results of activities that indicate the cause-effect relationship	Project personnel, Project records	Interview, discussion with Project staff
		Are there any additional important assumptions to be taken into account?	Influence of surrounding factors on the Project	Information on the relevant factors surrounding the Project	Project personnel, Project records	Interview, discussion
		Has there been any effect beyond the intended target groups?	Existence of relevant cases	Information on the sample cases in target area and other areas	Project personnel, Project records	Document review, interviews
		Has there been any unexpected effect on the policies and programs of implementing agencies?	Existence of relevant cases	Information on the relevant policies	Relevant documents, Project personnel, Project records	Document review, interviews
		Has there been any change in terms of relevant organization, laws, rules and regulations?	Existence of relevant cases	Information on the changes and new setup	Project personnel, Relevant documents	Document review, interviews

Evaluation Criteria	Evaluation question		Basis of judgment	Data needed	Data source	Data collection method
	Main question	Sub question				
	Have there been any other ripple effects?	Has there been any unexpected change in technical and/or methodological aspects of the irrigated agriculture?	Existence of relevant cases	Information on the changes that took place	Project personnel, Project records	Document review, interviews
		Has there been any unexpected effect in terms of gender, human rights, poverty gap, peace and conflicts?	Existence of relevant cases	Information on the cases of relevant events	Project personnel, Project records	Document review, interviews
		Has there been any unexpected effect on environmental concerns in the target areas?	Existence of relevant cases	Information on the cases of relevant events	Project personnel, Project records	Document review, interviews
	Are the impacts brought by the Project?	What are the factors that brought about the above mentioned positive and negative effects?	Project's attributes to the effects	Information on the other interventions and events in the target areas	Project personnel, sample beneficiaries	Interview, discussion, document review
Sustainability	Will the policy of improving and expanding irrigated agriculture continue ?	Is the possibility of continuation of the current policies on agricultural development high?	Policy commitment	Current program, future plan of the government, opinion of the Project personnel	Policy documents, Project personnel	Interview, discussion, document review
		Is there any alternative programs that can integrate the outcomes of the Project?	Existence of relevant programs	Current program, future plan of the government, opinion of the Project personnel	Policy documents, Project personnel	Interview, discussion, document review
		Are the implementing agencies committed to continue the activities?	Commitment of the SUST	Opinions and relevant documents of SUST and other relevant agencies	Project personnel, agricultural officers	Interview, discussion
	Are the implementing agencies capable to continue or further expand relevant activities of the Project?	Are the counterpart personnel capable of carrying out the activities?	Comparison with the baseline	Levels of competence, confidence, experiences and performance	Project personnel	Interview, discussion with Project personnel
		Are the necessary budgets allotted for the continuous application of developed extension package?	Budget allocation and plans	Budget plan of implementing agencies	Relevant staff of SUST, budget documents	Interview, confirmation of documents
		Are the agricultural officers and farming villages capable of continuing and expanding their activities initiated during the Project?	Comparison with the baseline	activity records and future plan of the community-based groups	Project personnel, agricultural officers, sample farmers	Interview, discussion
	Will the technologies and methodologies introduced by the Project continuously be utilized?	Are the SUST researchers likely to continue the striga research activities?	Possibility of further dissemination	Information on the progress and plans of the striga researches	Opinions of Project personnel	Document review, interview, discussion with stakeholders
		Is there any mechanism within SUST and GSMAI to continue / further disseminate the activities introduced by the Project in the future?	Existence of relevant programs	Information on the organizational setup and programs for continuation of activities	Project personnel, GSMAI officers, organograms	Interview, discussion, document review
		is the necessary equipment properly maintained?	Degree of maintenance and designation of the responsible entities	Budget allocation, history of maintenance of equipment	Project records, Project personnel	Document review, interviews
	Are there any factors that may affect the sustainability of the Project?	Is there any negative influence on the social and cultural aspects that may become obstacles in carrying out the activities?	Existence of relevant cases	Information on the cases of relevant events	Project personnel, Project records, sample beneficiaries	Interview, discussion
		Is there any negative influence on the environment that may inhibit the continuation of the activities?	Existence of relevant cases	Information on the cases of relevant events	Project personnel, Project records, sample beneficiaries	Interview, discussion

## Annex 5: Record of the Dispatch of Japanese Experts

### Long Term Experts

No.	Name	From	To	Organization	Expertise	Duration
1	H. Kuwata	20100301	20120228	JICA	Coordinator	2 years
2	S. Takeno	20120226	To date	JICA	Coordinator	3 years

### Short Term Experts

No.	Name	From	To	Organization	Positions	Expertise	Duration (days)
1	Y. Sugimoto	20100307	20100313	Kobe University	Professor	Bio-organic	7
2	H. Samejima	20100307	20100313	Kobe University	Researcher	Crop physiology	7
3	H. Samejima	20100405	20100831	Kobe University	Researcher	Crop physiology	149
4	A. Okazawa	20100619	20100625	Osaka University	Assistant Professor	Plant Physiology	7
5	Y. Sugimoto	20100619	20100625	Kobe University	Professor	Bio-organic	7
6	T. Inoue	20100619	20100625	Kobe University	Assistant Professor	Crop physiology	7
7	H. Nawata	20100629	20100705	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	7
8	T. Inoue	20100806	20100827	Tottori University	Researcher	Crop physiology	22
9	Y. Yamauchi	20100821	20100827	Kobe University	Assistant Professor	Plant Physiology	7
10	Y. Sugimoto	20101007	20101012	Kobe University	Professor	Bio-organic	6
11	H. Samejima	20101007	20101012	Kobe University	Researcher	Crop physiology	6
12	H. Samejima	20101103	20110228	Kobe University	Researcher	Crop physiology	118
13	H. Nawata	20101112	20101201	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	13
14	R. Nakamura	20101119	20101201	Research Institute for Humanity and Nature	Researcher	Cultural Anthoropology	13
15	S. Ishiyama	20101119	20101201	Research Institute for Humanity and Nature	Researcher	Cultural Anthoropology	13
16	Y. Sugimoto	20101221	20101228	Kobe University	Professor	Bio-organic	8
17	H. Nawata	20101222	20101230	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	8
18	H. Samejima	20110416	20120114	Kobe University	Researcher	Crop physiology	275
19	H. Nawata	20110601	20110622	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	22
20	S. Ishiyama	20110601	20110622	Research Institute for Humanity and Nature	Researcher	Cultural Anthoropology	22
21	T. Inoue	20110609	20110618	Tottori University	Researcher	Crop physiology	9
22	Y. Sugimoto	20110804	20110811	Kobe University	Professor	Bio-organic	8
23	T. Inoue	20110804	20110917	Tottori University	Researcher	Crop physiology	45

24	H. Nawata	20110812	20110827	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	16
25	S. Ishiyama	20110812	20110827	Research Institute for Humanity and Nature	Researcher	Cultural Anthoropology	16
26	Y. Yamauchi	20110903	20110912	Kobe University	Assistant Professor	Plant Physiology	10
27	Y. Sugimoto	20110910	20110917	Kobe University	Professor	Bio-organic	8
28	A. Okazawa	20110910	20110917	Osaka University	Assistant Professor	Plant Physiology	7
29	H. Nawata	20110920	20111001	Research Institute for Humanity and Nature	Associate Professor	Cultural Anthoropology	11
30	S. Ishiyama	20111009	20111031	Research Institute for Humanity and Nature	Researcher	Cultural Anthoropology	23
31	Y. Sugimoto	20111222	20111231	Kobe University	Professor	Bio-organic	10
32	H. Samejima	20120406	20120610	Kobe University	Researcher	Crop physiology	65
33	Y. Sugimoto	20120416	20120424	Kobe University	Professor	Bio-organic	9
34	T. Inoue	20120602	20120609	Tottori University	Researcher	Crop physiology	8
35	H. Samejima	20120627	20120804	Kobe University	Researcher	Crop physiology	38
36		20120811	20130111				156
37	Y. Sugimoto	20120728	20120804	Kobe University	Professor	Bio-organic	7
38	Y. Yamauchi	20120823	20120830	Kobe University	Assistant Professor	Plant Physiology	8
39	Y. Sugimoto	20120920	20120928	Kobe University	Professor	Bio-organic	9
40	M. Sasaki	20120920	20120928	Kobe University	Honorable Professor	Synthetic organic chemistry	9
41	A. Okazawa	20120920	20120928	Osaka Prefecture University	Associate Professor	Plant Physiology	9
42	H. Nakashima	20120920	20120928	Kobe University	Researcher	Synthetic organic chemistry	9
43	T. Inoue	20120920	20120928	Tottori University	Researcher	Crop physiology	9
44	Y. Sugimoto	20121221	20121229	Kobe University	Professor	Bio-organic	9
45	M. Sasaki	20121221	20121229	Kobe University	Honorable Professor	Synthetic organic chemistry	9
46	H. Iba	20121221	20121229	Kobe University	Associate Professor	Agricultural Economics	9
47	T. Yoshimoto	20121221	20121229	Kobe University	Researcher	Plant Physiology	9
48	Y. Sugimoto	20130310	20130316	Kobe University	Professor	Bio-organic	7
49	M. Kuse	20130310	20130316	Kobe University	Associate Professor	Natural products chemistry	7
50	H. Samejima	20130310	20130318	Kobe University	Researcher	Crop physiology	9
51	H. Samejima	20130412	20130705	Kobe University	Researcher	Crop physiology	34
52	H. Iba	20130531	20130606	Kobe University	Associate Professor	Agricultural Economics	6
53	Y. Sugimoto	20130720	20130726	Kobe University	Professor	Bio-organic	7
54	A. Okazawa	20130720	20130726	Osaka Prefecture University	Associate Professor	Plant Physiology	7
55	T. Inoue	20130720	20130728	Tottori University	Researcher	Crop physiology	9
56	H. Samejima	20130720	20130930	Kobe University	Researcher	Crop physiology	71
57	H. Samejima	20131001	20140117	Kobe University	Researcher	Crop physiology	112

58	Y. Sugimoto	20130907	20130914	Kobe University	Professor	Bio-organic	8
59	M. Kuse	20130907	20130914	Kobe University	Associate Professor	Natural products chemistry	8
60	Y. Yamauchi	20130907	20130914	Kobe University	Assistant Professor	Plant Physiology	8
61	Y. Sugimoto	20131220	20131227	Kobe University	Professor	Bio-organic	8
62	M. Kuse	20131220	20131227	Kobe University	Associate Professor	Natural products chemistry	8
63	H. Iba	20131220	20131227	Kobe University	Associate Professor	Agricultural Economics	8
64	H. Samejima	20140311	20140320	Kobe University	Researcher	Crop physiology	10
65	Y. Sugimoto	20140314	20140320	Kobe University	Professor	Bio-organic	7
66	M. Kuse	20140314	20140320	Kobe University	Associate Professor	Natural products chemistry	7
67	T. Yoshimoto	20140314	20140320	Kobe University	Researcher	Plant Physiology	7
68	H. Samejima	20140417	20140702	Kobe University	Researcher	Crop physiology	76
69	Y. Sugimoto	20140607	20140613	Kobe University	Professor	Bio-organic	7
70	M. Kuse	20140607	20140613	Kobe University	Associate Professor	Natural products chemistry	7
71	H. Iba	20140615	20140621	Kyoto University	Associate Professor	Agricultural Economics	7
72	H. Samejima	20140801	20140930 (planned)	Kobe University	Researcher	Crop physiology	31(+30)

## Annex 6: List of Equipment and Machineries

Note 1: Condition A: good in use B: under repair C: not in use D: discarded

Note 2: Degree of Utilization A: used frequently (almost daily) B: used well (1-3 times per week) C: used in specific season(s) only  
D: not so much used (3-11 times per year) (needs reasons) E: not used by specific reason (needs reasons)

(1) Laboratory: USD 898,036

(3) Field: USD 28,451

Grand Total: 1,048,144

(2) Office: USD 110,722

(4) Gedaref: 20,934

### (1) Equipment for the laboratory

Sl.	Date of Procurement	Item	Specifications	Quantity	Total Price			Conditions (*1)	Utilization (*2)	Remarks
					USD	JPY	SDG			
1	20100325	Color LASERJET All in One Printer	CM2320nf MFP	1			3,000	A	A	
2	20100325	LASERJET Printer	P2055d	1			1,200	A	A	
3	20100328	Desktop Computer	Optiplex 780	1			2,697	A	A	
4	20100531	Air Pump		10		231,000		A	C	
5	20100531	Measuring Tape		1		16,600		A	C	
6	20100531	Micrometer Caliper		1		16,000		A	C	
7	20100531	Digital Camera	Xacti	1		25,000		A	A	
8	20100531	Drying Shelf (basket type)		1		81,000		A	A	
9	20100531	Drying Shelf (net rack type)	Net Rack/Basket	1		71,000		A	A	
10	20100531	Label Printer	SR220	1		9,800		A	A	
11	20100531	Laboratory Wagon		1		34,000		A	A	
12	20100531	Liquid Nitrogen Cylinder	DR-10 A	1		130,000		A	A	
13	20100531	Portable Electronic Balance plus cover		1		35,500		A	A	
14	20100531	Stirring Bar		2		27,600		A	A	
15	20100531	Temperature and Humidity Recorder		3		89,400		A	A	
16	20100531	Temperature Recorder		10		248,000		A	C	
17	20100531	Tool Kit		1		52,000		A	C	
18	20100531	Trolley		1		12,000		A	D	
19	20100531	Voltage inverter and stabilizer		1		48,800		A	A	

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20	20100531	Water and Dust-proof Balance Platform		1		79,800		A	A	
21	20100531	Water and Dust-proof Clock		2		30,000		A	A	
22	20100623	Adpter for connection (Photosynthesis Yield)		1		125,000		A	A	
23	20100623	Osmometer	Osmomat 30	1		1,915,000		A	D	
24	20100623	Photosensor (for Osmometer)		1		32,000		A	D	
25	20100623	Thermistor (for Osmometer)		1		65,000		A	D	
26	20100623	Electric Conductivity (EC) METER	CM-53	1		36,750		A	C	
27	20100623	Leaf clip holder (for Photosynthesis Yield)		1		500,000		A	C	
28	20100623	Photosynthesis Yield Analyzer	Mini-pam	1		1,980,000		B	E	Under repair
29	20100705	Refrigrator 17 feet	MARF	1			1,800	A	A	
30	20100718	Circular (Analytical) Balance	PLE 310-3N	1			1,550	A	A	
31	20100718	Rectangular (Analytical)	FCB 12K1	1			1,090	A	A	
32	20100718	Rota filler	Rota Filler 3000	1			745	A	D	
33	20100718	Autoclave (50 -90L)	LAC-5040S	1			10,990	A	A	
34	20100718	Analytical (Sensative) Balance	ALS 220-4N	1			4,439	A	A	
35	20100718	Circulating Chiller	LCB-R08	2			14,780	A	A	
36	20100718	Sensitive Balance	KERN PFB	1			1,200	A	A	
37	20100718	Consort Power Supply for the Electrophoretic unit	MP 250	1			1,861	A	D	
38	20100718	Diaphragm (Vacum) Pump	GM-0.50	2			3,900	A	A	
39	20100718	Electrophoretic Unit	CVS10D	1			1,200	A	D	
40	20100718	Hotplate Magnetic Stirrer	LMS-1003	1			1,780	A	A	
41	20100718	Laminar flow bench	CR870FL	2			14,562	A	A	
42	20100718	Low Temperature Incubator	LBI-150E	2			7,977	A	A	
43	20100718	Micropipette (10 - 100ul)	Code 001.11.100	1			1,780	A	A	
44	20100718	Micropipette (100 - 1,000ul)	Code 001.11.901	2			1,780	A	A	
45	20100718	Microscope	MSZ5000-T-IL-TL MSZ5600(mit fototubus)	1			4,984	A	A	
46	20100718	Mini Centrifuge	MCF - 2360 / code 5944400	1			3,042	A	A	
47	20100718	Oven	LDO-080N	1			3,798	A	A	
48	20100718	Refrigrated Micro Centrifuge	MIKRO 220 R / Code 2200	1			18,913	A	B	
49	20100718	Shaking Water Bath, 20-99.9c , 20L	LSB-01	1			4,980	A	B	

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50	20100718	Votrex Mixer	LVM-202 LMS	2			1,540	A	A	
51	20100718	Water Distillation Apparatus	WD-1004	1			2,300	A	A	
52	20100805	Arabidopsis and Small Leaf Chamber (for LC pro)				480,000		A	C	
53	20100805	Broad Leaf Chamber (for LC pro)	LC-pro			670,000		A	C	
54	20100805	Dewar Flask				130,000		A	A	
55	20100805	Leaf area meter	AAC-410			2,700,000		A	B	
56	20100805	Micro syringe 10µl		2		4,700		A	B	
57	20100805	Micro syringe 25µl		2		5,760		A	B	
58	20100805	Narrow Leaf Chamber (for LC pro)	LC-pro			480,000		A	C	
59	20100805	Photosynthesis and transpiration meter (LC pro)	LC-pro			4,490,000		A	C	
60	20100829	Spectrophotometer	UV-1800		15,000			A	D	
61	20100905	Microscope Camera	DCM300 / VOPC80				1,850	A	A	
62	20100910	Incubator	Friocell 222				8,000	A	A	
63	20101010	Shaker + Tray	UNIMAX 1010	2	10,400			A	B	
64	20101010	Ultrawave ultrasonic baths (25 L, 0 - 80c)	QS25	1	3,300			A	A	
65	20101010	Ultrawave ultrasonic baths (4.4 L, 30 - 70c)	U500H	1	1,280			A	A	
66	20101010	Vibration damping table for balance	Bal 1986	3	1,530			A	A	
67	20101010	Freeze drying system	Lyotrap K12173-5	1	7,000			A	E	no work on molecular
68	20101010	pH Meter	FE20/FG2	1	660			A	A	
69	20101010	Adjustable Micropipette	E3111000181	2	1,216			A	A	
70	20101010	Analytical mill	IKA A11 basic	1	1,810			B	E	
71	20101010	Centrifuge	EBA 21	1	4,710			A	C	
72	20101108	Rotary evaporator	Liftbasis Value	2	13,700			A	A	
73	20110117	Refrigrator (Chest)	Ocean NJ40TLL	1			1,507	A	A	
74	20110203	Microscope	MSL4000-20/40-IL-TL	1			1,452	A	A	
75	20110315	5000 VA UPS		1			7,750	A	A	
76	20110317	Gas chromatograph (8 parts)	GC-2010 plus series	1	15,972		15,972	A	A	
77	20110320	Gas Chromatography (Hydrogen Generator)	GC-2010 plus series	1				A	A	

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78	20110324	Gas chromatograph	GC-2010 plus series	1	43,007			A	A	
79	20110321	Oven	LDO-080N	1			4,800	A	A	
80	20110321	Laminar flow bench	CR870FL	1			16,000	A	A	
81	20110322	Desktop Computer	Optiplex 780	1			2,490	A	A	
82	20110329	Illuminated Incubator	LH-220S FIXED	1		819,000		B	E	Under repair
83	20110616	Porometer (EM-AP4)		1		1,648,500		A	A	
84	20110616	Sensor head (PHS1) (for Porometer)		1		315,000		A	A	
85	20110710	Shelf for Reagent		1			924	A	A	
86	20110721	Desktop Computer	Optiplex 520	1			2,600	A	A	
87	20110817	HPLC		1	39,848		39,848	A	A	
88	20110825	Thermalcycler	FTC 3/05	1			22,600	A	E	no work on molecular
89	20110915	Canopy analyser		1		1,558,000		A	E	
90	20110915	Grain Polisher PEARLEST		1		58,000		A	C	
91	20110915	Pressure chamber		1		906,300		A	C	
92	20110915	Rice Husker TR-200		1		47,000		A	C	
93	20110915	RV-240 Large Rotary		1		952,200		A	B	
94	20110915	S-35 Disposable blade (for Rotary Microtome)		5		7,650		A	B	
95	20110915	SPAD-502 Plus (Chlorophyll meter)		1		124,200		A	A	
96	20110929	Exchangeable thermoblocks	TH 21	2			1,646	A	E	no work on molecular
97	20110929	Flexi Caster for		1			778	A	D	
98	20110929	Gel Documentation System	D1-HD	1			21,532	A	D	
99	20110929	Heating Block Thermal	MBT 250-2	1			4,770	A	E	no work on molecular
100	20110929	Horizontal Electrophoresis	MSMINI	1			1,487	A	D	
101	20110929	Shaking Incubator	KS 4000i control	1			24,127	A	D	
102	20110929	Ultra Low Temperature Freezer	BM 15 LC9002	1			38,312	A	E	no work on molecular
103	20111016	UPS 3000		1			4,350	A	A	
104	20111027	Water Distillation Apparatus	WD-1005	1			2,974	A	A	
105	20111101	UPS 3000		1			3,300	A	A	
106	20111115	Stabilizer		1			600	A	A	
107	20111116	Desktop Computer	Dell Optiplex 520	1			2,300	A	A	

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108	20111116	Hard Drive		1			700	A	A	
109	20111129	Microwave Oven	LG	1			390	A	A	
110	20111226	Stabilizer	FENZA, FRT-6	1			23,000	A	A	
111	20111229	Microscope	Olympus, DP-26	1	3,420			A	A	
112	20111229	Microscope Camera	Olympus, CX41	1	9,240			A	A	
113	20130417	Desktop computer	Dell optiplex990	1			6,090	A	A	
114	20130417	Desktop computer	Dell optiplex990	1			6,090	A	A	
115	20130417	Notebook computer	HP G6-1335	1			5,700	A	A	
116	20130527	Desktop computer	Dell optiplex790	1			5,490	A	A	
117	20130527	UPS	APC UPS 650 VA	1			680	A	A	
118	20140114	UV Handlab	6W, 245/366 nm, switchable with bench stand	1			5,280	A	A	
119	20140116	Refrigerator	LG, 11 feet	1			4,200	A	A	
120	20120430	Water Bath		1			1,000	A	D	
121	20120503	Laboratory oven		1			1,344	A	A	
122	20120529	UPS	APC UPS 650 VA	1			530	A	A	
123	20120529	UPS	APC UPS 650 VA	1			530	A	A	
124	20120717	Vaccum Cleaner	Kenwood	1			525	A	B	
125	20121205	Refrigerator	LG GL-M242YM/S	1			3,450	A	A	
126	20120717	Fume Hood with fan	2350x1500x800	1			20,490	B	E	to be repaired
127	20120705	Mixer Mills	Retsch MM-400	1		1,034,000		A	A	
128	20120717	Dewar Flask	10LD	3		137,000		A	A	
129	20120717	Dewar Flask	3000ml	3		48,000		A	A	
130	20120705	Photosynthesis System	LC Pro	1		5,102,370		A	C	
131	20120928	Artificial Climate Chamber	Biorton	1		922,000		A	A	
132	20120928	Temperature humidity sensor	sensor, battery, ventilator	1		294,000		A	A	
Sub-total by the time of the Mid-term Review					172,093	28,824,930	435,346			
Sub-total amount converted in USD at the rate of the time of the the Mid-term Review					706,543		(USD 1.00 = JPY80 = SDG 2.5)			

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134	20120717	Vaccum Cleaner	Kenwood	1				A	B	
135	20120717	Fencing mesh		1				A	A	
136	20120705	Mixer Mills with adapter	Retsch	1		1,034,000		A	C	
137			MM-400							
138	20120717	Auger clay typ soil	EDELMAN	3		51,000		A	C	
139			8cm diametere							
140	20120717	Auger Handle	EDELMAN	3		66,000		A	C	
141			60cm							

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142	20120717	Dewar Flask	Taylor-Wharton, 10L	1		137,000		A	A		
143		Dewar Flask	Taylor-Wharton, 3L	1		48,000		A	A		
144	20120928	Artificial Climate Chamber	Biorton	1		922,000		A	A		
145	20120928	Transformer	SU-2000G	1				A	A		
146	20120928	Temperature humidity sensor	sensor, battery, ventilator	1		294,000		A	A		
147	20121205	Refrigerator	LG GL-M242YM/S	1				A	A		
148	20121217	Fume Hood with fan	2350x1500x800	1				B	E	under repair	
149	20130417	Desktop computer	Dell optiplex990	2				A	A		
150	20130417	Notebook computer	HP G6-1335	1				A	A		
151	20130527	Desktop computer	Dell optiplex790	1				A	A		
152	20140114	UV Handlab	6W, 245/366 nm, switchable with bench stand	1			5,280	A	A		
153	20140116	Refrigerator	LG, 11feet	1				A	A		
154	20140211	Digital Cone Penetrometer	GPS Reading Unit, Cone, Spindle, Data Cable	2			884,800	A	B		
155	20140313	Stereo Microscope	Kruss, MSZ5000-T-IL-TL	1				A	A		
156	20140422	Vacuum pump	with buit-in filtering material	1				A	A		
157	20140604	Fraction Collector	CHF161RA	1		405,000		A	B		
158	20140604	Syringe	TERUMO 1ml	10		13,000		A	B		
159	20140604	Silica Gel	Merck TIC AL SHEETS SILICA GEL60, F254 20x20	10		132,000		A	B		
160	20140604	Disposable Syringe Filter	SRP 0.45µm 17820K	20		100,800		A	B		
Sub-total after Mid-term Review						0	3,202,800	965,541			
Sub-total amount converted in USD at the rate of the time of the Study							191,493		(USD 1.00 = JPY03.77 = SDG 6.011)		
Grand Total							898,036				

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R1  
 (2) Equipment for the office

Sl.	Date of Procurement	Item	Specifications	Quantity	Total Price			Conditions (*)	Utilization (**)	Remarks
					USD	JPY	SDG			
1	20100325	4 Port Mobile USB Hub		1			65	A	A	
2	20100325	Norton Antivirus 2010		1			200	A	E	expired
3	20100328	Office Desk		1			575	A	A	
4	20100328	Office Chair		1			160	A	A	
5	20100422	USB Switch Hub		1			130	A	A	
6	20100525	Shredder	Flamingo	1			175	A	A	
7	20100531	Refrigrator	LG	1			1,300	A	A	
8	20100621	GPS unitkit	GPS-CS3	1		18,900		A	D	
10	20100630	SD Memory		1			75	A	A	
11	20100630	Acer Monitor		1			960	A	A	
12	20100630	Water cooler		1			430	A	A	
13	20101028	UPS APC 650 KVA	APC 650	1			350	A	A	
14	20101111	Laptop	Toshiba Satellite L635	1			2,500	A	A	
15	20101111	Projector	Sony EX 7	1			1,850	A	B	
16	20101213	Projector Screen 150X150		1			475	A	B	
17	20110125	Laptop	Toshiba Satellite L635	1			2,600	A	A	
18	20110130	Portable Printer		1			1,850	A	A	
19	20110228	Photocopy machine	Afcio MP C2050	1			20,500	A	A	
20	20110301	USB Mouse		1			25	A	A	
21	20110530	GPS	GPSmap 62s	1			1,500	A	D	
22	20110616	Video Handy Camera		1			1,500	A	D	
23	20110914	Desktop computer	Dell Optiplex 780	1			2,950	A	A	
24		MDSL Portable Modem	Sudani	1			380	A	A	
25	20110310	Wireless Router	CISCO	1			300	A	A	
26	20111002	Paper Trimmer		1			160	A	A	
27		Portable Printer	Canon IP100	1				A	A	
28	20120306	Safe box	55cm	1			750	A	A	
29	20120911	Mobile Phone	Nokia1280	1			170	D	E	discarded
30	20120911	Mobile Phone	Nokia1280	1			170	D	E	discarded
31	20120911	Mobile Phone	Nokia1280	1			170	A	A	
32	20120415	External Hard Disk	Western Digital My Passport 500GB	1			580	A	A	
33	20120415	MDSL Portable Modem	Sudani	1			665	D	E	discarded
34	20120528	Wi-Fi router	Huawei	1			951	A	A	
35	20100325	Vehicle	Nissan Patrol GL - Model 2009	1			103,500	A	A	
36	20100331	Vehicle	Toyota Hilux double cab - 2.5L Diesel,	1	24,300			A	A	
37	20111228	Vehicle	Toyota Hilux double cab - 2.5L Diesel,	1	27,000			A	A	
Sub-total by the time of the Mid-term Review						51,300	18,900	147,966		
Sub-total amount converted in USD at the rate of the time of the the Mid-term Review						110,722		(USD 1.00 = JPY80 = SDG 2.5)		

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(3) Equipment for experimental field

Sl.	Date of Procurement (YYYY-MM-DD)	Item	Specifications	Quantity	Total Price			Conditions <sup>(*)</sup>	Utilization <sup>(**)</sup>	Remarks
					USD	JPY	SDG			
1	20100531	Weather Observation System				500,000		A	A	
2	20100531	Soil Moisture Meter				407,400		A	D	
3	20100531	Data logger for soil moisture meter				31,290		A	D	
4	20100531	Access tube for soil moisture meter				50,400		A	D	
5	20100531	Auger set for soil moisture meter				100,000		A	D	
6	20100531	Water and Dust-proof Platform				79,800		A	A	
7	20100531	Wagner pot				280,000		A	B	
8	20100623	Bird Net	(orange) size 18 x 27m, Square hole 30mm			8,240		A	A	
9	20100623	Animal Net size	120 cm x 50 m			30,800		A	A	
10	20110616	Soil moisture sensor	(ML2X/d-0.15) (2)			141,750		A	D	
11	20110616	Data logger (HH2)	(for Soil Moisture sensor			147,000		A	D	
12	20110616	Lod	(for Soil Moisture sensor			10,500		A	D	
13	20110929	Access tube	(for Soil Moisture Meter)			168,000		A	D	
14	20110929	Bird Net				41,600		A	A	
15	20120430	Gas cylinders with tube connections and regulators					490	A	D	
16	20120508	Plantation Pots					2,400	A	A	
17	20120717	Fencing mesh					400	A	A	
18	20120729	Plantation Pots					1,000	A	A	
19	20120730	Nitrogen gas cylinder with regulator					781	A	D	
20	20120717	Auger clay type soil	EDELMAN, 8cm diameter			51,000		A	D	
21	20120717	Auger Handle	EDELMAN, 60cm			66,000		A	D	
Sub-total by the time of the Mid-term Review					0	2,113,780	5,071			
Sub-total amount converted in USD at the rate of the time of the the Mid-term Review					28,451			(USD 1.00 = JPY80 = SDG 2.5)		

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(4) Equipment for the field activities in Gedaref

Sl.	Date of Procurement (YYYY-MM-DD)	Item	Specifications	Quantity	Total Price			Conditions <sup>(*)</sup>	Utilization <sup>(*)</sup>	Remarks
					USD	JPY	SDG			
1	20110530	Rain Gauge		1			2,400	D	E	Discarded
2	20110616	White Board		1			1,500	A	A	
3	20110803	Camera		1			2,800	A	A	
4	20111204	AC	LG 18 split AC	1			9,000	A	A	
5	20111205	Desktop Computer	Optiplex 780	1			3,600	A	A	
6	20111205	Laptop Computer	HP DM4	1			2,955	A	A	
7	20111205	UPS 650	APC 650	1			480	A	A	
8	20111215	Printer	CLX-3185	1			2,500	A	A	
9	20120909	FFS Shelter tent with poles		1			2,100	A	A	
Sub-total by the time of the Mid-term Review					0	0	27,335			
Sub-total amount converted in USD at the rate of the time of the the Mid-term Review					10,934			(USD 1.00 = JPY80 = SDG 2.5)		

Signature

### Annex 7: List of the Counterpart Personnel Participated in the Training and Research in Japan

No.	Name	Organization	Position	Theme of the Training	From	To
1	Abdel Gabar Eltayeb Babiker	SUST	Professor	Plant Science	20100912	20100917
					20110718	20110726
2	Ahmed El Sadig Mohamed Saeed	SUST	Associate Professor	Plant Science	20100912	20100917
3	Yassin Mohamed Ibrahim (Dagash)	SUST	Professor	Plant Science	20100912	20100917
4	Amani Hamad Eltayeb Hamad	SUST	Lecturer	Plant Science	20100912	20100917
					20110718	20110730
					20120604	20120901
5	Dr. Nagat El Moubarak El Tayeb	MAF	Director	Plant Science	20100912	20100917
6	Dr. Mohammed Badwi Hussein	SUST	Associate Professor	Social Economy	20100912	20100917
7	Dr. Mutasim Mekki Mahmoud El Rasheed	SUST	Associate Professor	Agricultural Economy	20100912	20100917
					20120226	20120311
					20130216	20130223
					20140712	20140716
8	Ahmed El Awad El Faki	SUST	Associate Professor	Plant Science	20100912	20100917
9	Rna Abdel Gabbar Eltyeab Babiker	SUST	Lecturer	Plant Science	20110605	20110904
10	Tagelsir El Haj	GSMAI	Extension Officer	Agricultural Extension	20120303	20120311
11	Reem Hassan Ishag Algaddal	SUST	Technician	Plant Science	20130602	20130901

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### Annex 8: List of Counterpart Personnel

Sl.	Name	Affiliation	Position	Period of Assignment				Remarks
				From		TO		
				Year	Month	Year	Month	
1	Abdel Gabar Eltayeb Babiker	SUST	Professor	2010	3	To date		Project Manager
2	Samia Osman Yagoub	SUST	Assistant Professor	2010	3	2012	8	Project member
3	Amani Hamad Eltayeb Hamad	SUST	Lecturer	2010	3	To date		Project member
4	Mutasim Mekki Mahmoud El Rasheed	SUST	Assistant Professor	2010	3	To date		Project member
5	Rna Abdel Gabbar Eltyeab Babiker	SUST	Lecturer	2010	3	2013	8	Project member
6	Ahmed Elawad Elfaki	SUST	Associate Professor	2010	3	To date		Project member
7	Mohammed Mahgoub Hassan Amir	MSC	Researcher	2010	3	To date		Project member
8	Yousif Mohamed Ahmed Idris	SUST	Professor	2010	3	2012	12	Project advisor
9	Salah-Eldin Sid Ahmed Ahmed	SUST	Professor	2013	1	To date		Project Director
10	Ahmed El Sadig Mohamed Saeed	SUST	Associate Professor	2010	3	To date		Project advisor
11	Tagelsir Ibrahim Mohamed Idris	SUST	Professor	2010	3	To date		Project advisor
12	Mahdi Abbas Saad Shakak	SUST	Associate Professor	2010	3	To date		Project advisor
13	Nagat El Moubarak El Tayeb	MFNE	Director	2010	3	To date		Project advisor
14	Abdallah Mudawie	GSMIAI	Director	2010	12	2012	4	Project advisor
15	Hgir Ahmed Ibrahim	GSMIAI	Director	2012	5	To date		Project advisor
16	Tagelsir El Haj	GSMIAI	Extensionist	2012	12	2012	3	Project advisor
17	Khalafalla Ahmed Ibrahim	ARC	Director	2012	5	To date		Project member
18	Ayman Awad	ARC	Researcher	2010	12	To date		Project member
19	Lutfi Abdel Rahaman Yousif	ARC	Researcher	2012	5	To date		Project member
20	Osman Abdelrahman	ARC	Researcher	2010	12	2012	8	Project advisor
21	Tilal Musa	ARC	Researcher	2013	1	To date		Project member
22	Yassin Mohamed Ibrahim(Dagash)	SUST	Professor	2010	3	To date		Project advisor
23	Mohammed Badwi Hussein	SUST	Associate Professor	2010	3	To date		Project advisor

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## Annex 9: List of Research Papers and Presentations by Sudanese Research Team Members

### <Research Papers>

1. Abdelhalim T. S., Finckh M. R., Babiker A. G. T., Oehl F., 2013, Species composition and diversity of arbuscular mycorrhizal fungi in White Nile state, Central Sudan. Archives of Agronomy and Soil Science, 60, 377-391.
2. Abdelhalim T. S., Finckh M. R., Butz A., Babiker A. G. T., 2013, Influence of root and stem exudates of tomatoes infected by different *Glomus* species on germination of *Phelipanche ramosa* L. Pomel in vitro. Global Journal of Plant Ecophysiology, 3, 44-51.
3. Hassan M. M., Abdel Gani M. E., Babiker A. G. T., 2013, Control of *Striga hermonthica* on sorghum inoculated with fenugreek (*Trigonella foenum-graecum*) seeds powder. Journal of Current Research in Science, 2013, 583-587.
4. Hassan M. M., Daffalla H. M., Modwi H. I., Osman M. G., Ahmed I. I., Abdel Gani M. E., Babiker A. G. T., Effects of fungal strains on seeds germination of millet and *Striga hermonthica*. Universal Journal of Agricultural Research, 2, 83-88.
5. Hassan, M.M., Daffalla, H.M., Yagoub, S.O., Osman, M.G., Agdelgani, M.E., Babiker, A.G.T. (2012). Studies on allelopathic influence of some plants on sorghum and *Striga hermonthica* (Del.) Benth. seed germination and seedling growth. Journal of Science, Technology and Environment, 1:127-139.
6. Hassan, M.M., Daffalla, H.M., Yagoub, S.O., Osman, M.G., Elhadi, E.A., Agdelgani, M.E., Babiker, A.G.T. (2012). Allelopathic Effects of Some Botanical Extracts on Germination and Seedling Growth of Sorghum bicolor L. Journal of Agricultural Technology, 8(4):1423-1469.
7. Hassan, M.M., Osman, M.G., Yagoub, S.O., Sherif, A.M., Rugheim, A.M.E., Mohamed, I.S., Agdelgani, M.E., and Babiker, A.G.T. (2012). Effects of bacterial strains and chicken manure on *Orobanche crenata* infesting faba bean. International Journal of Applied Science and Technology, 2(1): 122-129.
8. Hassan, M.M., Agdelgani, M.E., and Babiker, A.G.T. (2011). InVitor Evaluation of Some Soil Rhizosphere Bacteria for Biological Control of *Striga hermonthica* (Del.) Benth. International Research Journal of Applied and Basic Sciences, 2(2): 40-50.
9. Hassan, M.M., Agdelgani, M.E., and Babiker, A.G.T. (2011). Effects on Bacterial Strains and Isolates on in situ Germination, Subsequent Developmental Stage of *Striga Hermonthica* onto Sorghum Roots. Advances in Environmental Biology, 5(10): 3263-3269.
10. Hassan, M.M., Osman, M.G., Mohammed Ahmed, Abdalaleem, Kh.G., Agdelgani, M.E., and Babiker, A.G.T. (2011). Tissue Culture Techniques as New Approach to Combat *Striga hermonthica*. Advances in Environmental Biology, 5(8): 2122-2128.
11. Hassan, M.M., Abdelhalim, T.S., Yagoub, S.O., Osman, M.G., Agdelgani, M.E., Babiker, A.G.T. (2011). Effects of Arbuscularmycorrhiza Fungi (Amf), Plant Growth Promoting Bacteria (PFPR) and Interaction on *Striga hermonthica* Management in Sorghum. International Journal of Agriculture: Research and Review. Vol. 1(3), 107-115.
12. Hassan, M.M., Sugimoto, Y., Babiker, A.G.T., Yamauchi, Y., sman, M.G., Yagoub, S.O. (2010). Effect of NaCl on *Orobanche* spp and *Striga hermonthica* seeds germination during and after conditioning. Bioscience Research, 7(1): 26-31.
13. Hassan, M.M., Yagoub, S.O., Gabouch, N.A. (2010). Effect of different levels of organic manure on *Striga hermonthica* (Del.) Benth. and sorghum growth. Bioscience Research, 7(1):32-38.
14. Hassan, M.M., Agdelgani, M.E., Babiker, A.G.T., and Osman, M.G. (2010). Effect of *Klebsiella* Spp. and Different Ethylene Inhibitors on *Striga hermonthica* Benth. (Del.) Seeds Germination. Asian Journal of Agricultural Sciences, 2(3):94-98.
15. Hassan, M.M., Osman, M.G., Fatoma, A.M., Elhadi, E.A., and Babiker, A.G.T. (2010). Effect of Salinity on *Striga hermonthica* Seed Germination and Incidence on Infested Sorghum. Current Research Journal of Biological Sciences. 2(3): 210-213.

### < Presentations >

1. Suha Hassan Ahamed et al., Arbuscular mycorrhizal fungi (AMF) and *Bacillus megatherium*, a phosphorus solubilizing bacteria (BMP) for control of the root parasitic weed *Striga hermonthica* (Del.) Benth on sorghum. 8th International Conference on Plant Protection in the Tropics, Kuala Lumpur, Malaysia (2014 April)
2. Rashida Mohammed Ahamed Abusin et al., Effects of chlorsulfuron and nitrogen on *Striga* incidence and sorghum yield. 8th International Conference on Plant Protection in the Tropics, Kuala Lumpur, Malaysia (2014 April)
3. Rashida A., Alfatih A., Babiker A. G. T., Effects of chlorsulfuron and nitrogen on *Striga* incidence and sorghum growth and yield. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
4. Amani A., Hamid S. A., Babiker A. G. T. Effects of seed placement in soil on virulence of *Orobanche crenata* on Faba bean. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
5. Hassan M. M., Abdelgani M. E., Osman A. G., Rugheim A. M., Babiker A. G. T., Biological control of *Striga hermonthica* by soil microorganisms. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
6. Rna A. G. B., Dagash Y. M., Elhoussein A. A., Abdel Elhalim T. S., Babiker A. G. T., *Fusarium brachygibbosum* a plausible candidate for deployment as a bioagent for *Striga hermonthica* management in Sudan. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
7. Yahia M. A., Hassan M. M., Ali T. E., Rugheim A. M., Osman A. G., Abdelgani M. E., Babiker A. G. T., Fungi as candidates for biological control of broomrape (*Phelipanche ramosa* L.) in tomato (*Solanum lycopersicon*). The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
8. Tilal S. A., Babiker A. G. T., Finckh M. R., Arbuscular mycorrhizal fungi have the potential to reduce infection caused by the parasitic weed *Phelipanche ramosa* L. (Pomel) in tomato. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
9. Khogali I. I., Zeyar R. K., Babiker A. G. T., Influence of root exudates of *Desmodium* sp on *Striga hermonthica* (Del.) Benth and *Orobanche ramosa* L. germination. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
10. Tilar S. A., Babiker A. G. T. Hiba A. A. Finckh M. R. Effects of powder and aqueous extracts of *Euphorbia hirta* on *Phelipanche ramosa* germination and haustorium inhibition. The 3rd Pest Management Conference of the Sudan, Wad Medani, Sudan (2014 Feb).
11. Babiker A. G. T., Sugimoto, Y.: The project on improvement of food security in semi-arid regions of Sudan through management of root parasitic weeds: An introductory note on project activities, International Seminar on SATREPS Project for *Striga* Management (2012Sep23, Khartoum, Sudan)
12. Hassan, M. M., Yamauchi, Y., Sugimoto, Y.: *Orobanche minor* germination and interaction with red clover, International Seminar on SATREPS Project for *Striga* Management (2012Sep23, Khartoum, Sudan)
13. Rna Babiker, Yamauchi, Y., Sugimoto, Y.: Isolation of ACC synthase gene from *Striga gesnerioides*, International Seminar on SATREPS Project for *Striga* Management (2012Sep23, Khartoum, Sudan)
14. Amani, H. E., Sugimoto, Y.: Bioassay-guided purification of germination stimulants produced by sasame, International Seminar on SATREPS Project for *Striga* Management (2012Sep23, Khartoum, Sudan)
15. Rashida A., Alfatih A., Babiker A. G. T., Effects of triclopyr and nitrogen on *Striga* incidence and sorghum growth and yield. Annual Conference on Tropical and Subtropical Agricultural and Natural Resource Management, Göttingen-Kassel/Witzenhausen, Germany (2012 Sep).
16. Elrasheed, M., Iba, H., Sakamoto, K.: Empowering peasant women farmers in Sudan: potential and challenges through development of weed control techniques, Annual Meeting of Rural Sociological Society (2013 Aug)
17. Mutasim Elrasheed, Kiyohiko SaKaMoTo, Haruhiko Iba, Challenges for Farmers Field School in Sudan: Towards Participatory Synthesis of Traditional Practices and Modern Knowledge for Sustainable Farming and Livelihood, XVIII International Sociological Association, World Congress of Sociology, Yokohama, Japan (2014 July)

## Annex 10: Measures Taken to Respond to the Recommendations at the Mid-term Review

Recommendations	Measures taken
<p><b>(1) Revision of Master Plan</b></p> <p>Amendment on the project activities was discussed and agreed at JCC in December 2011 in accordance with the Master Plan, Annex 1 of the Record of Discussion signed on 10<sup>th</sup> Nov. 2009. The PDMe (Annex 1) including the revised narrative summary and objectively verifiable indicators were used for this Mid-term Review Study and the team suggests that the JCC approve it as PDM version 2 at the next meeting so that the Project can utilize it as the basic plan for the project activities and monitoring their progress.</p>	<p>The revised Master Plan as summarized as PDMe was duly approved as PDM version 2 at the JCC meeting held on December 25, 2012.</p>
<p><b>(2) Utilization and maintenance of equipment for research</b></p> <p>A number of research equipment was provided by JICA and Sudanese researchers were given training on its proper utilization, maintenance and management. Nevertheless, some of the equipment has not been utilized effectively somehow probably due to its complicated operational procedures and sophisticated machinery. Therefore, the Team recommends that the Project provide further opportunities of trainings to the C/Ps so as to facilitate its utilization.</p> <p>In terms of maintenance, it is advised that the Sudanese side, especially SUST, to secure funds and establish a mechanism for maintenance and service of the equipment in order to keep research activities even after the completion of the Project.</p>	<p>The Project has provided guidance on the basic operations and maintenance of the equipment. In addition to the researchers, one of the technicians of the <i>Striga</i> Research Laboratory participated in the training in Japan in 2013, which contributed to the further technology transfer particularly in this regard. These training in Japan were effectively augmented by the dispatch of a Japanese expert at three and six months after the training to provide follow-up guidance in the <i>Striga</i> Research Laboratory.</p>
<p><b>(3) Capacity Development for Output 1</b></p> <p>The progress of the Project was positively acknowledged, however, it is considered indispensable for the Project to encourage the Sudanese researchers to put the research results into shape such as scientific papers in order to ensure the sustainable progress towards the Project Purpose. The Japanese experts, usually heavily engaged in their respective domestic duties, are also expected to provide proper instruction or guidance on research activities before and after their trip employing electronic communication tools to further develop the capacity of the Sudanese researchers.</p>	<p>One young researcher per year participated in the JICA training course on Integrated Pest Management (IMP) over the years from 2010 to 2013, upon which the young scholars had opportunities to be guided by the Japanese researchers in Japan. In Sudan, at the <i>Striga</i> Research Laboratory, many graduate students were also involved in the Project who could also be guided by the Project team members. By the time of the Study, 17 research papers were published and 17 presentations were made by the Sudanese researchers. Unfortunately, two young researchers have left <i>Striga</i> Research Laboratory in 2012.</p>
<p><b>(4) Enhancement of smooth implementation of the activities for Output 2</b></p> <p>The Local Committee for FFS was established in Gedaref in April 2011 and has been implementing activities based on the formulated curriculums, which was summarized in the report on 2011. Subsequently, the Project is now expected to monitor the activities and share the conditions among the personnel concerned. Such a monitoring mechanism is believed to facilitate its smooth implementation and securing budget. Japanese expert(s) may help to promote the activities on Subject 7 as well as Subject 8.</p>	<p>There has been a Japanese researcher joined the research on Subject 7 since 2012, in close collaboration with the Sudanese researchers who had worked on the subject since the beginning of the Project. However, it should unfortunately be admitted that the activities on Subject 8 were mostly carried out by the Sudanese team members while the Japanese researcher who has been stationed in SUST for longer period of assignment occasionally took part in a part of the monitoring.</p>

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## 2. 日本側・スーダン側課題担当分野リスト

### 日本側・スーダン側担当課題リスト

#### **成果 1：革新的ストライガ防除技術が開発される**

##### 課題 1：新規自殺発芽誘導物質の開発

###### 【日本側】

神戸大学大学院：杉本幸裕 教授、滝川浩郷 教授、佐々木満 名誉教授、  
鮫島啓彰 学術推進研究員、中嶋瞳 学術推進研究員

###### 【スーダン側】

スーダン科学技術大学：Abdel Baiker 教授

##### 課題 2：ストライガ防除微生物の探索

###### 【日本側】

神戸大学大学院：久世雅樹 准教授

###### 【スーダン側】

科学コミュニケーション省：Mohammed Hassan 研究員  
スーダン科学技術大学：Reem Hassan Algaddal 技術職員  
農業研究機構：Tilal Musa 研究員

##### 課題 3：選択的除草剤の探索

###### 【日本側】

大阪大学大学院：岡澤敦司 准教授

###### 【スーダン側】

スーダン科学技術大学：Abdel Baiker 教授

##### 課題 4：宿主養水分収奪機構の解析

###### 【日本側】

神戸大学大学院：山内靖雄 助教授  
鳥取大学乾燥地研究センター：井上知恵 プロジェクト研究員

###### 【スーダン側】

スーダン科学技術大学：Amani Hamad 講師、Ismail 技術職員

##### 課題 5：イネ・ソルガムのストライガ抵抗性と環境適応性の評価

###### 【日本側】

神戸大学大学院：鮫島啓彰 学術推進研究員、吉本千壽 技術補佐員

###### 【スーダン側】

スーダン科学技術大学：Amani Hamad 講師、Ismail 技術職員

## 課題 6：抵抗性／耐性作物の選抜と新規輪作体系の考案

【日本側】

神戸大学大学院：久世雅樹 准教授

【スーダン側】

スーダン科学技術大学：Abdel Baiker 教授、Mutasim El Rasheed 助教授、  
Ismail 技術職員、Reem Hassan Algaddal 技術職員  
農業研究機構：Ayman Awad 研究員

## 成果 2：農民のストライガ管理慣行が改善される

## 課題 7：新技術受容性と生産者・消費者の嗜好の調査

【日本側】

神戸大学大学院：伊庭治彦 准教授

【スーダン側】

スーダン科学技術大学：Mutasim El Rasheed 助教授

## 課題 8：ストライガ対処法の共有に向けた農民学校の実施

【スーダン側】

ガダーレフ州農業・灌漑省：Hgir Ibrahim 氏

スーダン科学技術大学：Abdel Baiker 教授

農業研究機構：Khalafalla Ibrahim 所長、Ayman Awad 研究員、Lutfi Yousif 研究員

Organization Chart of Sudan University of Science and Technology

