The Republic of the Sudan

The National Center for Research (NCR)

地球規模課題対応国際科学技術協力（SATREPS）

The Project for development of counter measures against Striga to conquer poverty and improve food security in the Republic of the Sudan

Project Completion Report

July 2023

JAPAN INTERNATIONALCOOPERATION AGENCY

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Project Completion Report on the Project for development of countermeasures against Striga to conquer poverty and improve food security in the Republic of the Sudan

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I. Basic Information of the Project

1. Country: The Republic of Sudan

2. Title of the Project: Developing Countermeasures against Striga to conquer poverty and improve food security in Sudan

3. Duration of the Project (Planned and Actual)

2017/7/31 – 2022/7/30 (Planned)

2017/7/31 – 2023/3/31 (Actual)

The project was originally planned for the period of five years from July 31, 2017 to July 30, 2022. Due to problems caused by COVID-19 epoch, the National Center for Research (NCR) requested a two-years extension of the project in February 2021. Following the SATREPS regulation, the Japanese leader submitted a request letter of extension to JST on June 21. The request was approved by JST on October 18, 2021 and by JICA on January 23, 2022. The project period was extended to March 31, 2023.

4. Background (from Record of Discussions (R/D))

The Agriculture of Sudan has some 30% share in the GDP. It contributes about 80% to the non-oil export earnings, and provides 60% of the jobs. While agriculture in Sudan is practiced under both irrigated and rain-fed conditions, 90% of the cultivated area is under rain-fed. Sorghum, a staple food for the majority of people, also providing feed stuff to livestock, is one of the most important crops. However, its yield (0.44-0.78 ton/ha) is largely lower than the international average (1.28 ton/ha) and is declining further. It is reported that the yield decline is more obvious with the mechanized rain-fed system (where water shortage prevails) than the irrigated system, and the issue is a serious one since Sudan derives some 85% of sorghum production from that production system. Researchers also report that the decline in the yield is largely due to the increase of Striga, a root parasitic weed. Therefore, the management of Striga is of an urgent importance for Sudan in terms of livelihoods of subsistence farmers and the national food security. To deal with the problem, Government of Sudan (GOS) requested Government of Japan (GOJ) a technical cooperation project, titled Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds. The project

supported by JICA and Japan Science and Technology Agency (JST), was carried out in 2010-2015 by Sudan University of Science and Technology (SUST) and Kobe University as lead institutes. That project achieved results such as findings of a new chemical agent to induce suicidal germination of Striga, cultural practices to decrease the weed population and selection of Striga tolerant rice varieties.

To further the achievements, the GOS requested GOJ for technical cooperation by a new project with NCR as the implementing agency, supported by Agricultural Research Corporation (ARC), SUST and other relevant bodies from the Sudan side, and Kobe University as the lead institute from the Japanese side. In response, JICA dispatched a detailed planning survey team for discussion and planning of the Project in August-September, 2016.

5. Overall Goal and Project Purpose (from Record of Discussions (R/D))

Overall goal

Dissemination is in progress to control Orobanchaceae weeds including Striga using newly developed technical measures.

Project Purpose

An inter-ministerial structure materializes how to disseminate effective technical measures to control Orobanchaceae weeds including Striga, which are scientifically proved through Sudan-Japan collaboration.

6. Implementing Agency

The project implementing Agencies are as follows:

(1) NCR

(2) ARC

(3) JICA Expert: Researchers of Kobe University and Osaka Metropolitan University (former Osaka Prefecture University)

II. Results of the Project

1. Results of the Project

1-1 Input by the Japanese side (Planned and Actual)

The following are inputs from Japanese side to the Project as of February 2023. The Japanese researchers' visit to Sudan and Dubai, invitation of Sudanese

researchers to Japan and Dubai, and provision of equipment form Kobe University were approximately 40 million Japanese Yen (2017-23), 7 million Japanese Yen (2017-23) and 17 million Japanese Yen (2017-23), respectively.

Planned	Actual
(a) Dispatch of Experts - Long-term expert: 1 Project Coordinator - Short-term expert: Researchers of relevant subjects (including 1 Leader, Natural Product Chemistry, Synthetic Chemistry, Plant Physiology, Crop Science, etc.)	 - Long-term expert: 1 Project Coordinator - Short-term expert: Researchers of relevant subjects 1 Leader, Natural Product Chemist, 1 Synthetic Chemists, 2 Natural Product Chemists 4 Plant Physiologists, 1 Crop Scientist, 1 Microbiologist
(b) Training in Sudan and Japan as adequate	- Training in Sudan So many times in 2017, 2018, 2019, 2022, and 2023, see Annex 1-1. - Training in Japan Magdoline, Rania (2018/11/2-17) Natural Product Chemistry Nadia, Rihab (2019/4/1-5/31) Molecular Biology Rihab, Inas (2022/9/5-12/3) Molecular Biology, see Annex 1-3.
(c) Materials, Machinery and Equipment necessary for the Project	- Materials Chemicals, glassware, rockwool, GF/A, see Annex 1-6. - Machinery Vehicle, tractor, UPS, fume hood, laminar hood, generator, incubator, freezer, centrifuge, water purifier, freeze drier, spectrophotometer, see Annex 1-5. - Equipment microscope, mixer mill, blender, scale, electrophoresis, thermal cycler, see Annex 1-5.

1-2 Input by the Sudanese side (Planned and Actual)

Planned/Actual

As planned NCR in cooperation with relevant organizations provided the following :

(a) Services of counterpart personnel and administrative personnel as referred to in II-2 (Implementation Structure);

- Expenses for accommodation and travelling to Gedarif state, Gezira state,

River Nile state, Northern state, Blue Nile state and Khartoum state.
(b) Suitable office space with necessary equipment;
- Project Office space in Environment, Natural Resources and Desertification Research Institute (ENDRI).
- Furnished office for lab staff in the main laboratory.
(c) Support for obtaining official resident permit;
- N/A
(d) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
- Equipment were replaced to maintain convenient set up for lab arrangement.
- Maintenance of vehicles (ARC) for field work.
- Supply of field tools.
- Supply of equipment (refrigerator, laminar hood, incubator, microwave and pH meter).
(e) Facilitation for transport of the JICA experts for official travel within Sudan, such as issuing travel permit;
- Permission letters for official travelling to Gedarif state, Gezira state and River Nile state were issued.
- Approval for business trips for project coordinator and activity leaders.
- Exemption of JICA experts for foreign registration requirements and consular fee.
(f) Information as well as facilities in obtaining suitable furnished accommodation for the JICA experts and their families;
- N/A
(g) Information as well as support in obtaining medical service;
- Information on medical centers and centers for COVID vaccination was provided.
(h) Credentials or identification cards;
- N/A
(i) Available data (including maps and photographs) and information related to the Project;
- Reports, maps of the Sudanese states, photographs related to Striga and photographs of the visits by researchers' teams to demonstration trials, field experiments and meeting with project relevant authorities were provided. All the information and data that were required for publication of JICA annual Report

and Project brochure were also provided.
(j) Running expenses necessary for the implementation of the Project;
- Consumables as chemical reagents and glassware, hotel expenses outside Khartoum were covered, in addition to other expenses necessary for the implementation of the project such as utilities (electricity, fuel in Gedarif, and internet cost). Payment for Sudanese labors and technicians was also covered.
(k) Expenses necessary for transportation within Sudan of the equipment referred to in II-5 (1) as well as for the installation, operation and maintenance thereof; and
- Expenses necessary for transportation of equipment from Khartoum airport to the laboratory, tractor license, and maintenance of refrigerator, laminar hood, and centrifuge were covered.
- Custom clearance, transportation and maintenance responsibility for the equipment, in addition to equipment management after project termination (Annex 7-5) are also covered.
(l) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Sudan from Japan in connection with the implementation of the Project.
- A list of local companies was provided to facilitate the technical inspection (custom administration) for equipment imported by the local companies. Exemption of the provided equipment from customs duties and fiscal charges was issued. Cash receipt or payment receipt voucher was provided whenever was required.

Inputs from the Sudanese side to the Project are as described below.

Budget allocated by the government of Sudan during the project terms up to February 2023 was 22,300.00 SDG, 14,300.00 SDG from Ministry of Finance, 8,000.00 SDG from Ministry of Higher education and Scientific Research.

Components	Inputs
Allocation of Counterpart Researchers	Counterpart personnel - Project Director-Director General NCR - Project manager, weed scientist - Researchers (NCR: 17 persons and ARC: 7 persons) in relevant subjects, weed science, microbiology, biochemistry, soil science, agronomy. - Extension Staff

Facilities, Equipment and materials	- Office space in ENDRI - Furnished office for lab. staff. - Research space in Central lab, ENDRI - Research space in Main lab, NCR - Research space in New lab, NCR - Research space in MAPRI lab, NCR - Existing equipment for research activities (see Annex 1-8)
Local cost	Amount at NCR: 22,000,000 SDG

1-3 Activities (Planned and Actual)

Planned and Actual as planned, with delay and failure to complete as described below and in Section 2.

Activity 1 Development and verification of suicidal germination agents on Striga and Orobanche

This activity was conducted satisfactorily with fruitful results described in Section2.

Activity 2 Development of germination inhibitors for root parasitic weeds

The activity was conducted as planned and further information about structure-activity relationship was revealed during the extension period.

Activity 3 Demonstration of microorganisms to control germination of Striga

This activity was conducted satisfactory and very fruitful results were obtained reflecting the efficient application of microorganism in reducing striga and increasing crop performance.

Activity 4 Verification of stability and durability of Striga-resistance in rice

This activity was given up with two major reasons.

1) Import of rice seeds to Sudan was not achieved due to lack of reliable information about necessary procedures.

2) Stable water supply to the experimental field in Shambat was not achieved, resulting in wilting rice and Striga plants.

Activity 5 Identification of useful substances in Striga that will encourage farmers to remove and utilize the weed

This activity partially reached its goal by identifying several flavonoids from Striga leaves.

Activity 6 Dissemination of Striga control measures through Farmers Field Schools

This activity was achieved satisfactorily by demonstrating the positive effects of the ISM package to manage Striga and disseminating the technology through FFSs.

Activity 7 Establishment of a functional implementation structure to forward Striga control measures by Sudan's lead

Inter-ministerial committee is issued by the Minister of Higher Education and Scientific Research. The committee is composed of 20 representatives of the relevant institutes concerned with research, dissemination, technology transfer and funding, in addition to farmers' society and agricultural companies. The objectives of this committee are to follow up the implementation and dissemination of the project outputs to ensure sustainability based on the scientific and practical achievement.

2. Achievements of the Project

2-1 Output and Indicators

2-1-1 Output 1

Outputs and indicators are as described below.

Innovative technical measures to control Striga are developed by Sudan-Japan collaboration.	
For Activity 1. Development and verification of suicidal germination agents on Striga and Orobanche	
Indicators	Achievement
1-1 Suicidal germination inducers to control Striga are evaluated	This activity was satisfactorily carried out with the following reasons. - Work at Kobe University, showed that T-010 is adequately active. - Further, research conducted at Shambat Research Station of ARC showed that the stimulant resulted in adequate reduction in Striga emergence under greenhouse and field conditions. - Effects of repeated application on efficacy of T-010 using bathtubs showed that emergence of *S. hermonthica* was delayed and reduced. - No clear discretion could be made in emergence of the parasite in bathtubs treated with T-010 once, twice or thrice. - Unrestricted Striga parasitism reduced sorghum shoot height by 10-36% and shoot dry weight by 42-63%.
1-2 Suicidal germination approach to control Orobanche is applied	This activity was behind the original plan because manipulation of germination stimulant production by Orobanche host plant was prioritized to development of germination stimulants for Orobanche. After success of the manipulation of stimulant production, the project embarked on the study on effects of suicidal germination approach to control Orobanche. Effects of the suicidal germination approach are undertaken at Shambat station. Further compounds were synthesized and

	tested, but more practical compound than T-010 was not developed.
For Activity 2. Development of germination inhibitors for root parasitic weeds	
2-1 Planteose metabolism inhibitors and cytokinin oxidase inhibitors are developed	This activity was satisfactory caried out as follows. - OmAGAL2 which is the enzyme catalyzing the first step of planteose metabolism was identified at the molecular level. - Twenty-eight compounds including PI-28 were screened as OmAGAL2 inhibitors from a chemical library composed of 15,000 compounds. - Several PI-28 derivatives were developed, which exhibited higher inhibitory activity toward *Orobanche minor* radicle elongation than PI-28.
2-2 The effects of the inhibitors on Striga control are examined	This activity was satisfactory caried out as follows. - Potentialities of a range of microbial isolates collected in Sudan as Striga germination inhibitors and promoters were recorded.
For Activity 3. Demonstration of microorganisms to control germination of Striga	
3-1 The performance of the microorganisms that influence Striga germination revealed by the previous project (SATREPS 1) is verified	- The activity was successfully accomplished. - Nitrogen fixers (*Azospirillum brailense*), *Azotocater* spp, *Pseudomonas putida*, P solubilizers *(Bacillus megaterium* var phosphaticum)(BMP), mycorrhiza (*Glomus* sp.) and their combinations were tested against Striga in sorghum both in laboratory and green house proved to be efficient. - The bacterial isolates and strains reduced Striga germination by 45-77%.
3-2 Active metabolites of the microorganisms are identified	This activity was satisfactorily performed. - One compound that inhibits seed germination of *O. minor* and a putative compound that promotes seed germination of *O. minor* by acting in concert with a synthetic strigolactone was identified. - Potential microbes for control of *O. minor* on red clover were found. - Research technology in applied microbiology has been transferred to two young Sudanese researchers.
3-3 Arbuscular mycorrhizal fungi species and isolates are screened	This activity was satisfactory carried out as follows: - Application of the *Trichoderma*, BMP each alone or in combinations in *S*. *hermonthica* on sorghum was accomplished. - In a greenhouse experiment, AMF isolates, reduced Striga emergence by 53-89% and improved sorghum height by 17-46%. - In field experiment sorghum intercropped with cowpea and inoculated with AMF or Trichoderma reduced Striga infestation by 85-78%, respectively as compared to the control. However sole crop treated with AMF or Trichoderma reduced Striga infestation by 65-60%, respectively as compared to the corresponding control.

	- With respect to yield, sorghum inoculated with the combination of AMF+*Trichoderma* increased sorghum yield 3.5 and 3 fold in intercropped and sole crop, respectively.
3.4 The performance of the microorganisms on *P. ramosa* in tomato is verified	- Laboratory and greenhouse experiments were accomplished. Potential microbes and resistant cultivars on *Phelipanche ramosa* in tomato and *O. minor* in red clover were reported to be efficient.
3.5 bacteria and fungi, resistant cultivar, and pursuit on *Orobanche crenata* in faba bean incidence, are corroborated on field	- *Trichoderma* sp. and their combinations with bacteria strains (BMP and Rhizobium) were tested against Orobanche in faba bean both in green house and field and proved to be efficient. - The greenhouse experiments, showed that *T. harzianum* and imazethapyr significantly reduced *O. crenata* emergence (82 and 89%, respectively) and increased faba bean biomass and plant height in comparison to the infested un-inoculated un-treated control. BMP, TAL1399 significantly increased plant height, faba bean biomass, number of nodules and decreased *O. crenata* emergence in comparison to the infested control. - *Trichoderma* sp.; BMP and Rhizobium, resistant cultivars and the herbicide pursuit each alone or in combinations were tested against Orobanche in faba bean were evaluated both in closed field, proved to be efficient.
For Activity 4. Verification of stability and durability of Striga-resistance in rice	
4-1 Stability and durability of resistance of the rice cultivars identified by SATREPS I are investigated	- This activity was given up because stable water supply to the experimental field in Shambat was not achieved, resulting in wilting rice and Striga plants. - For future research, Striga plants were grown on NERICA4 in pots and seeds were collected.
4-2 The effects of the Striga seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition	- This activity was given up because import of rice seeds to Sudan was not achieved due to lack of reliable information about necessary procedures.

2-1-2 Output 2

Outputs and indicators are as described below.

Useful substances that will encourage farmers to weed and utilize are identified in Striga.	
For Activity 5. Identification of useful substances in Striga that will encourage farmers to remove and utilize weed	
5-1 An ethnobotanical survey on indigenous knowledge of purported medicinal uses of	- Ethnobotanical survey was achieved as planned. The survey found that in some parts of Africa, as well as in Sudan, the plant has been used in folk medicine for years to treat many ailments, such as leprosy,

Striga is undertaken	leprous ulcers, pneumonia, and fungal infections, and has anti-spasmodic activities.
5-2 A bioassay-guided fractionation of active ingredients is undertaken	- Four compounds were isolated from dried leaves of Striga hermonthica, as major ingredients. Bioactivity-guided fractionation was not achieved.
5-3 The active compound is characterized	- The isolated metabolites were identified as chrysoeriol, apigenin, apigenin 7−*O*−β−glucoside, luteolin. Some of the flavonoids were reported to have anti-mutagenic and anti-cancer activities.
5-4 The metabolites specifically accumulated in Striga before flowering are identified by conducting metabolome analyses of young and flowering Striga plants	- Metabolome analyses of Striga leaves were conducted, suggesting that the leaves contain metabolites of commercial value.

2-1-3 Output 3

Outputs and indicators are as described below.

The improved cultural practices to control *Striga* are being disseminated.	
For Activity 6. Dissemination of *Striga* control measures through Farmer Field Schools	
6-1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treated with acetolactate synthase inhibiting herbicides is corroborated on farm	- Farmers' Field Schools (FFS) were successfully transferred the effective Integrated Striga Management (ISM) to the farmers and improved sorghum productivity. In each FFS demonstration field in a two-course rotation (sorghum/trap crop) was conducted. - Other implemented ISM practices include water harvesting in low rainfall areas (North Gedarif), sowing of striga tolerant sorghum variety, fertilizer (urea at 40 kg/fed) were applied at sowing and the herbicide chlorsulfuron at 1.0 g a.i/fed was applied as soil directed spray 3-4 weeks after sowing sorghum. - FFS activities at 10 locations at North and Central Gedarif districts were established. Area and number of participants in each FFS site are varied from 4 to 10 feddan and from 13 to 25 farmers, respectively.
6-2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on farm	- Laboratory and greenhouse results of the effects of intercropping sorghum with leguminous crops inoculated with microorganisms on Striga management and sorghum growth and yield were evaluated under field conditions at Gedarif. Sorghum inoculated with the combination of *Trichoderma*+ BMP+*A. brasilenses* showed the lowest Striga emergence as compared to the control. However, the combination of *Trichoderma*+BMP significantly increased sorghum yield (1.7 fold) as compared to the control.

6-3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm	- Approaches for the analysis of yield data obtained from FFS sites were discussed at the face-to-face meeting. - FFS demonstration fields used two course crop rotation and/or intercropping that consisted of sorghum followed and/or intercropped by a trap crop. - The selection of trap crops was based on laboratory testing of crops that showing their ability to induce suicidal germination of striga seeds without being parasitized.
6-4 The adoption rate and socio-economic impact of the striga management packages are measured	- The purposes of FFS was successful achieved. In the 2018/2019 - 2020/2021 seasons, the FFS were implemented in 2-3 locations per season. - In 2021 and 2022, the FFS were implemented in 10 locations. - Results showed the positive impact of intervention by implementing ISM in lowering Striga damage and increasing sorghum grain yield by 70% to .400% compared to traditional farmers' production methods. - Socio-economic survey showed positive effects of implementing ISM packages in the FFS demonstration fields on increasing gross margin of return in comparison to traditional farming methods. The study also showed that most of the participating farmers are females (89%) and 83% of the participants are young farmers (less than 50 years old). -The actual impact of the applied technology on farmers' lives and poverty reduction was reported in a socioeconomic study (see Annex 7-4).
6-5 Farmer awareness of the parasite is raised by transferring available striga management strategies employing Farmer Field Schools and other media	- Demonstration fields, in which all ISM packages were implemented to display to farmers' suitable production practices for Striga management and improvement of sorghum growth, were successfully established in each Farmers' Field School (FFS). - Directly participating farmers in FFS meet periodically, especially at application of each ISM component. Also from these FFS meetings message was broadcasted in the local media to explain to farmers the importance of the applied ISM package component in managing of Striga and improvement of crop growth and yield. - At crop maturity stages field days were organized in which many farmers from the neighboring villages were invited to see and discuss the impact of applied ISM packages on Striga management and increasing sorghum productivity. Other stakeholders in sorghum production chain had also been invited to the field days to enable farmers to discuss with them availability of inputs required, ways of financing inputs and market opportunities for their products. All participants were amazed at the result of the

	packages - In each FFS around 25 farmers directly participated in the school and many others indirectly participated by attending Field Days, through messages broadcasted in the local mass media or by direct contact of farmer to farmer. - Seminar for farmers was conducted on Oct 13, 2022 at Field Days and 280 farmers including neighbor farmers of FFS participated. The seminar explained to the farmers the whole process of growing sorghum successfully using ISM in Gedarif and the process of marketing project, seeing the difference of the project intervention in Striga management and sorghum yield in of FFS and the neighboring fields.

2-1-4 Output 4

Outputs and indicators are as described below.

An NCR managed structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control and for dissemination and sustainability of successful applications.	
For Activity 7. Establishment of a functional implementation structure to forward Striga control measures lead by Sudanese	
7-1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side	-NCR, ARC and SUST have signed the Collaboration Agreement for Striga Control Measures in 2021 (see Annex 7-1). -The NCR suggested Three Years Action Plan for Striga control measures dissemination. The plan is submitted to Ministry of Finance for budget and 30,000,000 SDG is secured (see Annex 7-2).
7-2 The established implementation structure for Striga control measures is functioning	- Inter-ministerial committee to enforce implementation of innovative technologies during the project duration and after completion is approved and issued by the Minister of Ministry of Higher Education and Scientific Research (see Annex 7-3).

2-2 Project Purpose and indicators

Outputs and indicators are as described below.

An inter-ministerial structure materializes how to disseminate effective technical measures to control Orobanchaceae weeds including *Striga*, which are scientifically proved through Sudan-Japan collaboration.	
1) A functional inter-ministerial structure (as Steering Committee) accepts innovative technologies developed for *Striga* control	- Inter-ministerial Committee has already accepted technologies developed for *Striga* control.
2) Three Years Action Plan is formulated for NCR, ARC and SUST	-The NCR suggested Three Years Action Plan for Striga control measures dissemination. The plan is submitted to

for the collaborative control of Striga through research and dissemination	Ministry of Finance for budget and 30,000,000 SDG is secured - Inter-ministerial Committee (IC) has been established by a decision issued by the Minister of Higher Education and Scientific Research, including membership representatives of all relevant institutions and stake holders. - It is considered as a substantive step forward that will lead to Output-4 of PDM and achievement of the Project Purpose. - NCR also promised to keep vital dialogs with prospective IC members and clarify the roles they would play as agreed upon with other concerned institutions and experts, in particular MoAF to ensure the dissemination and employment of Striga control measures.

3. History of PDM Modification

PDM was officially authorized by the Record of Discussions signed on January 29, 2017 on the project of "Development of Countermeasures against STRIGA to conquer Poverty and Improve Food Security in Sudan", National Center for Research (NCR) of Sudan and Japan International Cooperation Agency (JICA) as version 1. Dr. Zeinab of Project Director, DG of NCR suggested the amendment at the 4th JCC Meeting on July 19, 2022, and agreed to amend Project Design Matrix (PDM). Minutes of Meeting between NCR and JICA has been signed for the amendment of PDM as follows on July 25, 2022.

Original	Amended version
2) Medium-term budgetary plans are formulated for NCR, ARC and SUST for the collaborative control of Striga through research and dissemination. Means of Verification NCR, ARC, SUST and GSMAI documents on Striga control	2) Three Years Action Plan is formulated for NCR, ARC and SUST for the collaborative control of Striga through research and dissemination. Means of Verification NCR, ARC and SUST documents to be submitted to Ministry of Finance.

4. Others

4-1 Results of Environmental and Social Considerations (if applicable)

On April 11, 2019, the president Bashir was overthrown by the military after prolonged protests outside the ministry of defense in Khartoum. The demonstrators stayed outside the ministry and insisted on a swift transfer of authority to a civilian administration. However, on 3 June they were dispersed

by force and many were killed. The Japanese Ministry of Foreign Affairs raised the ‘Sudan’s safety level from Level 1 (Exercise caution) to Level 2 (Avoid non-essential travel) in April and further to Level 3 (Avoid all travel) in June. Since then, visits of the Japanese SATREPS Project researchers to Sudan have been officially barred.

JICA HQs asked Kobe University to keep minimum activities so that the project can move quickly when the Japanese members’ visit to Khartoum becomes possible. In response to the request, Kobe University decided to allocate its budget flexibly to invite Sudanese researchers to Japan or send Japanese researchers and invite Sudanese researchers to Dubai.

Following the establishment of a new support team in Khartoum in March 2020, the Japanese researchers were supposed to resume visits to Sudan. However, all the visits planned in March were canceled due to the Coronavirus outbreak all over the world. To make up for the delay in the original plan caused by the COVID-19 pandemic, the project period was extended to the end of March, 2023. In addition to meetings at Dubai, Japanese researchers’ visit to Sudan resumed in November, 2022. Before JICA decided the extension of the project period, a political turmoil arose in Sudan on 25 October, 2021. JICA requested the Japanese members on 14 November to refrain from contacting the Sudanese counterparts. JICA also requested Kobe University on 17 November to stop procuring equipment for the counterpart. On behalf of Kobe University, JICA Sudan office embarked on the procurement on 2 March, 2022. It took more than 10 months to introduce all items to the main laboratory of NCR.

Environmentally friendly technical package of using soil beneficial microbes is now introduced in the field for evaluation for management of Striga as an attempt to reduce environmental pollution that may take place at different compartments (soil, water, air) as a result of using chemical agricultural inputs.

4-2 Results of Considerations on Gender/Peace Building/Poverty Reduction, Disability, Disease infection, Social System, Human Well-being, Human Right, and Gender Equality (if applicable)

1) After acceptation of new members in JCC on 26th December 2017, percentage of female members became more than 40% (9 female and 13 male members) on the Sudanese side. Currently, more than half of the project core members on the Sudanese side are female, including project director and

project manager.
2) Among the four coordinators joined the former and current SATREPS projects, JICA selected and assigned a female coordinator for the first time, who joined the project in February, 2020.
3) Overcoming poverty and improvement of food security through Striga management are the main goals of the project. Activities VI and VII were designed in line with the goals through a discussion that was made at the 2nd Steering Committee before the official start of the project (July 11, 2017).
4) A socioeconomic study is taking place to assess the actual impact of the applied technology on farmers' lives and poverty reduction.
5) Using soil beneficial microbes that are now introduced in the field for management of Striga is a remarkably low input technology that saves a great deal of farmers' expenditures and hence increasing their returns and improving their livelihoods and social status.

III. Results of Joint Review

1. Results of Review based on DAC Evaluation Criteria

1-1 Relevance

The relevance of the Project is evaluated as extremely high.

Agricultural sector is the most important one in Sudan since it provides staple food for the majority of inhabitants and provides work power as well. Since rain fed sector is the main producer for food and cash crops, the government puts pronounced importance on it and takes serious action towards every source of threat on this sector.

Sorghum, which is the target of this project, is a major crop, and control of the parasite on sorghum is extremely important. In recent years, the parasitism of *Striga* has also been confirmed in wheat, and this project has impacts on other projects.

1-2 Coherence

The coherence of the Project is evaluated as very high.

Management of *Striga* is of an urgent importance for Sudan since it extremely affects livelihoods of subsistence farmers and the national food security in general. That's why the government has allocated remarkable amount of fund

as a local component in a Sudan-Japan collaboration project for the management of Striga and other Orobanchaceae parasitic weeds as well. In addition, Three Years Action Plan was established and fund was secured for it by the Ministry of Finance in order to spread and sustain the employment of Striga management practices all over the country. There was no collaboration with other JICA's projects and other international organizations.

1-3 Effectiveness

The effectiveness of the project is evaluated as High.

The outputs and the project purpose has been almost 100% achieved. The project members have done a lot in terms of research, technical transfer and capacity development, under difficult situations from the political and hygienic points of view. Project goals were mostly achieved.

1-4 Efficiency

The efficiency of the project is evaluated as high.

Due to the spread of COVID-19 pandemic significantly suppressed the Project activities, the project period has been extended by 8 months. During the extended period, the procured equipment which had been postponed and Farmers Field School were achieved. If the equipment was provided more smoothly, the project secured more time available for technical transfer. Project costs were within budget.

1-5 Impact

The impact of the Project is evaluated as very high.

Overall Goal is that Dissemination is in progress to control Orobanchaceae weeds including Striga using newly developed technical measures. NCR has always continued research on Striga Control and has explained its importance in Sudan. Collaboration agreement has been signed with NCR, ARC, and SUST in 2021. In Oct 2022 the International Committee, a cross ministerial organization for Striga Control has been established with the approval of the Ministry of Higher Education, and the Ministry of Agriculture, Ministry of Finance and two private companies (Arab Sudanese Seed Company and CTC Group) have agreed. Even after the end of the project, NCR will continue to disseminate effective measures against Striga in Sudan.

1-6 Sustainability

The sustainability of the Project is evaluated as very high.

In order to continue the research work on Striga Control, NCR has applied to the Ministry of Finance for a three-years budget after the end of the project, which has been approved in Oct 2022. The implementing agencies for the sustainability of the project effects are NCR, ARC and SUST.

Regarding the sustainability of the project's effect on Striga control, aim to expand the scope of research not only to sorghum but also to grains such as rice, wheat and millet, and to develop a Striga Control Package that can be used in regions other than Sudan.

NCR staff trained in Japan have the skills to use the research equipment installed and continuously make use of them.

2. Key Factors Affecting Implementation and Outcomes

In April 2019, Sudan's long-term dictatorship of Bashir, which had lasted for about 30 years collapsed in the wake of citizen demonstrations. Due to the deteriorating security situation associated with this, the Project Coordinator had been absent until September, after which he returned to Japan due to the termination of the contract. Despite the absence of the Project Coordinator, NCR has continued our lab experiments and FFS activities in small scale. The 2nd Project Coordinator arrived in February 2020, and just when we thought the project would finally resume, COVID-19 has spread globally from March 2020, the Project Coordinator temporarily returned to Japan in April to resume activity stopped. During these periods, we could not purchase the necessary reagents or make a necessary business trip without project budget, so we managed to continue our activities with local components. Even in such worst conditions, we have continued lab experiments and FFS activities, and finally achieved our goal in the final year of the project.

3. Evaluation on the results of the Project Risk Management

3-1 Revolution

Researchers did their activities as usual when there was no demonstration, however, when there was an announcement for demonstration, researchers came very early morning and took the data or observations and went back homes before the closure of the streets and bridges by military in the mid days. Researchers that are living in more safe areas where there was no mobility

restriction, or nearby to the laboratories and the experimental farm, they used to come and did all the planned work for most of the activities. Researchers also worked from homes e.g. discussions and meeting virtually or by phone calls whenever was possible and the internet was available. The early preparation of electrical generator helped to execute the research activities and to overcome problems of electricity supply instability.

3-2 COVID-19

The Medical Health Authority officials in Khartoum state accepted the request of NCR General Director for permission to work during the period of lockdown. Therefore, Researchers executed their work following the precautions for COVID-19 and all steps to protect themselves and others. NCR facilitated and accelerated the vaccine delivery to the staff.

3-3 Political Turmoil

After political turmoil in 25th of October 2021, all ministers and executive officials were changed, the NCR Director General and the Project manager met the appointed Minister in charge of Higher education and scientific research and officials in charge of Ministry of Finance and introduced to them the project objectives and activities and challenges facing the project. Due to the degrading Sudanese economy, NCR was not able to get the full local component from the Ministry of Finance. Nevertheless, the NCR, relying on its resources, was able to complete the laboratory refurbishment and keep the project running; Also, NCR received a budget from The Ministry of Higher Education and Scientific Research to meet the expenses of the project.

4. Lessons Learnt

Though project researchers had faced many difficulties, SATREPS collaboration research work was excellent and produced very precious and valuable results not only in Sudan but also in Africa. Mutual interest between the involved institutes of the project, collaboration and proper coordination lead to the successful achievement. This positive effect of the project will promote the counterparts collaborative research in the near future.

During the project period, JCC meetings were held annually in Khartoum, and virtually during lockdown. These meetings were so effective to keep good communication and mutual understanding between researchers

involved in the different project activities from the different institutes. It was noticed that face-to-face meetings in a third country such as Dubai, UAE were valuable opportunities to promote the project under difficult situations.

Description of the project activities and results in the organized national seminars which had been attended by relevant ministries, universities, farmers union and private sectors, was very helpful in distributing the knowledge and the magnitude of the Striga problem. Also, organized seminars in states where the parasitic weeds are in problem maximized the benefit of the project outcomes.

Open access facilities of Striga Research Laboratory are certainly expected to be very effective to researchers in the different institutes of NCR and other relevant institutes and universities.

5. Performance

Research on natural enemies was more or less confined to insects and pathogens, however work on suppressive soils should be intensified and could be merged with the emerging approach of increasing virulence of bioagents. In essence infection by parasitic Orobanchaceae is a symptom of an ailing soil and replenishment of soil health through promotion of proliferation of beneficial soil microbes is paramount to increased crop productivity and improved quality, Further, can the dice be turned and Striga be transformed into a useful plant?

6. Additionality

Weedy Orobanchaceae are pernicious invasive plants, difficult to control, endowed with a complex biology, comprising copious seed production, prolonged viability and pronounced dormancy and ease of dissemination aided by numerous vectors including biotic and abiotic ones. We will continue our research to tackle this complex and difficult weed and overcome poverty and food security.

IV. For the Achievement of Overall Goals after the Project Completion

1. Prospects to achieve Overall Goal

The government of Sudan remarkably values the project and its pronounced achievements and hence took serious actions at different levels towards

achieving the goals specially those at their final stages of being realized and to ensure dissemination of the released packages and to support the sustainability of the project. Actions taken could be listed as:

1) Professor Zeinab, DG of NCR, Project Director suggested the amendment at the 4th JCC Meeting on July 19, 2022, and agreed to amend Project Design Matrix (PDM) from a medium term budgetary plan to Three Years Action Plan for the control of Striga through research and dissemination.

2) Ministry of Finance, as a response to the request made by NCR DG (step 1 above) secured 30,000,000 SDG for the accomplishment of Three Years Action Plan.

3) Ministry of Higher Education and Scientific Research has issued a decision of formulating IC for follow up and execution of the action plan involving all the relevant ministries and institutions.

4) Professor Zeinab, DG of NCR, Project Director and Professor Somaya project manager agreed to appoint 2 research assistants and 4 technicians from the new intake of NCR to the Striga Research Laboratory.

2. Plan of Operation and Implementation Structure of the Sudanese side to achieve Overall Goal

The overall plan is encompassing the employment of all the released technologies and packages and to disseminate them among farmers at all affected areas in Sudan via close coordination between the different institutions involved through a sequence of steps:

1) Completion of the parts of the research work which is in its final stages in order to grasp the benefit of the resulting outcome.

2) Integration of the newly employed control measures as a component of the existing packages, microbial control techniques as a vital example.

3) Emphasize and ensure the active disseminate of the Striga control packages among farmers at all affected areas in Sudan.

4) The well-established highly equipped laboratory with up to date apparatus and instruments, supplied by JICA, enabled high quality research on the control of Orobanchaceae weeds and in addition represents a corner stone for the establishment of a parasitic weed control unit or department in the near future.

3. Recommendations for the Sudanese side

Introduction of tractors and lab equipment as well as training in Japan and

Sudan have improved the situation on the Sudanese counterpart to promote research for combatting parasitic weeds. Design of attractive and practically important themes for young researchers would be important to make the most of the introduced facilities by JICA highly fruitful. Incorporation of as much research results as possible into the Integrated Striga Management package as effective components would be expected and recommended.

4. Monitoring Plan from the end of the Project to Ex-post Evaluation

The project will be continuously monitored by NCR after the completion of the Project, the plan of post-monitoring will be as follows:

1) IC to enforce implementation of innovative technologies during the project duration and after completion is approved.

2) Three Years Action Plan prepared by NCR, ARC and SUST was submitted to Ministry of Finance for budget.

3) Ministry of Finance secured 30 million SDG for the implementation of the Inter-ministerial committee action plan

4) Several NGOs are adopting, at least in part, the results of the project developed technology as per the demonstration trials undertaken in farmers' fields at the Gedarif state will be considered in the action plan. The project partner Dr. Hanan Abdel Tauwab acting as a consultant for the NGOs helped inviting their Representatives to the FFS seminar and their active participation was grasped.

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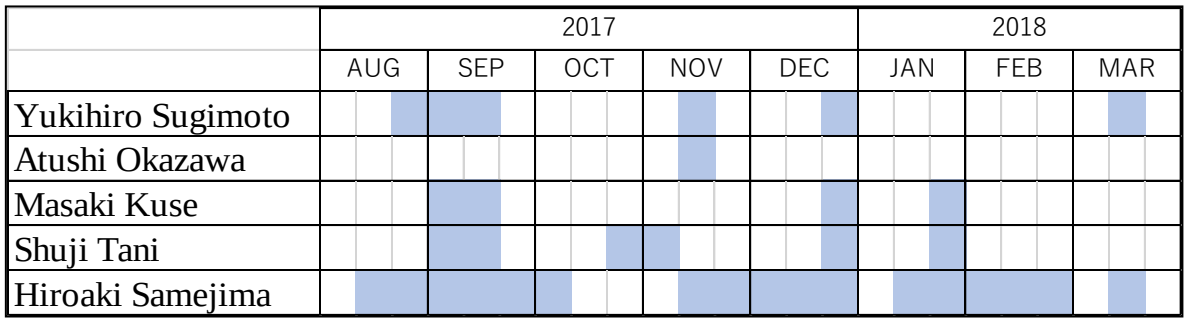
Annex1-1

List of Dispatched Japanese Experts (Japanese to Sudan)

2017 academic year

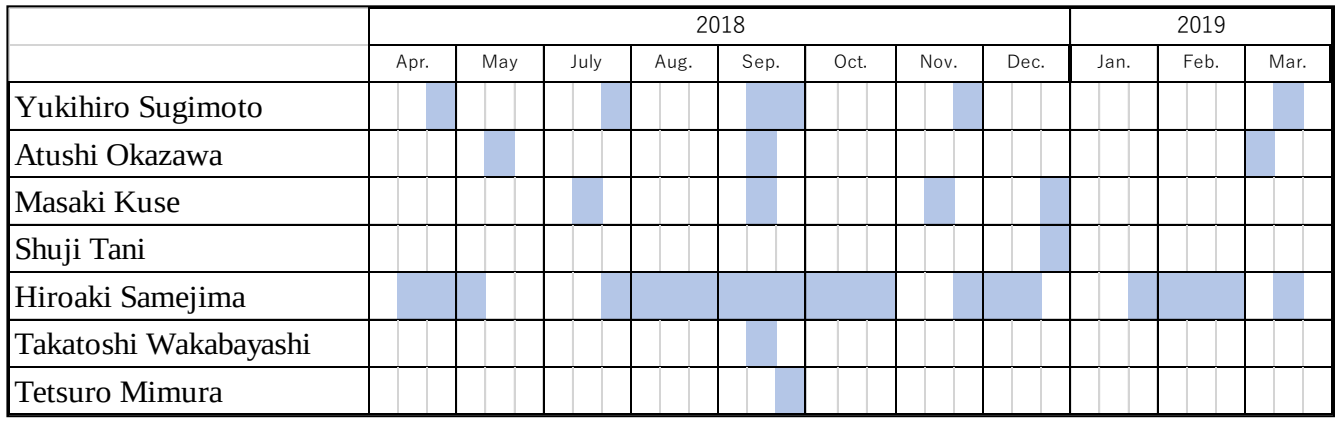
Hiroaki Samejima	2017. 8.15	2017.10.12	Crop Science
Yukihiro Sugimoto	2017. 8.25	2017. 9.15	Project management Natural Product Chemistry
Shuji Tani	2017. 9. 2	2017. 9.16	Microbiology
Masaki Kuse	2017. 9. 2	2017. 9.16	Natural Product Chemistry
Masaki Kuse	2017.10.27	2017.11. 3	Natural Product Chemistry
Atushi Okazawa	2017.11.17	2017.11.23	Project Management Plant Physiology
Yukihiro Sugimoto	2017.11.17	2017.11.24	Project management Natural Product Chemistry
Hiroaki Samejima	2017.11.17	2017.12.28	Crop Science
Yukihiro Sugimoto	2017.12.22	2017.12.28	Project management Natural Product Chemistry
Shuji Tani	2017.12.22	2017.12.29	Microbiology
Masaki Kuse	2017.12.22	2017.12.29	Natural Product Chemistry
Hiroaki Samejima	2018. 1.17	2018. 2.27	Crop Science
Hiroaki Samejima	2018 . 3.18	2018. 3.25	Crop Science
Shuji Tani	2018. 1.26	2018. 2. 2	Microbiology
Masaki Kuse	2018. 1.26	2018. 2. 2	Natural Product Chemistry
Yukihiro Sugimoto	2018. 3.18	2018. 3.25	Project management Natural Product Chemistry



2018 academic year

Hiroaki Samejima	2018. 4.18	2018. 5. 8	Crop Science
Yukihiro Sugimoto	2018. 4.27	2018. 5. 3	Project management Natural Product Chemistry
Atushi Okazawa	2018. 5.11	2018. 5.16	Project Management Plant Physiology
Hiroaki Samejima	2018. 6.23	2018.10.25	Crop Science
Masaki Kuse	2018. 7.13	2018. 7.20	Natural Product Chemistry
Yukihiro Sugimoto	2018. 7.27	2018. 8. 4	Project management Natural Product Chemistry
Takatoshi Wakabayashi	2018. 9.15	2018. 9.19	Plant Physiology
Masaki Kuse	2018. 9.14	2018. 9.21	Natural Product Chemistry
Atushi Okazawa	2018. 9.14	2018. 9.20	Project Management Plant Physiology
Yukihiro Sugimoto	2018. 9.14	2018. 9.28	Project management Natural Product Chemistry
Tetsuro Mimura	2018. 9.22	2018. 9.27	Plant Physiology
Masaki Kuse	2018.11.10	2018.11.16	Natural Product Chemistry

Hiroaki Samejima	2018.11.22	2018.12. 3	Crop Science
Yukihiro Sugimoto	2018.11.27	2018.12. 9	Project management Natural Product Chemistry
Hiroaki Samejima	2018.12. 8	2018.12.15	Crop Science
Shuji Tani	2019. 1.25	2019. 2.1	Microbiology
Masaki Kuse	2019. 1.25	2019. 2.1	Natural Product Chemistry
Hiroaki Samejima	2019. 1.25	2019. 2.26	Crop Science
Atushi Okazawa	2019. 3. 1	2019. 3. 6	Project Management Plant Physiology
Hiroaki Samejima	2019. 3. 7	2019. 3.16	Crop Science
Yukihiro Sugimoto	2019. 3. 7	2019. 3.16	Project management Natural Product Chemistry



2019 academic year

Yukihiro Sugimoto	2019.4.29	2019.5.3	cancelled do to difficult situations in Sudan
Takatoshi Wakabayashi	2019.4.29	2019.5.3	
Yukihiro Sugimoto	2020.3.13	2020.3.20	
Masaki Kuse	2020.3.13	2020.3.20	
Atushi Okazawa	2020.3.24	2020.3.28	

2020 academic year

Visits to Sudan was forbidden due to political turmoil and outbreak of COVID-19

2021 academic year

2022 academic year

Masaki Kuse	2022.11.12	2022.11.16	Natural Product Chemistry
Shuji Tani	2022.11.12	2022.11.16	Microbiology
Masaki Kuse	2022.12.10	2022.12.16	Natural Product Chemistry
Yukihiro Sugimoto	2023.1.6	2023.1.13	Final Evaluation Team
Atushi Okazawa	2023.1.6	2023.1.13	
Shuji Tani	2023.1.6	2023.1.11	
Takatoshi Wakabayashi	2023.1.6	2023.1.12	
Hiroaki Samejima	2023.1.6	2023.1.12	
Yukihiro Sugimoto	2023.3.18	2023.3.23	Final JCC Meeting
Atushi Okazawa	2023.3.18	2023.3.23	

Annex1-2

List of Counterparts

Project Director:	Dr. Migdam E. Abdelgani
	Dr. ElGasim Ali Elgasim
	Dr. Zeinab Osman
Project Manager:	Dr. AbdelGabar Eltayeb Babiker
	Dr. Somaya Sir Elkhatim Mohamed Salih

Research Groups & Members

Activity 1

Dr. AbdelGabar Eltayeb Babiker (Leader)	NCR
Dr. Randa Hassan Elsalahi Osman (Leader)	NCR-ENDRI

Activity 2

Dr. Somaya Dir Elkhatim mohamed Salih (Leader)	NCR
Ms. Rihab Eshasg	NCR-ENDRI
Ms. Inas Ishag Ahmed	NCR-ENDRI

Activity 3

Dr. Mohammed Mahgoub Hassan (Leader)	NCR-ENDRI
Ms. Rania Alrasheed Abakeer Abdalla	NCR-ENDRI
Ms. Magdoline Mustafa Ahmed Osman	NCR-ENDRI
Dr. Mohamed Ahmed Mohamed Adlan	NCR-ENDRI
Dr. Abdelmagid Adlan Hamed Babiker	NCR-ENDRI
Dr. Hanan Ibrahim Modawi	NCR-ENDRI
Dr. Nadia Yaseen Osman	NCR-ENDRI
Dr. Suha Hassan Ahmed	NCR-ENDRI

Activity 4

Dr. Khogali Izzeldin Idris (Leader)	ARC Shambat

Activity 5

Dr. Awatif Siribel (Leader)	NCR-MAPRI
Dr. Hanaa Hassab Elrasoul Abdelkareem	NCR-MAPRI
Dr. Mohamed Babiker	NCR-MAPRI

Activity 6

Dr. Dafalla Ahmed Dawoud (Leader)	ARC-Wadmedani
Dr. Abbas Elsir Elamin Bousati	ARC-Wadmedani

Dr. Khalafalla Ahmed Ali	ARC-Wadmedani
Mr. Hagir Ahmed Ibrahim Ahmed	ARC-Wadmedani
Dr. Hanan Abdel Tawab Sulman	ARC-Gadaref
Dr. Mohamed Ahmed Abdalla	ARC-Wadmedani

Activity 7

Dr. Zeinab Osman (Leader)	NCR
Dr. Somaya Dir Elkhatim mohamed Salih	NCR
Dr. Randa Hassan Elsalahi Osman	NCR-ENDRI

Annex1-3

List of Trainings (Sudanese to Japan)

SOMAYA SIRELKHATIM MOHAMED SALIH	2017/11/4	2017/11/10	Discussion
RANDA HASSAN ELSALAHI OSMAN	2017/11/4	2017/11/10	Discussion
Mohammed Mahgoub Hassan	2018/5/8	2018/5/13	Discussion
Khogeli Izzeldin Idris Elsayed	2018/5/8	2018/5/12	Discussion
MAGDOLINE MUSTAFA AHMED OSMAN MAGDOLINE	2018/11/2	2018/11/17	Training
RANIA ALRASHEED ABAKEER ABDALLA	2018/11/2	2018/11/17	Training
NADIA YASSEEN GAFAR OSMAN	2019/4/1	2019/5/31	Training
RIHAB ESHAG MOHAMMEDALHASAN ALI	2019/4/1	2019/5/31	Training
ABDELGABAR ELTAYEB BABIKER ELHAJ	2019/10/5	2019/10/9	Discussion
KHOGALI IZZELDIN IDRIS ELSAYED	2019/12/11	2019/12/15	Discussion
SOMAYA SIRELKHATIM MOHAMED SALIH	2020/1/11	2020/1/17	Discussion
RANDA HASSAN ELSALAHI OSMAN	2020/1/11	2020/1/17	Discussion
ISMAEL IBRAHIM ELMUNSOR ABDALLA	2020/2/26	2020/3/1	Discussion
RIHAB ESHAG MOHAMMEDAL HASAN ALI	2022/9/5	2022/12/3	Training
INAS ISHAG AHMED ISHAG	2022/9/5	2022/12/3	Training

Annex1-4

Meeting at Dubai

Yukihiro Sugimoto	2019/9/22	2019/9/24
SIDDIG OMER SIDDIG OMER		

Yukihiro Sugimoto	2019/11/26	2019/11/28
DAFALLA AHMED DAWOUD AHMED		

Shuji Tani	2019/12/15	2019/12/17
MOHAMMED MAHGOUB HASSAN AMIR		

Atushi Okazawa	2020/2/1	2020/2/3
Takatoshi Wakabayashi		
MOHAMMED MAHGOUB HASSAN AMIR		
SOMAYA SIRELKHATIM MOHAMED SALIH		
NADIA YASSEEN GAFAR OSMAN		

Yukihiro Sugimoto	2022/6/22	2022/6/26
Atushi Okazawa		
Zeinab Osman		
SOMAYA SIRELKHATIM MOHAMED SALIH		

Yukihiro Sugimoto	2022/8/6	2022/8/10
Atushi Okazawa		
RANDA HASSAN ELSALAHI OSMAN		
DAFALLA AHMED DAWOUD AHMED		

Yukihiro Sugimoto	2022/11/2	2022/11/6
Atushi Okazawa		
RANDA HASSAN ELSALAHI OSMAN		

Yukihiro Sugimoto	2023/2/26	2023/3/2
Atushi Okazawa		
SOMAYA SIRELKHATIM MOHAMED SALIH		

Annex1-5

List of Provision of Equipment

	Equipment	Place	Arrival date	Purpose
【FY2017】				
Kobe	Refregerator（4°C） NC-ME18A, Nippon Freeza	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Lab Table top	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Ultrasonic Cleaner UT-206H YAMATO Science	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Ultrasonic Cleaner UT-606 YAMATO Science	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Drying Shelf DS-S-AS	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Flask with bafl and rim 500ml	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Binocular stereoscopic microscope	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Binocular stereoscopic microscope	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Franction collector CHF122SC ADVANTEC	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Franction collector CHF122SC ADVANTEC	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Water purifier, cartridge type WL100	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Drying oven DVS602	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Rotary evaporator one set with transformer N-1300E-W	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Autoclave SN510	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Clean bench SN510	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Shaker BR-43FL-MR	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Shaker BR-43FL-MR	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	スタッカブルベース　タイテック	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Refregerated Mecro Centrifugte MX-307	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	High speed Refregerated Micro Centrifege Unit AX-511	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Angle Rotor TMA-300	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Rotor rack AF015-24	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Kobe	Rotor rack AF015-24	National Center for Research	2018/2/28 2018/6/26	Developoment of countermeasures against Striga
Local	Oven (100 L) Labtec LDO-030D/LDO-100E	National Center for Research	2018/3/6	Developoment of countermeasures against Striga
Local	Oven (100 L) Labtec LDO-030D/LDO-100E	Shambat, ARC	2018/3/6	Developoment of countermeasures against Striga
Local	Incubator (30 L) LIB-030M	National Center for Research	2018/3/6	Developoment of countermeasures against Striga
Local	Tractor (83 HP) with attachment	Shambat, ARC	2018/3/7	Developoment of countermeasures against Striga
Local	UPS (6000 VA) (x4)	National Center for Research	2018/3/7	Developoment of countermeasures against Striga
Local	Toyota Land Cruiser (diesel)	National Center for Research	2018/3/7	Developoment of countermeasures against Striga
Local	Toyota Hilux (diesel)	National Center for Research	2018/3/7	Developoment of countermeasures against Striga
Local	Fume hood Lab Tech LFH-120SCL	National Center for Research	2018/3/8	Developoment of countermeasures against Striga

Local	Fume hood Lab Tech LFH-120SCL	National Center for Research	2018/3/8	Develoopment of countermeasures against Striga
Local	Generator (30 KVA)	National Center for Research	2018/3/12	Develoopment of countermeasures against Striga
Local	Green house	Shambat ARC	2018/2/7	Develoopment of countermeasures against Striga
Local	Green house	Shambat ARC	2018/2/7	Develoopment of countermeasures against Striga
Local	Green house	Shambat ARC	2018/2/7	Develoopment of countermeasures against Striga
Local	Stabilizer ST300W4 GGT08070671	Shambat ARC	2018/2/8	Develoopment of countermeasures against Striga
Local	Stabilizer ST300W4 GGT08070671	Shambat ARC	2018/2/8	Develoopment of countermeasures against Striga
Local	Stabilizer Geevox 5 KVA GX-5000VRL	National Center for Research	2018/3/19	Develoopment of countermeasures against Striga
Local	Stabilizer Geevox 5 KVA GX-5000VRL	National Center for Research	2018/3/19	Develoopment of countermeasures against Striga
Local	Stabilizer Geevox 5 KVA GX-5000VRL	National Center for Research	2018/3/19	Develoopment of countermeasures against Striga
Local	Stabilizer Geevox 5 KVA GX-5000VRL	National Center for Research	2018/3/19	Develoopment of countermeasures against Striga
Local	Stabilizer Geevox 5 KVA GX-5000VRL	National Center for Research	2018/3/19	Develoopment of countermeasures against Striga
【FY2018】				
Local	Cooled incubator 10L LCI-011E	National Center for Research	2018/10/18	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	National Center for Research	2018/10/18	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	National Center for Research	2018/10/18	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	National Center for Research	2018/10/18	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	National Center for Research	2018/10/18	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	Shambat ARC	2018/8/13	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	Shambat ARC	2018/8/13	Develoopment of countermeasures against Striga
Local	Desk-top computer Coire i3, RAM 4GB 500GB HDD HP 290	National Center for Research	2019/3/19	Develoopment of countermeasures against Striga
Local	lor Printer HP MFP M477fdw	National Center for Research	2019/3/19	Develoopment of countermeasures against Striga
Local	Cooled incubator 10L LCI-011E	National Center for Research	2019/3/19	Develoopment of countermeasures against Striga
【FY2019】				
Local	Wireless HDD WD 3TB	Project Office	2020/3/11	Develoopment of countermeasures against Striga
【FY2021】				
Local	HP Color Printer MFP M479fdw	Project Office	2021/5/5	Develoopment of countermeasures against Striga
Local	Tractor Giad ARMATRAC-752e (75 hp) with 5 attachments	Gadaref ARC	2021/5/25	Develoopment of countermeasures against Striga
Local	Seeds of Sorgham, Sesami, GroundNuts for Gadaref	Gadaref ARC	2021/5/6	Develoopment of countermeasures against Striga
Local	Chemicals for Gadaref	Gadaref ARC	2021/5/10	Develoopment of countermeasures against Striga
Local	Fertilizer for Gadaref	Gadaref ARC	2021/7/6	Develoopment of countermeasures against Striga
Local	Air Condition 18 power Midea	Project Office	2022/2/1	Develoopment of countermeasures against Striga
Local	Lab Char x 10	National Center for Research	2022/2/1	Develoopment of countermeasures against Striga
Local	Air Condition 18 power Midea	National Center for Research	2022/2/1	Develoopment of countermeasures against Striga
Local	Reagent steel cabinet	National Center for Research	2022/2/6	Develoopment of countermeasures against Striga

Local	Air Condition 18 power Midea	National Center for Research	2022/2/9	Developoment of countermeasures against Striga
Local	Portable Chlorophyll Meter TYS5N	National Center for Research	2022/2/21	Developoment of countermeasures against Striga
Local	Digital Ph Meter 3510 Jenway	National Center for Research	2022/2/22	Developoment of countermeasures against Striga
Local	-20 Freezer OCEAN CVK397NFZSA	National Center for Research	2022/2/24	Developoment of countermeasures against Striga
Local	Balance Table 980 x 700 x 900	National Center for Research	2022/3/1	Developoment of countermeasures against Striga
Local	Lab Working Top and cabinet 4 set	National Center for Research	2022/3/1	Developoment of countermeasures against Striga
Local	Micropipette 0.5-10 Isolab x 5	National Center for Research	2022/3/1	Developoment of countermeasures against Striga
Local	Micropipette 100-1000 Isolab x 5	National Center for Research	2022/3/1	Developoment of countermeasures against Striga
Local	Colony Counter Isolab	National Center for Research	2022/3/8	Developoment of countermeasures against Striga
Local	Digital Balance Kern & Sohn PFB200-3	National Center for Research	2022/3/7	Developoment of countermeasures against Striga
Local	Blender Isolab	National Center for Research	2022/3/8	Developoment of countermeasures against Striga
Local	Vortex Mixerr IKA	National Center for Research	2022/3/8	Developoment of countermeasures against Striga
Local	Magnetic Stirrer up to 380 degree LMS-1003	National Center for Research	2022/3/10	Developoment of countermeasures against Striga
【FY2022】				
Local	Green House (Protected House)	National Center for Research	2022/4/10	Developoment of countermeasures against Striga
Local	Rotary evaporator	National Center for Research	2022/4/12	Developoment of countermeasures against Striga
Local	Oil bath	National Center for Research	2022/4/12	Developoment of countermeasures against Striga
Local	Lab Working Top and cabinet 7 set	National Center for Research	2022/4/12	Developoment of countermeasures against Striga
Local	Poweer Supply 45KVA	National Center for Research	2022/4/19	Developoment of countermeasures against Striga
Kobe	Rockwool 36 pcs	National Center for Research	2022/5/29	Developoment of countermeasures against Striga
Kobe	Glass Paper Fileter 40 pcs	National Center for Research	2022/5/29	Developoment of countermeasures against Striga
Local	Electricity box for Green House	National Center for Research	2022/6/2	Developoment of countermeasures against Striga
Local	Fertilizer, Seed and chemicals for Gadaref	National Center for Research	2022/6/28	Developoment of countermeasures against Striga
Local	Electrophoresis	National Center for Research	2022/7/17	Developoment of countermeasures against Striga
Local	Plant pot for experiment in green house 200pcs	National Center for Research	2022/7/25	Developoment of countermeasures against Striga
Local	Material water supply for green house	National Center for Research	2022/8/2	Developoment of countermeasures against Striga
Local	2 set of Lab door	National Center for Research	2022/8/24	Developoment of countermeasures against Striga
Local	Laminar Hood	National Center for Research	2022/8/29	Developoment of countermeasures against Striga
Local	Deep Freezer -86	National Center for Research	2022/8/29	Developoment of countermeasures against Striga
Local	Mixer Mill	National Center for Research	2022/8/29	Developoment of countermeasures against Striga
Local	Thermal Cycler	National Center for Research	2022/8/29	Developoment of countermeasures against Striga
Local	Lab Working Top and cabinet 1 set	National Center for Research	2022/8/29	Developoment of countermeasures against Striga
Local	Digital Balance Kern & Sohn 0.01 x 2000g	National Center for Research	2022/8/31	Developoment of countermeasures against Striga

Local	Digital Balance Kern & Sohn 0.0001	National Center for Research	2022/8/31	Developoment of countermeasures against Striga
Local	Mini Centrifuge IKA	National Center for Research	2022/8/31	Developoment of countermeasures against Striga
Local	Mini Centrifuge IKA	National Center for Research	2022/8/31	Developoment of countermeasures against Striga
Local	HPLC	National Center for Research	2022/9/15	Developoment of countermeasures against Striga
Local	UV Spectrophotometer	National Center for Research	2022/10/20	Developoment of countermeasures against Striga
Local	Digital Balance Kern & Sohn 30Kg	National Center for Research	2022/11/9	Developoment of countermeasures against Striga
Local	Gel Documentation	National Center for Research	2022/11/15	Developoment of countermeasures against Striga
Local	Portable Leaf Area Meter	National Center for Research	2022/11/15	Developoment of countermeasures against Striga
Local	Water Philter for lab	National Center for Research	2022/11/28	Developoment of countermeasures against Striga
Local	Cooled Incubator 294L	National Center for Research	2022/11/29	Developoment of countermeasures against Striga
Local	Desk-top computer Coire i3, RAM 4GB 500GB for Digital Microscope	National Center for Research	2022/1/8	Developoment of countermeasures against Striga
Local	Desk-top computer Coire i5, RAM 4GB 500GB for Digital Microscope	National Center for Research	2022/1/9	Developoment of countermeasures against Striga
Local	Millipore Ultra Water Purifier	National Center for Research	2022/1/11	Developoment of countermeasures against Striga
Local	Digital Microscope	National Center for Research	2022/1/11	Developoment of countermeasures against Striga
Local	Fluorescent Stereomicroscope	National Center for Research	2022/1/11	Developoment of countermeasures against Striga
Local	Tanq for Liquid Nitrogen	National Center for Research	2022/1/19	Developoment of countermeasures against Striga
Local	Vacum Pump	National Center for Research	2022/1/22	Developoment of countermeasures against Striga
Local	Desk-top computer Coire i5, RAM 4GB 500GB for UV Spectrophotometer	National Center for Research	2022/1/31	Developoment of countermeasures against Striga
Local	Fire extinguisher for lab x 2	National Center for Research	2022/2/7	Developoment of countermeasures against Striga
Local	Ice Maker for lab	National Center for Research	2022/2/14	Developoment of countermeasures against Striga
Local	UV Lamp for lab x 3	National Center for Research	2022/2/14	Developoment of countermeasures against Striga
Local	Water Bath Shaker	National Center for Research	2022/2/14	Developoment of countermeasures against Striga
Local	Eppendorf Electroporator	National Center for Research	2022/2/21	Developoment of countermeasures against Striga
Local	Growth Chamber	National Center for Research	2022/2/21	Developoment of countermeasures against Striga
Local	Freeze Drier System	National Center for Research	2022/2/22	Developoment of countermeasures against Striga
Local	ThermoMixer Eppendorf	National Center for Research	2022/2/22	Developoment of countermeasures against Striga
Local	ThermoBlock Eppendorf	National Center for Research	2022/2/22	Developoment of countermeasures against Striga
Local	UV Lamp for TLC detection	National Center for Research	2022/2/22	Developoment of countermeasures against Striga
Local	Hot Plate	National Center for Research	2022/2/23	Developoment of countermeasures against Striga
Local	Multichannel Micropipette, Isolab	National Center for Research	2022/2/26	Developoment of countermeasures against Striga

Annex 1-6

Consumable List

【2021】		Contents		
Aug 15	Khawarismi		54,000	
Aug 15	Rovan	Sodium	15,000	
Aug 15	Fifth Medical	Filter Paper	82,000	
【2022】				
Feb 6	Seiseban			
		Agar 500g x 6	180,000	
		Casen 500g x 2	20,000	
		HPLC Syringe 100 ul x 1	32,000	
		Tank for TLC 20*20 x 1	45,000	277,000
Feb 6	Rovan	Ammonia 2.5L x 3	22,500	
		Disposable Petri Dishes 5ml x 2	50,000	
		Ethyle acetate 2.5L x 3	22,500	
		Screw cap test tubes 30ml x 100	30,000	125,000
Feb 6	Khawarismi	Cartridge filte r 0.45um x 2	70,000	
		Falcon tubes 50ml x 2	6,000	
		Isopropnol Analar 2.5L x 2	20,000	96,000
Feb 8	Khawarismi	Ethanol Analar 2.5L 2	45,000	
		Face mask box x 52	52,000	
		Steel wire stable up to 120C loop 50mm * 200mm x 6	6,000	103,000
Feb 8	Rovan	Aluminium foil 3.48sqm 7.62*457mm x 11	27,500	
		Hand gloves medium powder free x 40	144,000	
		Magnesium sulphate 500g x 4	14,000	
		test tube with screw cap glass 16*100mm x 100	3,000	188,500
Feb 8	prime	Test tube racks blue isolap x 5	21,790	21,790
Feb 9	prime	Parafilm M sealing film 100mm*38m x 3	91,518	91,518
Feb 15	Rovan	PDA 500g x 2	50,000	
		Rose bengal 25g x 2	14,000	64,000
Nov 8	Khawarismi	plastic dishes 9cm x 2	66,000	
		petri dishes glass 9cm x 60	60,000	
		PDA 500g x 3	90,000	

		Whatman filter x10	50,000	
		Corborer 6pc in set x1	15,000	281,000
Nov 8	Rovan	forceps small medium large x3	4,500	
		micropipette (10-100) x2	15,000	
		blue tips Carton x1	1,500	
		yellow tips Carton x 1	1,500	
		dextrose (Golucose) 500g x3	13,500	
		ethanol 2.5 L x 5	55,000	
		petroleum ether 2.5L x 2	18,000	
		Acetone sol. 2.5L x 2	17,000	
		Hexane 2.5L x 2	18,000	
		Athyle acetate 2.5L x 1	8,500	
		Methanol sol. 2.5 L x 2	13,000	
		Sodium sulphate 500g x 1	4,000	169,500
Nov 8	Rovan	Syringe 5ml , box x 4	24,000	
		Syringe 3ml, box x 3	16,500	
		Syringe 10ml, box x 3	18,000	
		Chloroform 2.5L x 3	25,500	
		Propan 2 Ol /Isopropanol 2.5L x 3	28,500	
		Ethanol 99.9% 2.5L x 3	33,000	
		Glucose 500g x10	45,000	
		N.N Dimethylformamide 100g x 5	60,000	
		Acetic Acid x 3	18,000	
		Magnesium chlorid hexa hydrate 500g x 5	20,000	
		Magnesium sulphate hepta hydreate 500g x 5	17,500	
		Potasium chloride 500g x 5	20,000	
		Sodium hydroxide solution 500g x 2	7,000	
		hydrochloric acid 2.5L x 2	17,000	350,000
N0v 10	Seiseban	White tips 1pack (1000) x1	1,500	
		Tips rack x 2	11,000	
		Eppendorf tubes 1.5ml bag x 5	25,000	
		Plastic foil 3.37m x 10	25,000	
		Falcon tubes 25ml 100pcs x 1	4,500	
		Falcon tube 50ml, 100pcs x 1	7,000	

		Wash bottle 500ml x 2	4,000	
		Agaarose 50-800pb -1kpb 100g x 1	47,000	
		EDTA 500g x 5	27,500	
		Tris - Hcl 100g x 5	22,500	
		Tryptone 500g x 2	77,000	
		Yeast extract 500g x 2	72,000	
		Agar 500g x 2	70,000	
		Tween 20 500ml x 2	18,000	
		PH meter buffer 500ml x 1	11,000	423,000
		Buchner funnl 75mm x 2	8,000	
		Buchner funnl 100mm x 2	9,000	
		Screw cap bottle 100ml x 2	3,000	
		Screw cap bottle 250ml x 2	5,600	
		Screw cap bottle 500ml x 2	7,000	455,600
Dec 1	Khawarismi	PCR tubes bag x 10	60,000	60,000
Nov 10	Seiseban	Plastic foil 3.37m x 10	25,000	25,000
Dec 1	Seiseban	PCR master mix kit intron x 1	55,000	
		Ethidium bromide 1g x 1	20,000	75,000
Dec 1	Khawarismi	Loding dye stain 1ml x 1	35,000	
		Lader 1000 x 1	85,000	
		Microfiltter 0.45 1box x 1	50,000	
		Sodium hypochlorite 1L x 5	15,000	
		Parafilm 1box x 1	50,000	235,000
Jan 8	Seiseban	96 well test plate（F- bottom with lid） x 1	3,000	
		Soluble starch 500g x 1	13,500	
		Dextrin 500g x 1	18,000	
		Maltose 500g x 1	14,250	
		Meat extact 500g x 1	33,000	
		Copper sulphate penta hydrate 500g x 1	8,000	
		Manganese chloride tetra hydrate 500g x 1	6,500	
		Zinc sulphate dihydrate 500g x 1	6,500	
		liron sulphate heptahydrate 500g x 1	6,800	
		Sodium molybdate Dihydrate 500g x 1	7,500	
		Boric Asid 500g x 1	6,000	

		Cobalt chloride hexhydrate 500g x 1	22,500	145,550
Jan 25	Rovan	Auto Sampler for HPLC x 100	40,000	
		Syrnige filter 0.45 100pcs x 1	40,000	80,000
Jan 26	Rovan	Filtering flask 1L x 2	60,000	
		Buchner funnel 80mm x 2	10,000	
		Filter paper 9cm x 2	4,000	74,000
Feb 12	Seiseban	Reagent bottle 100ml x 3	4,500	
		Reagent bottle 250ml x 3	6,000	
		Conical flask 100ml x 6	7,200	
		Conical flask 250ml x 6	12,000	
		Conical flask 500ml x 6	21,000	
		Conical flask 1L x 6	30,000	
		Beaker 100ml x 6	9,000	
		Beaker 250ml x 6	12,000	
		Beaker 500ml x 6	21,000	
		Beaker 1000ml x 6	36,000	158,700
Feb 20	Seiseban	Agarose for 50-100bp 100g x 5	425,000	
		DNA lader 100bp 1 x 10	600,000	
		Tris - Hcl 100g x 2	40,000	1,065,000
Feb 20	Infirad	Trizol Reagent 1 x 4	720,000	
		Diethyl pyrocarbonate 1 x 1	80,000	
		Agarose for 1 kp 1 x 1	150,000	
		Lader 1kp for 500 sample each 1 x 2	240,000	
		X-gal 5bromo 4-chloro 3-indolyl -B-D-10 galatoside 1x1	120,000	
		IPTG isopropyl B-D thaioglctopyranoside 1 x 1	120,000	
		Ampicilin sodium salt 1 x 2	200,000	
		pure link RNA mini kit. for 100 sample 1 x 1	300,000	
		pure link RNA mini kit. (50preps) 1 x 1	300,000	
		ISOSPIN PLANT RNA kit 1 x 2	600,000	
		PCR and gel clean up 100 preps	300,000	
		10x a attachment mix for 250 sample each 1 x 1	100,000	
		Code 1 PCR master mix 1 x 1	120,000	
		DNA fragment purification kit 1 x 1	300,000	
		PT - PCR kit 1x 2	800,000	4,450,000

Annex 1-7

Local Cost (Japanese Side)

<2017 July - 2018 March>

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**6,423,000**

<2018April - 2019March >

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**6,712,000**

<2019April - 2020 March >

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**2,680,000**

<2020April 4 - 2021March>

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**1,595,000**

<2021April - 2022March>

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**7,111,000**

<2022April - 2023March>

Budget Article	Content	Payment Amount (Yen)
Miscellaneous	Lab materials/Office management	
Air Fare	Air Fare	
Travel Allowance	Travel Allowance, Accomodation, Transportation	
Fees and honorarium	Employment of technical assistants	
Total		**12,539,000**

Annex 1-8

❖ Local Cost by Government of Sudan

2017 - 2023

N	Item	Budget/SDG
1	Laboratory refurbishment and office maintenance	8,000,000
2	Farmer field School	6,000,000
3	Equipment	2,000,000
4	Laboratory , pot and field experiments	2,000,000
5	Protected house	500,000
6	Utilities	2,500,000
7	Seminars and meetings	1,000,000
	Total	22,300,000 SDG

Annex2-1

1）Artieles with DOI

1-1）Joint with Japanese and Sudanese Researches

					DOI
1	2016	Identification of Striga hermonthica resistant upland rice varieties in Sudan and their resistance phenotypes	Samejima, H., Mustafa A.E.L., Babiker, A.G.T., Sugimoto, Y.,	Frontiers in Plant Science, 2016	10.3389/fpls.2016.00634
2	2016	Practicality of suicidal germination induction for controlling Striga hermonthica	Samejima, H., Babiker, A.G.T., Hirosato Takikawa, Mitsuru Sasaki, Sugimoto, Y.	Pest Management Science, 72 (11), 2035-2042, 2016	10.1002/ps.4215
3	2018	Improvement of food security in semiarid regions of Sudan through management of root parasitic weeds	Hiroaki Samejima, Abdel Gabar Babiker, Yukihiro Sugimoto	Crop Production under Stressful Conditions, Application of Cutting-edge Science and Technology in Developing Countries, 2018.08,,pp. 159-175	10.1007/978-981-10-7308-3_9
4	2021	Isolation and identification of metabolites from ethyl acetate leaf extract of Solenostemma argel	Hassabelrasoul, H., Moriguchi, M., Kang, B, Siribel, A. A., Kuse, M.	Agriculture and Natural Resources 55 (5) 757-763, 2021.	10.34044/j.anres.2021.55.5.06

1-2）Japanese

5	2017	Enhanced production of nojirimycin via Streptomyces ficellus cultivation using marine broth, and inhibitory activity of the culture for seed of parasitic weeds	Kazuo Harada, Yurika Kurono, Saya Nagasawa, Tomoka Oda, Yudai Nasu, Takatoshi Wakabayashi, Yukihiro Sugimoto, Hideyuki Matsuura, Satoru Muranaka, Kazumasa Hirata, Atsushi Okazawa	Journal of Pesticide Science, 42 (4), 166-171, 2017	10.1584/jpestics.D17-036
6	2017	Recent Research Progress in Combatting Root Parasitic Weeds	Hiroaki Samejima and Yukihiro Sugimoto,	Biotechnology and Biotechnological Equipment, 2018.03, 322, pp.221-240	10.1080/13102818.2017.1420427
7	2018	Evidence for species-dependent biosynthetic pathways for converting carlactone to strigolactones in plants	Moe Iseki, Kasumi Shida, Takatoshi Wakabayashi, Masaharu Mizutani, Hirosato Takikawa, Yukihiro Sugimoto,	Journal of Experimental Botany, 69 (9), 2305-2318, 2018	10.1093/jxb/erx428
8	2018	Reductive metabolism of the D-ring in strigolactones by plants	Misa Yamauchi, Kotomi Ueno, Toshio Furumoto, Takatoshi Wakabayashi, Masaharu Mizutani, Hirosato Takikawa, Yukihiro Sugimoto,	Bioorganic and Medicinal Chemistry, 26 (18), 4225-4233, 2018	10.1016/j.bmc.2018.07.016
9	2018	The bioconversion of 5-deoxystrigol isomers to monohydroxylated strigolactones by plants	Kotomi Ueno, Hitomi Nakashima, Masaharu Mizutani, Hirosato Takikawa, Yukihiro Sugimoto	Journal of Pesticide Science, 43 (3), 198-206, 2018	10.1584/jpestics.D18-021
10	2018	Aberrant protein phosphatase 2C leads to abscisic acid insensitivity and high transpiration in parasitic Striga	Hijiri Fujioka, Hiroaki Samejima, Hideyuki Suzuki, Masaharu Mizutani, Masanori Okamoto, Yukihiro Sugimoto,	Nature Plants, 5 (3), 258-262, 2019	10.1038/s41477-019-0362-7
11	2019	How dose Striga hermonthica bewitch its hosts	Hijiri Fujioka, Hiroaki Samejima, Masaharu Mizutani, Masanori Okamoto, Yukihiro Sugimoto	Plant Signaling & Behavior, 15 (7), Article: 1605810.	10.1080/15592324.2019.1605810
12	2019	Direct conversion of carlactonoic acid to orobanchol by cytochrome P450 CYP722C in strigolactone biosynthesis	Takatoshi Wakabayashi, Misaki Hamana, Ayami Mori, Ryota Akiyama, Kotomi Ueno, Keishi Osakabe, Yuriko Osakabe, Hideyuki Suzuki, Hirosato Takikawa, Masaharu Misutani, Yukihiro Sugimoto,	Science Advances, 5, eaax9067, 2019	10.1126/sciadv.aax9067
13	2020	CYP722C from Gossypium arboreum catalyzes the conversion of carlactonoic acid to 5-deoxystrigol	Takatoshi Wakabayashi, Kasumi Shida, Yurie Kitano, Hirosato Takikawa, Masaharu Mizutani, Yukihiro Sugimoto,	Planta, 251 (5), 97, 2020	10.1007/s00425-020-03390-6
14	2020	Concise synthesis of heliolactone, a non-canonical strigolactone isolated from sunflower	Shunya Yamamoto, Taiki Atarashi, Masaki Kuse, Yukihiro Sugimoto, Hirosato Takikawa,	Bioscience, Biotechnology, and Biochemistry, 84 (6), 1113-1118, 2020	10.1080/09168451.2020.1734444
15	2020	The effect of nojirimycin on transcriptome of germinating Orobanche minor seeds	Atsushi Okazawa, Takatoshi Wakabayashi, Toshiya Muranaka, Yukihiro Sugimoto, Daisaku Ohta	Journal of Pesticide Science, 45 (4), 230-237, 2020	10.1584/jpestics. D20-057
16	2020	Conversion of methyl carlactonoate to heliolactone in sunflower	Takatoshi Wakabayashi, Hikaru Shinde, Nanami Shiotani, Shunya Yamamoto, Masaharu Mizutani, Hirosato Takikawa, Yukihrio Sugimoto,	Natural Product Research, 36 (9), 2215–2222, 2022	10.1080/14786419.2020.1826477
17	2020	Identification and characterization of sorgomol synthase in sorghum strigolactone biosynthesis	Takatoshi Wakabayashi, Shunsuke Ishiwa, Kasumi Shida, Noriko Motonami, Hideyuki Suzuki, Hirosato Takikawa, Masaharu Mizutani, Yukihrio Sugimoto,	Plant Physiology, 185 (3), 902-913, 2021	10.1093/plphys/kiaa113
18	2020	Studies on strigolactone BC-ring formation: Chemical conversion of an 18-hydroxycarlactonoate derivative into racemic 4-deoxyorobanchol/5-deoxystrigol via acid-mediated cascade cyclization	Nanami Shiotani, Takatoshi Wakabayashi, Yusuke Ogura, Yukihiro Sugimoto, Hirosato Takikawa,	Tetrahedron Letters, 60, Article 152922, 2021	10.1016/j.tetlet.2021.152922
19	2021	Germination stimulatory activity of bacterial butenolide hormone in Streptomyces albus J1074 toward seeds of a root parasitic weed Orobanche minor	Atsushi Okazawa, Hiroaki Samejima, Shigeru Kitani, Yukihiro Sugimoto, Daisaku Ohta	Journal of Pesticide Science, 46 (2), 242-247, 2021	10.1584/jpestics.D21-014
20	2021	Specific methylation of (11R)-carlactonoic acid by an Arabidopsis SABATH methyltransferase	Takatoshi Wakabayashi, Ryo Yasuhara, Hirosato Takikawa, Masaharu Mizutani, Yukihiro Sugimoto:	Planta, 254:8, 2021	10.1007/s00425-021-03738-6
21	2021	Synthesis of racemic orobanchols via the acid-mediated cascade cyclization: Insight into the process of BC-ring formation in strigolactone biosynthesis	Nanami Shiotani, Takatoshi Wakabayashi, Yusuke Ogura, Hironori Okamura, Yukihiro Sugimoto, Hirosato Takikawa	Tetrahedron Letters, 68, 153469, 2021	org/10.1016/j.tetlet.2021.153469
22	2021	Involvement of α-galactosidase OmAGAL2 in planteose hydrolysis during seed germination of Orobanche minor	Atsushi Okazawa, Atsuya Baba, Hikaru Okano, Tomoya Tokunaga, Tsubasa Nakaue, Takumi Ogawa, Shuichi Shimma, Yukihiro Sugimoto, Daisaku Ohta	Journal of Experimental Botany, 73 (7), 1992–2004, 2022 Apr	10.1093/erab527
23	2021	Isolation and identification of naturally occurring strigolactones.	Kotomi Ueno, Takatoshi Wakabayashi, Yukihiro Sugimoto	Methods in Molecular Biology, vol. 2309. Humana, New York, 2021.pp. 13-23. In Prandi C., Cardinale F. (eds) Strigolactones.	10.1007/978-1-0716-1429-7_2
24	2021	Structure elucidation and biosynthesis of orobanchol	Wakabayashi, T., Ueno, K., Sugimoto, Y	Frontiers in Plant Science, 13:835160. 2022	10.3389/fpls.2022.835160
25	2021	有機合成化学を基盤とするストリゴラクトン研究	滝川浩郷	有機合成化学協会誌、79, 819–828, 2021	10.5059/yukigoseikyokaishi.79.819

26	2022	Identification of 6-epi-heliolactone as a biosynthetic precursor of avenaol in Avena strigose	Daisuke Moriyama, Takatoshi Wakabayashi, Nanami Shiotani, Shunya Yamamoto, Yui Furusato, Kohki Yabe, Masaharu Mizutani, Hirosato Takikawa, Yukihiro Sugimoto	Bioscience, Biotechnology, and Biochemistry, 86 (8), 998–1003, 2022 Aug.	org/10.1093/bbb/zbac069

1-3）Sudanese

2）Others

1-1）Joint with Japanese and Sudanese Researches

1-2）Japanese

27	2016	根寄生雑草除去に向けた自殺発芽誘導剤の開発と実証試験.	鮫島啓彰, 滝川浩郷, 杉本幸裕	バイオサイエンスとインダストリー, 74, 314–315, 平成28年7月.	
28	2016	根寄生雑草の潜在的危険性と生活環に着目した防除の試み.	杉本幸裕, 滝川浩郷	学術の動向, 18–23, 平成28年8月.	
29	2016	根寄生雑草の生存戦略の化学的解明と防除への応用.	鮫島啓彰, 滝川浩郷, 杉本幸裕	関東雑草研究会報, 27, 5–19, 平成29年2月.	
30	2016	オミクス解析による根寄生雑草選択的除草剤の標的探索.	岡澤敦司	日本農薬学会誌, 42, 84–90, 平成29年2月.	
31	2017	イネのストライガ抵抗性評価法としてのライゾトロン実験の信頼性.	鮫島啓彰	植物の化学調節, 52, 112–116, 平成30年1月.	
32	2018	根寄生雑草ストライガの猛威と、総合防除に向けた研究開発の動向—ストライガによる農作物への被害を防ぐ	鮫島啓彰, 杉本幸裕	化学と生物, 56, 697–702, 平成30年9月.	
33	2018	ストリゴラビリンス　ー植物生理活性物質ストリゴラクトンの構造多様性、	上野琴巳、杉本幸裕	化学、73 (12), 66-67, 平成30年12月.	
34	2019	寄生植物ストライガの養水分奪取機構の解明、	岡本昌憲、藤岡聖、杉本幸裕	化学と生物、58 (3), 138-140, 令和2年3月	
35	2019	第2章　寄生性高等植物、	鮫島啓彰、杉本幸裕	pp. 106-110 眞山滋志、難波成任編　植物病理学　第二版、文永堂、東京、令和2年3月	
36	2020	「魔女の雑草」ストライガに秘められた謎、	杉本幸裕	植物の生長調節、55 (1), 67-69, 令和2年5月	
37	2020	典型的ストリゴラクトンの生合成、	若林孝俊、水谷正治、杉本幸裕	化学と生物、58 (11), 628-634, 令和2年11月	
38	2021	ストリゴラクトンの立体と構造の多様性、	上野琴巳、滝川浩郷、杉本幸裕	農薬学会誌、46 (2), 136-142, 2021 Aug.	
39	2021	ストリゴラクトンの生合成経路の解明と応用、	若林孝俊、杉本幸裕	植調、55 (9), 15-19, 2021Dec	

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1. Eltayeb A. H., Sugimoto Y, Hassan[3] M. M., BabikerA. G. T. Response of germination stimulants and their Purification produced by Sesame (*Sesamum indicum* L.) on *Striga hermonthica*(Del.) Benth. Germination. Accepted paper.
2. Mohmed H.H.A, Siribel A.A., Kuse M., (2022), Isolation and identification of the flavonoids of *Striga hermonthica* plant, 11th international scientific conference of national center for research, Sudan.
3. Hassabelrasoul H., Moriguchi M., Kang B., Siribel A.A., Kuse M., (2021), Isolation and identification of metabolites from the ethyl acetate extract of the leaves of *Solenostemma argel*, Agr. Nat. Resour. 55, 757−763.
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5. Azarig M.A., Hassan M.H., Rugheim A.M.E., Ahmed M.M., Abakeer R.A., Abusin R.M.A., Abdelgani M.E. (2020). Impact *Trichoderma harzianum* and bacterial strains biological control against *Striga hermonthica* in sorghum. Annals of Plant Sciences, 9 (10) 4049 - 4059.
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7. Yahia M.Y.A., Hassan, M.M., Elamin M.A., Abdalla N.K., Rugheim A.M.E., Osman A.G., AbdelganiM.E.and Babiker A.G.T. (2020). *Trichoderma harzianum* and bacterial strains as bioagents for suppressing *Orobanche crenata* growth and parasitism in faba bean. International Journal of Agriculture, Environment and Bioresearch, 5 (3): 10-20.
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11. Abakeer R.A., Hassan M.M., Ahmed M.M, Osman A.G., Abdelgani M.E., Babiker A.G.E. and Rugheim A.M.E (2018). Seed Priming Influence on *Strigahermonthica* Infested Sorghum Growth, Sudan Academy of Sciences Journal, 13: 59-73.

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16. Elabaied E.M., Rugheim A.M.E., Hassan M.M., Ahmed M.M., Yahia M.A., Abakeer R.A., Abusin R.M.A., Osman A.G., Abdelgani M.E. and Babiker A.G.T. (2017). Influence of bacteria on *Orobanche crenata* seed bank size, incidence and *Vicia faba* L. performance, American-Eurasian Journal of Sustainable Agriculture 11(4):30-39. IF: 2.5

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18. Abusin R.M.A, Eltayeb A.H, Hassan M.M. and Babiker A.G.T. (2017). Integrated Management of *Striga hermonthica* on Sorghum, Asian Journal of Advances in Agricultural Research 4(2): 1-8.

19. S. H. Ahmed, M. E. Abdelgani, A. E. Babiker and R. M. Abusin (2015). "Influence of triclopyr and nitrogen on management of *Striga hermonthica* on sorghum. World Journal of Science, Technology, and sustainable development, 389-398.www.emeraldgrouppublishing.com

Supervision:

Ph.D awarded

1-Hanaa HassabElrasoul Abdelkareem Mohmed, (2022), Isolation and identification of the metabolites of Sudanese medicinal plants and synthesis of flavonoid glycosides, graduate school of agricultural science, Kobe University, Japan.

2-Abdel Rahman Hamed Abdel Rahman Hashim (2017). Genotypic variability in Cotton (*Gossypium hirsutum* L.) As a trap crop for *Striga hermonthica* (Del.) Benth., Sudan Academy of Sciences (SAS).

3-Suha. H. Ahmed (2017).Interactions of Arbuscular Mycorrhizal Fungi (AMF) Herbicide on *Striga hermonthica* (Del) Benth Management. Sudan Academy of Sciences (SAS).

M. Sc. Students (awarded)

1- Nehad Yassin Mohammed Ali (2020). Effects of *Trichoderma sspp.* on *Striga*germination and sorghum growth, Elneelain University, Graduate collage.

2- Mahdi Yahia Adam (2019). Interactions between *Trichoderma harzianum* fungi, bacterial strains and chemical herbicide under conventional and low input fertilization field condition in faba bean (*Vicia faba* L.): Growth response and broomrape (*Orabanche crenata*Forsk.) biocontrol, Faculty of Agriculture, Omdurman Islamic University.

3- Rania Al Rasheed Abakeer (2019). Effects of seed priming and bacteria on *Striga hermonthica* (Del.) Benth. infestation in sorghum cultivars, Sudan Academy of Sciences (SAS).

4- Maha KamalElhadiKhairallah (2018). Role of aqueous and chemical *Striga* extracts on *Strigahermonthica* seeds germination, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.

5- IsraaMobarkAlabied (2017). Impacts of bacteria, fertilizers and imazethapyr herbicide on *Orobanche crenata* in faba bean, Sudan Academy of Sciences (SAS)**.**

6- Nadir Rhmatallah Babiker (2018). Mycorrhizal fungi and *Trichodermaharzianum* as biocontrol agents for suppression of *Striga hermonthica* in sorghum, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.

7-

Ph.D. Students (ongoing):

1- Mona M Azirg (2018). *Trichoderma* spp.: A biocontrol agent for sustainable management of *Strigahermonthica* in sorghum, Sudan Academy of Sciences (SAS).

2- Al sitiea Al zubearFadul Al atie (2023). Isolation, Identification and Evaluation of Efficient Native Arbuscular Mycorrhizal Fungi for Striga hermonthica Del. (Benth.)

Management in Sorghum, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies

3- Sally Suliman Atta Saad (2023). Trichoderma spp: A potential Fungi as a component of a integrated Orbanche Crenata (Forsk) Management Strategy in faba bean , AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies

M. Sc. Students (Ongoing):

4- Mammon Haroun El Tahir (2018). Implications of *Azospirillumbrasilense* co-inoculated with *Azomonas* spp. and nutrient addition on *Strigahermonthica* incidence in sorghum under greenhouse and laboratory conditions, Sudan Academy of Sciences (SAS).

5- Hassan Abdel Rahman Ismail Ahmed (2018). Influence of bacterial strains, Triclopyr and cultural practices on *Striga hermonthica* (Del.) Benth. incidence in sorghum, Sudan Academy of Sciences (SAS) .

B.Sc. Students (awarded)

1. Mona AbdelraoufAbozaid (2108). Effects of growth promoting bacteria and cultivars on Striga hermonthica and wheat growth, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.
2. Marwa Hassan Abdulla (2017). Effect of Trichoderma harzianum extraction on Orobancheramosa germination, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.
3. Mona Hussein Mohamed (2017). Impacts of Trichoderma harzianum extraction on germination and haustorium initiation of Striga hermonthica, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.
4. Omsalama Mohamed Hassan Mohamed (2017). Effects of $C_2H_4O_2 \cdot NH_3$ and KH_2PO_4 on sorghum and Striga hermonthica growth, AL- Neelain University,Faculty of Science and Technology, Department of Environmental Studies.

5. Hanan Ali Adam (2018). Allelopathic effect of Striga chemical extracts as Potential Bio-herbicide against Striga hermonthica germination, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.
6. Omsalama Mohamed Hassan Mohamed (2017). Effects of C2H4O2·NH3 and KH2PO4 on sorghum and Striga hermonthica growth, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.
7. Reem Salah Eldein Husain. (2018). Biocontrol of *Orobanche crenata* weed on Faba bean with *Trichoderma harzianum* and Mycorrhiza Fungi. University of Bahri, Collage of Agriculture, Department of pests and plant health.
8. Zainab Ali Mohamed Sallih (2017). Effect of different concentrations of fungal priming seeds on growth of sorghum cultivars, AL- Neelain University, Faculty of Science and Technology, Department of Environmental Studies.

Patent

1- A patent has been registered (new technology for Orobanche control in faba bean), Intellectual Property right Office, Sudan, 2022.

Project Design Matrix (PDM) Ver.1 (R/D version)

Project Title: Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

Project Sites: Khartoum (laboratories, experimental farms, training facilities, and other related facilities of NCR, MOAF, ARC and SUST), Gedaref State (farming communities for extension approaches including Farmer Field Schools)

Target Groups: Direct Beneficiaries: Sudanese *Striga* researchers in NCR, ARC and SUST; extension staff of GSMAI for dissemination of improved technologies; and farmers who participate in the field school and experiments. Indirect Beneficiaries: Farmers in Gedaref

Project Duration: 5 years from 2017 to 2022

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Dissemination is in progress to control Orobanchaceae weeds including *Striga* using newly developed technical measures.	- Specific suggestions and action plan proposed by the Project on practical use of innovative technologies developed for *Striga* control are applied outside Gedaref State.	- Governmental documents, Interviews, Questionnaire survey	
Project Purpose An inter-ministerial structure materializes how to disseminate effective technical measures to control Orobanchaceae weeds including *Striga*, which are scientifically proved through Sudan-Japan collaboration.	1) A functional inter-ministerial structure (as Steering Committee) accepts innovative technologies developed for *Striga* control. 2) Medium-term budgetary plans are formulated for NCR, ARC and SUST for the collaborative control of *Striga* through research and dissemination.	- Governmental documents; - NCR, ARC and SUST documents on Budget; - NCR, ARC, SUST and GSMAI documents on *Striga* control.	- No change of organizational mandates that seriously affects the project occurs;
Output 1. Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration. 2. Useful substances that will encourage farmers to weed and utilize are identified in *Striga*. 3. The improved cultural practices to control *Striga* are being disseminated. 4. An NCR managed structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control.	**Under Output 1** **For Activity 1. Development and verification of suicidal germination agents on *Striga* and *Orobanche*** 1-1 Suicidal germination inducers to control *Striga* are evaluated. 1-2 Suicidal germination approach to control *Orobanche* is applied. **For Activity 2. Development of germination inhibitors for root parasitic weeds** 2-1 Planteose metabolism inhibitors and cytokinin oxidase inhibitors are developed. 2-2 The effects of the inhibitors on *Striga* control are examined. **For Activity 3. Demonstration of microorganisms to control germination of *Striga*** 3-1 The performance of the microorganisms that influence *Striga* germination revealed by the previous project (SATREPS I) is verified. 3-2 Active metabolites of the microorganisms are identified. 3-3 Arbuscular mycorrhizal fungi species and isolates are screened. **For Activity 4. Verification of stability and durability of *Striga*-resistance in rice** 4-1 Stability and durability of resistance of the rice cultivars identified by SATREPS I are investigated. 4-2 The effects of the *Striga* seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition.	- Proceedings of meetings; - Published scientific papers; - Bulletins; - Syllabuses and handouts of joint seminars; - Documents on Farmer Field Schools and other farmer participation; - Documents on Steering Committee meetings and related activities.	- Change of C/Ps that seriously affects the Project does not occur.

ANNEX 3

	Under Output 2 **For Activity 5. Identification of useful substances in *Striga* that will encourage farmers to remove and utilize the weed** 5-1 An ethnobotanical survey on indigenous knowledge on purported medicinal uses of *Striga* is undertaken. 5-2 A bioassay-guided fractionation of active ingredients is undertaken. 5-3 The active compound is characterized. 5-4 The metabolites specifically accumulated in *Striga* before flowering are identified by conducting metabolome analyses of young and flowering *Striga* plants. **Under Output 3** **For Activity 6. Dissemination of *Striga* control measures through Farmer Field Schools** 6-1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treated with acetolactate synthase inhibiting herbicides is corroborated on farm. 6-2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on station and on farm. 6-3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm. 6-4 The adoption rate and socio-economic impact of the *Striga* management packages are measured. 6-5 Farmer awareness of the parasite is raised by transferring available *Striga* management strategies employing Farmer Field Schools and other media. **Under Output 4** **For Activity 7. Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.** 7-1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side. 7-2 The established implementation structure for *Striga* control measures is functioning.		
Activities **Under Output 1** **Activity 1.** Development and verification of suicidal germination agents on *Striga* and *Orobanche* **Activity 2.** Development of germination inhibitors for root parasitic weeds **Activity 3.** Demonstration of microorganisms to control germination of *Siriga*	**Inputs** **Japanese side** [Experts] - Long-term expert: 1 Project Coordinator - Short-term expert: Researchers (including 1 Leader) [Materials and Equipment] - Materials and equipment necessary for the project [Training in Japan]	**Sudanese side** [Counterpart personnel] - 1 Leader - Researchers - Extension Staff as adequate [Materials and Equipment] - Materials and equipment necessary for the project other than those supplied by JICA [Facilities]	- Security in the project areas does not deteriorate. - The prices of materials and equipment do not seriously soar. **Pre-conditions**

ANNEX 3

Activity 4. Verification of stability and durability of *Striga*-resistance in rice **Under Output 2** **Activity 5.** Identification of useful substances in *Striga* that will encourage farmers to weed and utilize **Under Output 3** **Activity 6.** Dissemination of *Striga* control measures through Farmer Field Schools **Under Output 4** **Activity 7.** Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.	- C/P training in Sudan and Japan as adequate	- Project Office - Laboratories - Experimental farm plots - Farmer Field School sites	- Security of Sudan stays stable.

ANNEX 3

MINUTES OF MEETINGS
BETWEEN
NATIONAL CENTER FOR RESEARCH
AND
JAPAN INTERNATIONAL COOPERATION AGENCY
ON THE PROJECT FOR
DEVELOPMENT OF COUNTERMEASURES AGAINST *STRIGA* TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN

Referring to the Record of Discussions signed on 29th January 2017 on the project of "Development of Countermeasures against STRIGA to conquer Poverty and Improve Food Security in Sudan", National Center for Research (NCR) of Sudan and Japan International Cooperation Agency (JICA) agreed to amend Project Design Matrix (PDM) as in Annex1 based on the discussions in the 4th JCC meeting which was held on 19th July 2022.

Khartoum, 25th, July 2022

Prof. Zeinab Osman
Director General
National Center for Research
The Republic of The Sudan

Mr. Koji Sakane
Chief Representative
Sudan Office
Japan International Cooperation Agency

Annex 1: Contents of Amendment

Annex 2: Revised Project Design Matrix (PDM ver.2)

ANNEX 3

Contents of Amendment

Amendment in **the 2nd Objectively Verifiable Indicators for Project Purpose**

Before	Amended Version
2) Medium-term budgetary plans are formulated for NCR, ARC and SUST for the collaborative control of *Striga* through research and dissemination. Means of Verification NCR, ARC, SUST and GSMAI documents on Striga control	2) Three years Action plans are formulated for NCR, ARC and SUST for the collaborative control of *Striga* through research and dissemination. Means of Verification NCR, ARC and SUST documents to be submitted to MOFEP

Reason:

Due to the change of government structure in Sudan since 25th October 2021, government's budget distribution process becomes unpredictable and beyond the control of project stakeholders involved, and the correlation between 'formulation of budgetary plan" and 'materialization of an inter-ministerial structure', as stipulated in the Project Purpose, becomes less relevant.

In addition, the term "medium-term" is ambiguous to relevant ministries and organizations in Sudan.

In order to pursue the achievements of Project Purpose even under the current situation and to accelerate all stakeholders' efforts toward the realization of Project Purpose, a more concrete and action-oriented indicator is introduced, as a substitute for the current one.

Project Design Matrix (PDM ver.2)

Project Title: Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

Project Sites: Khartoum (laboratories, experimental farms, training facilities, and other related facilities of NCR, MOAF, ARC and SUST), Wad Medani (laboratories and field facilities of ARC) and Gedaref State (farming communities for extension approaches including Farmer Field Schools)

Target Groups: Direct Beneficiaries: Sudanese *Striga* researchers in NCR, ARC and SUST; extension staff of GSMAI for dissemination of improved technologies; and farmers who participate in the field school and experiments. Indirect Beneficiaries: Farmers in Gedaref

Project Duration: 5 years from 2017 to 2022

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Dissemination is in progress to control Orobanchaceae weeds including *Striga* using newly developed technical measures.	- Specific suggestions and action plan proposed by the Project on practical use of innovative technologies developed for *Striga* control are applied outside Gedaref State.	- Governmental documents, Interviews, Questionnaire survey	
Project Purpose An inter-ministerial structure materializes how to disseminate effective technical measures to control Orobanchaceae weeds including *Striga*, which are scientifically proved through Sudan-Japan collaboration.	1) A functional inter-ministerial structure (as Steering Committee) accepts innovative technologies developed for *Striga* control. 2) Three years Action plans are formulated for NCR, ARC and SUST for the collaborative control of *Striga* through research and dissemination.	- Governmental documents; - NCR, ARC and SUST documents on Budget; - NCR, ARC, SUST and documents to be submitted to MOFEP	- No change of organizational mandates that seriously affects the project occurs;
Output 1. Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration. 2. Useful substances that will encourage farmers to weed and utilize are identified in *Striga*. 3. The improved cultural practices to control *Striga* are being disseminated. 4. An NCR managed structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control.	**Under Output 1** **For Activity 1. Development and verification of suicidal germination agents on *Striga* and *Orobanche*** 1-1 Suicidal germination inducers to control *Striga* are evaluated. 1-2 Suicidal germination approach to control *Orobanche* is applied. **For Activity 2. Development of germination inhibitors for root parasitic weeds** 2-1 Planteose metabolism inhibitors and cytokinin oxidase inhibitors are developed. 2-2 The effects of the inhibitors on *Striga* control are examined. **For Activity 3. Demonstration of microorganisms to control germination of *Striga*** 3-1 The performance of the microorganisms that influence *Striga* germination revealed by the previous project (SATREPS I) is verified. 3-2 Active metabolites of the microorganisms are identified. 3-3 Arbuscular mycorrhizal fungi species and isolates are screened. **For Activity 4. Verification of stability and durability of *Striga*-resistance in rice** 4-1 Stability and durability of resistance of the rice cultivars identified by SATREPS I are investigated. 4-2 The effects of the *Striga* seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition.	- Proceedings of meetings; - Published scientific papers; - Bulletins; - Syllabuses and handouts of joint seminars; - Documents on Farmer Field Schools and other farmer participation; - Documents on Steering Committee meetings and related activities.	- Change of C/Ps that seriously affects the Project does not occur.

ANNEX 3

	Under Output 2 **For Activity 5. Identification of useful substances in *Striga* that will encourage farmers to remove and utilize the weed** 5-1 An ethnobotanical survey on indigenous knowledge on purported medicinal uses of *Striga* is undertaken. 5-2 A bioassay-guided fractionation of active ingredients is undertaken. 5-3 The active compound is characterized. 5-4 The metabolites specifically accumulated in *Striga* before flowering are identified by conducting metabolome analyses of young and flowering *Striga* plants. **Under Output 3** **For Activity 6. Dissemination of *Striga* control measures through Farmer Field Schools** 6-1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treated with acetolactate synthase inhibiting herbicides is corroborated on farm. 6-2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on station and on farm. 6-3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm. 6-4 The adoption rate and socio-economic impact of the *Striga* management packages are measured. 6-5 Farmer awareness of the parasite is raised by transferring available *Striga* management strategies employing Farmer Field Schools and other media. **Under Output 4** **For Activity 7. Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.** 7-1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side. 7-2 The established implementation structure for *Striga* control measures is functioning.		
Activities **Under Output 1** **Activity 1.** Development and verification of suicidal germination agents on *Striga* and *Orobanche* **Activity 2.** Development of germination inhibitors for root parasitic weeds **Activity 3.** Demonstration of	**Inputs** **Japanese side** [Experts] - Long-term expert: 1 Project Coordinator - Short-term expert: Researchers (including 1 Leader) [Materials and Equipment]	**Sudanese side** [Counterpart personnel] - 1 Leader - Researchers - Extension Staff as adequate [Materials and Equipment]	- Security in the project areas does not deteriorate. - The prices of materials and equipment do not seriously soar.

ANNEX 3

microorganisms to control germination of *Striga* **Activity 4.** Verification of stability and durability of *Striga*-resistance in rice **Under Output 2** **Activity 5.** Identification of useful substances in *Striga* that will encourage farmers to weed and utilize **Under Output 3** **Activity 6.** Dissemination of *Striga* control measures through Farmer Field Schools **Under Output 4** **Activity 7.** Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.	- Materials and equipment necessary for the project [Training in Japan] - C/P training in Sudan and Japan as adequate	- Materials and equipment necessary for the project other than those supplied by JICA [Facilities] - Project Office - Laboratories - Experimental farm plots - Farmer Field School sites	**Pre-conditions** - Security of Sudan stays stable.

RECORD OF DISCUSSIONS
ON
DEVELOPMENT OF COUNTERMEASURES AGAINST *STRIGA* TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN
AGREED UPON BETWEEN
NATIONAL CENTER FOR RESEARCH
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Khartoum, 29/1/2017

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Based on the Minutes of Meetings on the Detailed Planning Survey on Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan (hereinafter referred to as "the Project") signed on 26th September 2016 between the National Center for Research (hereinafter referred to as "NCR") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with NCR and relevant organizations to develop a detailed plan of the Project.

Both parties agreed the details of the Project and the main points discussed as described in the Appendix 1 and the Appendix 2, respectively.

Both parties also agreed that NCR, the counterpart to JICA, will be responsible for the implementation of the Project in cooperation with JICA, coordinating with other relevant organizations, and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of the Republic of the Sudan (hereinafter referred to as "Sudan").

The Project will be implemented within the framework of the Note Verbales exchanged on (date) between the Government of Japan (hereinafter referred to as "GOJ") and the Government of Sudan (hereinafter referred to as "GOS").

Appendix 1: Project Description
Appendix 2: Main Points Discussed

Appendix 1

PROJECT DESCRIPTION

I. BACKGROUND

The Agriculture sector of Sudan has some 30% share in the GDP. It contributes about 80% to the non-oil export earnings, and provides 60% of the jobs. While agriculture in Sudan is practiced under both irrigated and rain-fed conditions, 90% of the cultivated area is under rain-fed. Sorghum, a staple food for the majority of people, also providing feed stuff to livestock, is one of the most important crops. However, its yield (0.44-0.78 ton/ha) is largely lower than the international average (1.28 ton/ha) and is declining further. It is reported that the yield decline is more obvious with the mechanized rain-fed system (where water shortage prevails) than the irrigated system, and the issue is a serious one since Sudan derives some 85% of sorghum production from that production system. Researchers also report that the decline in the yield is largely due to the increase of *Striga*, a root parasitic weed. Therefore, the management of *Striga* is of an urgent importance for Sudan in terms of livelihoods of subsistence farmers and the national food security. To deal with the problem, GOS requested GOJ a technical cooperation project, titled Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds. The project, supported by JICA and Japan Science and Technology Agency (JST), was carried out in 2010-2015 by Sudan University of Science and Technology (SUST) and Kobe University as lead institutes. That project achieved results such as findings of a new chemical agent to induce suicidal germination of *Striga*, cultural practices to decrease the weed population and selection of *Striga* tolerant rice varieties.

To further the achievements, the GOS requested GOJ for technical cooperation by a new project with NCR as the implementing agency, supported by Agricultural Research Corporation (ARC), SUST and other relevant bodies from the Sudan side, and Kobe University as the lead institute from the Japanese side. In response, JICA dispatched a detailed planning survey team for discussion and planning of the Project in August-September 2016.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Project Design Matrix (PDM) (Annex 1) and the Plan of Operation (Annex 2).

1. Input
   (1) Input by JICA
      (a) Dispatch of Experts
         - Long-term expert: 1 Project Coordinator
         - Short-term experts: Researchers of relevant subjects (including 1 Leader, Natural Product Chemistry, Synthetic Chemistry, Plant Physiology, Crop Science, and others as adequate.)

      (b) Training in Sudan and Japan as adequate

(c) Materials, Machinery and Equipment necessary for the Project

In case of importation, the materials, machinery and equipment under II-1 (1) (c) above will become the property of Sudan upon being delivered C.I.F. (cost, insurance and freight) to the Sudanese authorities concerned at the ports and/or airports of disembarkation.

(2) Input by NCR

NCR, in cooperation with relevant organizations, will take necessary measures to provide the following at its own expense:

(a) Services of counterpart personnel and administrative personnel as referred to in II-2 (Implementation Structure);
(b) Suitable office space with necessary equipment;
(c) Support for obtaining official resident permit;
(d) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
(e) Facilitation for transport of the JICA experts for official travel within Sudan, such as issuing travel permit;
(f) Information as well as facilities in obtaining suitable furnished accommodation for the JICA experts and their families;
(g) Information as well as support in obtaining medical service;
(h) Credentials or identification cards;
(i) Available data (including maps and photographs) and information related to the Project;
(j) Running expenses necessary for the implementation of the Project;
(k) Expenses necessary for transportation within Sudan of the equipment referred to in II-1 (1) (c) as well as for the installation, operation and maintenance thereof; and,
(l) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Sudan from Japan in connection with the implementation of the Project.

2. Implementation Structure

The project organization chart is given in the Annex 3. The roles and assignments of relevant organizations are as follows:

(1) NCR

(a) Project Director

As the implementing agency of the Project, NCR assigns the Director General as the Project Director responsible for overall administration and implementation of the Project.

(b) Project Manager

The Research Professor (Weed Science) of NCR will be responsible for managerial and technical matters of the Project.

(c) Other personnel for implementing of the Project

Researchers to collaborate with JICA experts for the Activities shown in PDM, and other support staff, etc.

(2) ARC

As collaborating institute, ARC assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(3) SUST

As collaborating institute, SUST assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(4) Gedaref State Ministry of Agriculture and Irrigation (GSMAI)

As collaborating agency, GSMAI assigns Extension Staff for activities including Farmer Field School to collaborate with JICA experts and ARC researchers in the relevant subject.

(5) Ministry of Higher Education and Scientific Research (MoHESR)

As supervising Ministry for NCR and SUST, MoHESR provides advice and necessary supports for the Project, including assignment of a member to the Steering Committee (SC) explained in II 2. (7).

(6) Ministry of Agriculture and Forestry (MoAF)

As supervising Ministry for ARC and GSMAI, MoAF provides advice and necessary supports for the Project, including assignment of a member to a SC explained in II 2. (7).

(7) Steering Committee (SC)

SC encompassing relevant ministries and organizations is set up by NCR's initiative to collectively address important weed problems including *Striga*. The SC also facilitates smooth implementation of the Project and promotes dissemination of technologies developed by the Project to farmers. In the Joint Coordination Committee (JCC) explained in II 1. (9), it works as Sudanese part of it. The SC will continue to function even after the Project. NCR will also set up a Technical Committee (TC) for Sudanese side to discuss technical matters.

(8) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to NCR and relevant organizations on matters pertaining to the implementation of the Project. The JICA experts will be researchers of Kobe University, Osaka Prefecture University and other supporting research institutes.

(9) Joint Coordination Committee (JCC)

A JCC will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will review the progress, revise the overall plan when necessary, approve an annual work plan, conduct evaluation of the Project, share relevant information, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members

of JCC is shown in the Annex 4.

3. Project Sites and Beneficiaries

Project Sites: Khartoum (laboratories, experimental farms, training facilities and other related facilities of NCR, MoAF, ARC and SUST), Wad Medani (laboratories and field facilities of ARC) and Gadaref State (farming communities for extension approaches including Farmer Field Schools);

Direct Beneficiaries: Sudanese *Striga* researchers in NCR, ARC and SUST; extension staff of GSMAI for dissemination of improved technologies; and farmers who participate in the Farmer Field School, other extension approaches and experiments.

Indirect Beneficiaries: Farmers in Gedaref

4. Duration

Five (5) years from 2017 to 2022. (The Project' s first day is when the first JICA Expert arrives in Sudan or the first Sudanese trainee arrives in Japan.)

5. Environmental and Social Considerations

NCR will abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF NCR AND GOS

1. NCR and GOS will take necessary measures to:

(1) ensure that the technologies and knowledge acquired by the Sudan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Sudan, and that the knowledge and experience acquired by the personnel of Sudan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and,

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) (a) above and their families, which are no less favorable than those granted to experts and members of the missions and their families of third countries or international organizations performing similar missions in Sudan.

2. NCR and GOS will take necessary measures to:

(1) provide security-related information as well as measures to ensure the safety of the JICA experts;
(2) permit the JICA experts to enter, leave and sojourn in Sudan, wherever relevant, for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees;

3. Other privileges, exemptions and benefits will be provided in accordance with

the Note Verbales exchanged on (date) between the GOJ and the GOS.

4.NCR, in coordination with relevant organizations of Sudan, will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. MONITORING AND EVALUATION

JICA and NCR will jointly and regularly monitor the progress of the Project through the Monitoring Sheets based on the PDM and Plan of Operation (PO). The Monitoring Sheets will be reviewed every six (6) months. Also, Project Completion Report will be drawn up one (1) month before the termination of the Project.

JICA will conduct the following evaluations and surveys to verify sustainability and impact of the Project.

1. Ex-post evaluation, three years after the project completion, in principle;
2. Review and follow-up surveys on necessity basis.

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, NCR will take appropriate measures to make the Project widely known to the people of Sudan.

VI. MISCONDUCT

If JICA receives information related to suspected corrupt or fraudulent practices in the implementation of the Project, NCR and relevant organizations will provide JICA with such information as JICA may reasonably request, including information related to any concerned official of the government and/or public organizations of Sudan.

NCR and relevant organizations will not, unfairly or unfavorably treat the person and/or company which provided the information related to suspected corrupt or fraudulent practices in the implementation of the Project.

VII. MUTUAL CONSULTATION

JICA and NCR will consult each other whenever any major issues arise in the course of Project implementation.

VIII. AMENDMENTS

The Record of Discussions may be amended by the minutes of meetings between JICA and NCR. However, PO may be amended in the Monitoring Sheets.

The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

Annex 1 Project Design Matrix (PDM)
Annex 2 Tentative Plan of Operation
Annex 3 Project Organization Chart
Annex 4 List of Proposed Members of Joint Coordination Committee

Project Design Matrix (PDM)

Project Title: Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan
ProjectSites: Khartoum (laboratories, experimental farms, training facilities, and other related facilities of NCR, MOAF, ARC and SUST), Wad Medani (laboratories and field facilities of ARC) andGedarefState (farming communities for extension approaches including Farmer Field Schools)
Target Groups: Direct Beneficiaries: Sudanese*Striga* researchers in NCR, ARCand SUST;extension staff of GSMAIfor dissemination ofimproved technologies; and farmers who participate in the field school and experiments.Indirect Beneficiaries: Farmers in Gedaref
Project Duration: 5 years from 2017 to 2022

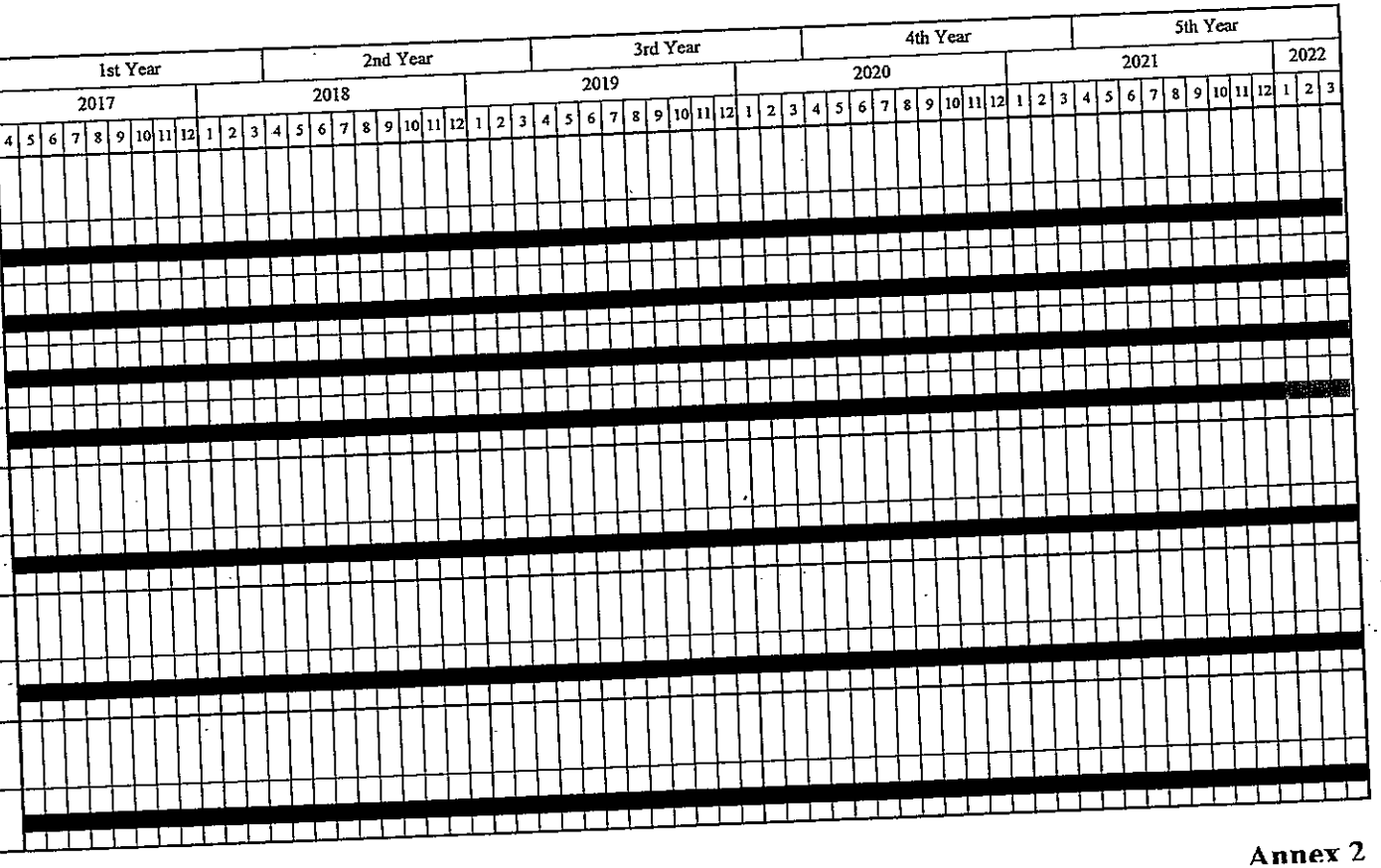
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Dissemination is in progress to control Orobanchaceae weeds including *Striga* using newly developed technical measures.	- Specific suggestions and action plan proposed by the Project on practical use of innovative technologies developed for *Striga* control are applied outside Gedaref State.	- Governmental documents, Interviews, Questionnaire survey	
Project Purpose An inter-ministerial structure materializes how to disseminate effective technical measures to control Orobanchaceae weeds including *Striga*, which are scientifically proved through Sudan-Japancollaboration.	1) A functionalinter-ministerial structure (as Steering Committee)acceptsinnovative technologies developed for *Striga* control. 2) Medium-term budgetary plansare formulated for NCR, ARC and SUSTfor the collaborative control of*Striga*through research and dissemination.	- Governmental documents; - NCR, ARC and SUST documents on Budget; - NCR, ARC, SUST and GSMAI documents on *Striga* control.	- No change of organizational mandates that seriously affects the project occurs;
Output 1. Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration. 2. Useful substances that will encourage farmers to weed and utilize are identified in *Striga*. 3. The improved cultural practices to control *Striga* are being disseminated. 4. An NCR managed structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for*Striga* control.	**Under Output 1** **For Activity 1. Development and verification of suicidal germination agents on *Striga* and *Orobanche*** 1-1 Suicidal germination inducers to control *Striga* are evaluated. 1-2 Suicidal germination approach to control *Orobanche* is applied. **For Activity 2. Development of germination inhibitors for root parasitic weeds** 2-1 Planteose metabolism inhibitors and cytokinin oxidase inhibitors are developed. 2-2 The effects of the inhibitors on *Striga* control are examined. **For Activity 3. Demonstration of microorganisms to control germination of *Striga*** 3-1 The performance of the microorganisms that influence *Striga* germination revealed by the previous project (SATREPS I) is verified. 3-2 Active metabolites of the microorganisms are identified. 3-3 Arbuscularmycorrhizal fungi species and isolates are screened. **For Activity 4. Verification of stability and durability of *Striga*-resistance in rice** 4-1 Stability and durability of resistance of the rice cultivars identified by SATREPS I are investigated. 4-2 The effects of the *Striga* seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition.	- Proceedings of meetings; - Published scientific papers; - Bulletins; - Syllabusesand handouts of joint seminars; - Documents on Farmer Field Schools and other farmer participation; - Documents on Steering Committee meetings and related activities.	- Change of C/Ps that seriously affects the Project does not occur.

	Under Output 2 **For Activity 5. Identification of useful substances in *Striga* that will encourage farmers to remove and utilize the weed** 5-1 An ethnobotanical survey on indigenous knowledge on purported medicinal uses of *Striga* is undertaken. 5-2 A bioassay-guided fractionation of active ingredients is undertaken. 5-3 The active compound is characterized. 5-4 The metabolites specifically accumulated in *Striga* before flowering are identified by conducting metabolome analyses of young and flowering *Striga* plants. **Under Output 3** **For Activity 6. Dissemination of *Striga* control measures through Farmer Field Schools** 6-1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treated with acetolactate synthase inhibiting herbicides is corroborated on farm. 6-2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on station and on farm. 6-3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm. 6-4 The adoption rate and socio-economic impact of the *Striga* management packages are measured. 6-5 Farmer awareness of the parasite is raised by transferring available *Striga* management strategies employing Farmer Field Schools and other media. **Under Output 4** **For Activity 7. Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.** 7-1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side. 7-2 The established implementation structure for*Striga* control measures is functioning.		
Activities **Under Output 1** **Activity 1.**Development and verification of suicidal germination agents on *Striga* and *Orobanche* **Activity 2.**Development of germination inhibitors for root parasitic weeds **Activity 3.**Demonstration of microorganisms to control germination of *Striga*	**Inputs** **Japanese side** [Experts] - Long-term expert: 1 Project Coordinator - Short-term expert: Researchers (including 1 Leader) [Materials and Equipment] - Materials and equipment necessary for the project [Training in Japan]	**Sudanese side** [Counterpart personnel] - 1 Leader - Researchers - Extension Staff as adequate [Materials and Equipment] - Materials and equipmentnecessary for the project other than those supplied by JICA [Facilities]	- Security in the project areas does not deteriorate. - The prices of materials and equipment do not seriously soar. **Pre-conditions**

Activity 4. Verification of stability and durability of *Striga*-resistance in rice **Under Output 2** **Activity 5.** Identification of useful substances in *Striga* that will encourage farmers to weed and utilize **Under Output3** **Activity 6.** Dissemination of *Striga* control measures through Farmer Field Schools **Under Output4** **Activity 7.** Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.	- C/P training in Sudan and Japan as adequate	- Project Office - Laboratories - Experimental farm plots - Farmer Field School sites	- Security of Sudan stays stable.

Annex 2. Tentative Plan of Operation (PO)

Outputs / Activities	Leaders for the Activity	
	Japanese Side	Sudanese Side
1 Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration		
1 Development and verification of suicidal germination agents on *Striga* and *Orobanche*	Takikawa, Sugimoto, Kobe Univ.	Babiker, NCR, Randa, NCR
2 Development of germination inhibitors for root parasitic weeds	Okazawa, Osaka Pref. Univ.	Somaya, NCR
3 Demonstration of microorganisms to control germination of *Striga*	Tani, Kuse, Kobe Univ.	Hassan, NCR
4 Verification of stability and durability of *Striga*-resistance in rice	Samejima, Kobe Univ.	Dawoud, ARC, Babiker, NCR
2 Useful substances that will encourage farmers to weed and utilize are identified in *Striga*.		
5 Identification of useful substances in *Striga* that will encourage farmers to weed and utilize	Kuse, Sugimoto, Kobe Univ.	Siribel Awatif, NCR
3 The improved cultural practices to control *Striga* are being disseminated.		
6 Dissemination of *Striga* control measures through Farmer Field Schools	Samejima, Kobe Univ.	Dawoud, ARC Ayman, ARC
4 A structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control.		
7 Establishment of a functional implementation structure to forward *Striga* control measures	Sugimoto, Kobe Univ.	Migdam, NCR



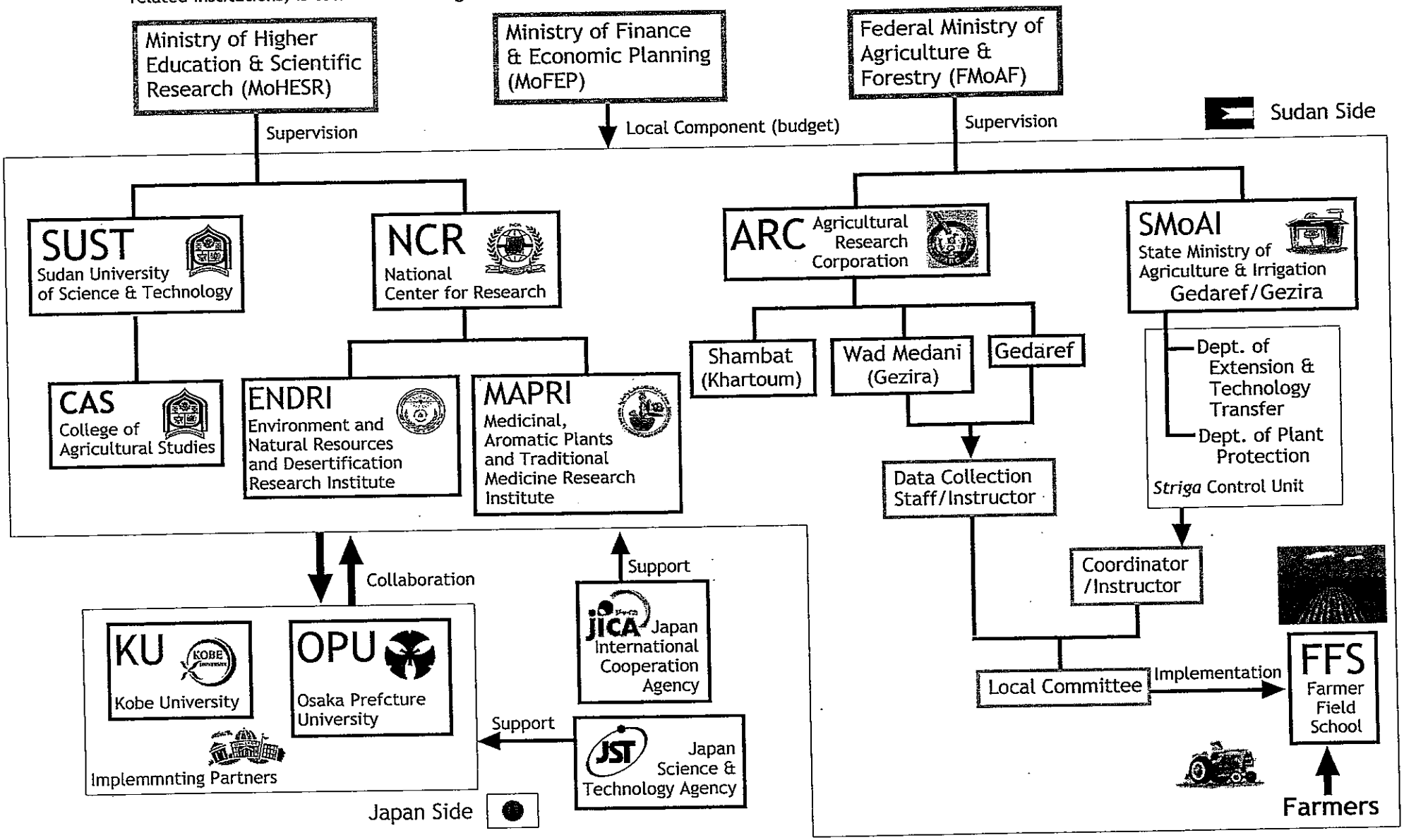
Annex 2

Legend
Core operation period
Preparatory or follow-up period

ProjectOrganization Chart:

Project for Developing Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

Project Purpose: The extension system for effective control technologies against the *Orobanchaceae* weeds including *Striga*, developed in collaboration with the Sudanese related institutions, is established/strengthened.



Annex 4

List of Proposed Members of Joint Coordination Committee (JCC)

1. FUNCTION

The Joint Coordination Committee (JCC) will meet at least once a year and whenever necessity arises. The main functions of JCC are as follows:

- Formulate annual operational work plan of the Project based on the tentative schedule of implementation within the framework of the Record of Discussions (R/D);
- Review overall progress and achievements of the Project;
- Examine major issues arising from or in connection with the Project;
- Work out modification of activities depending on the necessity;
- Ensure smooth implementation of the Project and secure ministerial coordination, guidance and supervision, information sharing, as well as draw expertise from other ministries, departments, and organizations.

2. COMPOSITION

JCC will be composed of the following members.

(1) Co-Chairpersons
- Representative of NCR and Leader of JICA Expert Team

(2) Sudanese Side:
- Project Director
- Project Manager
- Other representative(s) of NCR
- Representative of ARC
- Representative of SUST's College of Agricultural Studies (CAS)
- Representative of Federal Ministry of Finance and Economic Planning (FMoFEP)
- Representative of Federal Ministry of International Cooperation (FMoIC)
- Representative of Federal Ministry of Higher Education and Scientific Research (FMoHESR)
- Representative of Federal Ministry of Agriculture and Forestry (FMoAF)
- Representative of State Ministry of Agriculture (Gedaref)

(3) Japanese Side:
- JICA Experts (including the Leader, Coordinator, and other experts)
- Representative of JICA Sudan Office

(4) Observer:
- Representative of State Ministry of Agriculture (Khartoum)
- Representative of State Ministry of Agriculture (River Nile)
- Representative of State Ministry of Agriculture (Gezira)
- Representative of State Ministry of Agriculture (Northern State)
- Official(s) from the Embassy of Japan
- Representative of Japan Science and Technology Agency (JST)
- Other person(s) appointed by Co-Chairpersons

Appendix 2

MAIN POINTS DISCUSSED

1. Social implementation of research outcomes:
- As the Project intends to ultimately benefit farmers victimized by *Striga*, securing research-extension linkage is vital.
- The initiative NCR has taken to establish an SC encompassing related ministries and organizations is a substantive step forward that will lead to Output-4 of PMD and achievement of the Project Purpose.
- NCR is encouraged to keep vital dialogs with prospective SC members and clarify the roles they would play as agreed with other concerned institutions and experts, in particular MoAF for dissemination of *Striga* control measures.

2. Appropriate planning and use of equipment:
- The Project being a technical cooperation, only the equipment indispensable for technology transfer will be considered for the input of the Project. NCR, in cooperation with related ministries and organizations, is encouraged to make best use of project procured equipment, during and after the Project, including putting in place a well-defined management responsibility.
- The capacity built and equipment provided at SUST in the project entitled Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds will also be made best use by participating researchers for the new project.

3. The program under which the Project is implemented:
- Both sides noted that the Project is implemented under the Science and Technology Research Partnership for Sustainable Development (hereinafter referred to as "SATREPS") program, promoted by JICA and JST in collaboration. SATREPS aims to develop new technologies and their applications for tackling global issues, and also aims at capacity development of researchers and research institutes in both countries.

MINUTES OF MEETINGS
BETWEEN
THE JAPANESE DETAILED PLANNING SURVEY TEAM
AND
THE NATIONAL CENTER FOR RESEARCH
ON
JAPANESE TECHNICAL COOPERATION FOR
DEVELOPMENT OF COUNTERMEASURES AGAINST *STRIGA* TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN

The Japanese Detailed Planning Survey Team (hereinafter referred to as "the Team"), organized by the Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Mr. Hajime Nabeta, visited the Republic of The Sudan (hereinafter referred to as "Sudan") from 23rd August to 2nd September and from 17th to 26th September 2016, for the purpose of formulating the technical cooperation project "Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan" (hereinafter referred to as "the Project").

During its stay in Sudan, the Team exchanged views and had a series of meetings with the authorities concerned of the Government of Sudan ("GOS" hereinafter) with respect to the implementation of the Project. As a result of the discussions, both sides reached common understanding concerning the designed framework of the Project referred to in the document attached hereto.

Khartoum, 26th September 2016

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Leader, Japanese Detailed Planning Survey Team
Japan International Cooperation Agency

Migdam E. Abdelgani
Director General
National Center for Research
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Director
International Affairs
Ministry of Higher Education and Scientific Research
The Republic of The Sudan

Ahmed Hamid Mahmoud
Director
Bilateral Cooperation
Ministry of International Cooperation
The Republic of The Sudan

ATTACHED DOCUMENT

I. TENTATIVE BASIC FRAMEWORK OF THE PROJECT

Both sides agreed on the basic framework of the Project as described in the Project Design Matrix (hereinafter referred to as "PDM") (Annex 1) and the Tentative Plan of Operation (hereinafter referred to as "PO") (Annex 2). The outline of the Project is as follows.

1. Project Title:
   Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

2. Project Duration:
   Five (5) years from 2017 to 2022 (tentative)

3. Project Sites:
   Khartoum (laboratories, experimental farms, training facilities and other related facilities of National Center for Research (NCR), Ministry of Agriculture and Forestry (MoAF), Agricultural Research Corporation (ARC) and Sudan University of Science and Technology (SUST)), and Gedaref State (farming communities for extension approaches including Farmer Field Schools).

4. Overall Goal:
   Dissemination is in progress to control *Striga* using newly developed technical measures.

5. Project Purpose:
   An inter-ministerial structure to control Orobanchaceae weeds including *Striga* is leading dissemination of effective technical measures scientifically proved through Sudan-Japan collaboration.

6. Outputs:
   Output 1: Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration.
   Output 2: Useful substances that will encourage farmers to weed and utilize are identified in *Striga*.
   Output 3: The improved cultural practices to control *Striga* are being disseminated.
   Output 4: A structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control.

7. Activities:
   <u>Under Output 1</u>
   Activity 1: Development and verification of suicidal germination agents on *Striga* and *Orobanche*.
   Activity 2: Development of germination inhibitors for root parasitic weeds.
   Activity 3: Demonstration of microorganisms to control germination of *Striga*.

Activity 4: Verification of stability and durability of *Striga*-resistance in sorghum and rice.

Under Output 2

Activity 5: Identification of useful substances in *Striga* that will encourage farmers to weed and utilize.

Under Output 3

Activity 6: Dissemination of *Striga* control measures through Farmer Field Schools.

Under Output 4

Activity 7: Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.

II. IMPLEMENTATION STRUCTURE OF THE PROJECT

Both sides identified the organizations and functionaries to be engaged in the project implementation as follows, and agreed on the project organization chart (Annex 3). A Joint Coordination Committee will be organized as shown in 1 (6).

1. Implementation Structure

(1) NCR

(a) Project Director

As the implementing agency of the Project, NCR assigns the Director General as the Project Director responsible for overall administration and implementation of the Project.

(b) Project Manager

The Research Professor (Weed Science) of NCR will be responsible for managerial and technical matters of the Project.

(c) Other personnel for implementing of the Project

Researchers to collaborate with JICA experts for the Activities shown in I 7 above, and other support staff, etc.

(2) ARC

As collaborating institute, ARC assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(3) SUST

As collaborating institute, SUST assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(4) Gedaref State Ministry of Agriculture and Irrigation (GSMAI)

As collaborating agency, GSMAI assigns Extension Staff for activities including Farmer Field School to collaborate with JICA experts and ARC researchers in the relevant subject.

(5) Ministry of Higher Education and Scientific Research (MoHESR)

As supervising Ministry for NCR and SUST, MoHESR provides advice and necessary supports for the Project, including assignment of a member to

the SC mentioned in II 1. (7).

(6) Ministry of Agriculture and Forestry

As supervising Ministry for ARC and GSMAI, MoAF provides advice and necessary supports for the Project, including assignment of a member to the SC mentioned in II 1. (7).

(7) Steering Committee

A Steering Committee (SC) encompassing relevant ministries and organizations is set up by NCR's initiative to collectively address important weed problems including *Striga*. The SC also facilitates smooth implementation of the Project and promotes dissemination of technologies developed by the Project to farmers. In the Joint Coordination Committee (JCC) explained in II 1. (8), it works as Sudanese part of it. The SC will continue to function even after the Project. NCR will also set up a Technical Committee (TC) for Sudanese side to discuss technical matters.

(8) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to NCR and relevant organizations on matters pertaining to the implementation of the Project. The JICA experts will be researchers of Kobe University, Osaka Prefecture University and other supporting research institutes.

(9) Joint Coordination Committee

A Joint Coordination Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will review the progress, revise the overall plan when necessary, approve an annual work plan, conduct evaluation of the Project, share relevant information, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex 4.

III. MAIN POINTS DISCUSSED

Both sides agreed on the specific points of the Project as follows.

1. Social implementation of research outcomes:

- As the Project intends to ultimately benefit farmers victimized by *Striga*, securing research-extension linkage is vital.
- The initiative NCR has taken to establish a Steering Committee (SC) encompassing related ministries and organizations is a substantive step forward that will lead to Output-4.
- NCR is encouraged to keep vital dialogs with prospective SC members and step by step clarify the roles they would play as agreed with other concerned institutions and experts, in particular MoAF for dissemination of *Striga* control measures.

2. Appropriate planning and use of equipment:

- The Project being a technical cooperation, only the equipment indispensable for technology transfer will be considered. NCR, in cooperation with related ministries and organizations, is encouraged to make best use of project procured equipment, during and after the Project, including putting in place a well-defined management responsibility.
- The capacity built and equipment provided at SUST in the project entitled Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds will also be made best use by participating researchers for the new project.

IV. SIGNING OF THE RECORD OF DISCUSSIONS

Both sides confirmed the draft Record of Discussions (hereinafter referred to as "R/D"), which stipulates the framework of the Project, shown as Annex 5. The draft R/D will be finalized and signed by the representative of the Government of Sudan and JICA Sudan Office subsequent to the final approval of implementation of the Project at JICA Headquarters.

V. OTHER MATTERS

Both sides noted that the Project is implemented under the Science and Technology Research Partnership for Sustainable Development (hereinafter referred to as "SATREPS") program, promoted by JICA and JST in collaboration. SATREPS aims to develop new technologies and their applications for tackling global issues, and also aims at capacity development of researchers and research institutes in both countries.

Annex 1	Tentative PDM
Annex 2	Tentative Plan of Operation (PO)
Annex 3	Tentative Project Organization Chart
Annex 4	A Tentative List of Proposed Members of Joint Coordination Committee
Annex 5	Draft Record of Discussions (R/D)

Annex 1

Project Design Matrix (PDM) (tentative)

Project Title: Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

ProjectSites: Khartoum (laboratories, experimental farms, training facilities, and other related facilities of NCR, MoAF, ARC and SUST), Gedaref State (farming communities for extension approaches including Farmer Field Schools)

Target Groups: Direct Beneficiaries: Sudanese *Striga* researchers in NCR, ARC and SUST; extension staff of GSMAI for dissemination of improved technologies; and farmers who participate in the field school and experiments. Indirect Beneficiaries: Farmers in Gedaref

Project Duration: 5 years from 2017 to 2022

Prepared on 26th Sep. 2016 (ver. 0)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Dissemination is in progress to control *Striga* using newly developed technical measures.	- Specific suggestions and action plan proposed by the Project on practical use of innovative technologies developed for *Striga* control are applied outside Gedaref State.	- Governmental documents, Interviews, Questionnaire survey	
Project Purpose An inter-ministerial structure to control Orobanchaceae weeds including *Striga* is leading dissemination of effective technical measures scientifically proved through Sudan-Japan collaboration.	1) A functionalinter-ministerial structure (as Steering Committee)for the control of *Striga*is established. 2) Medium-term budgetary plansare formulated for NCR, ARC and SUSTfor the collaborative control of*Striga*through research and dissemination. 3) The farmers in Gedaref utilize the technical measures developed by the Project.	- Governmental documents; - NCR, ARC and SUST documents on Budget; - NCR, ARC, SUST and GSMAI documents on *Striga* control.	- No change of organizational mandates that seriously affects the project occurs;
Output 1. Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration. 2. Useful substances that will encourage farmers to weed and utilize are identified in *Striga*. 3. The improved cultural practices to control *Striga* are being disseminated. 4. A structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for*Striga* control.	**Under Output 1** **For Activity 1. Development and verification of suicidal germination agents on *Striga* and *Orobanche*** 1-1 Suicidal germination inducers to control *Striga* are evaluated. 1-2 Suicidal germination approach to control *Orobanche* is applied. **For Activity 2. Development of germination inhibitors for root parasitic weeds** 2-1 Plantcose metabolism inhibitors and cytokinin oxidase inhibitors are developed. 2-2 The effects of the inhibitors on *Striga* control are examined. **For Activity 3. Demonstration of microorganisms to control germination of *Striga*** 3-1 The performance of the microorganisms that influence *Striga* germination revealed by the previous project (SATREPS I) is verified. 3-2 Active metabolites of the microorganisms are identified. 3-3 Arbuscularmycorrhizal fungi species and isolates are screened. **For Activity 4. Verification of stability and durability of *Striga*-resistance in sorghum and rice** 4-1 Stability and durability of resistance of the rice cultivars identified by SATREPS I are investigated. 4-2 The effects of the *Striga* seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition.	- Proceedings of meetings; - Published scientific papers; - Bulletins; - Syllabusesand handouts of joint seminars; - Documents on Farmer Field Schools and other farmer participation; - Documents on Steering Committee meetings and related activities.	- Change of C/Ps that seriously affects the Project does not occur.

Under Output 2

For Activity 5. Identification of useful substances in *Striga* that will encourage farmers to remove and utilize the weed

5-1 An ethnobotanical survey on indigenous knowledge on purported medicinal uses of *Striga* is undertaken.

5-2 A bioassay-guided fractionation of active ingredients is undertaken.

5-3 The active compound is characterized.

5-4 The metabolites specifically accumulated in *Striga* before flowering are identified by conducting metabolome analyses of young and flowering *Striga* plants.

Under Output 3

For Activity 6. Dissemination of *Striga* control measures through Farmer Field Schools

6-1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treated with acetolactate synthase inhibiting herbicides is corroborated on farm.

6-2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on station and on farm.

6-3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm.

6-4 The adoption rate and socio-economic impact of the *Striga* management packages are measured.

6-5 Farmer awareness of the parasite is raised by transferring available *Striga* management strategies employing Farmer Field Schools and other media.

Under Output 4

For Activity 7. Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.

7-1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side.

7-2 The established implementation structure for *Striga* control measures is functioning.

Activities

Under Output 1

Activity 1. Development and verification of suicidal germination agents on *Striga* and *Orobanche*

Activity 2. Development of germination inhibitors for root parasitic weeds

Activity 3. Demonstration of microorganisms to control germination of *Striga*

Inputs

Japanese side

[Experts]

- Long-term expert: 1 Project Coordinator
- Short-term expert: Researchers (including 1 Leader)

[Materials and Equipment]

- Materials and equipment necessary for the project

[Training in Japan]

Sudanese side

[Counterpart personnel]

- 1 Leader
- Researchers
- Extension Staff as adequate

[Materials and Equipment]

- Materials and equipment necessary for the project other than those supplied by JICA

[Facilities]

- Security in the project areas does not deteriorate.
- The prices of materials and equipment do not seriously soar.

Pre-conditions

Activity 4. Verification of stability and durability of *Striga*-resistance in sorghum and rice **Under Output 2** **Activity 5.** Identification of useful substances in *Striga* that will encourage farmers to weed and utilize **Under Output 3** **Activity 6.** Dissemination of *Striga* control measures through Farmer Field Schools **Under Output 4** **Activity 7.** Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead.	- C/P training in Sudan and Japan as adequate	- Project Office - Laboratories - Experimental farm plots - Farmer Field School sites	- Security of Sudan stays stable.

Annex 2 Tentative Plan of Operation (PO)

Outputs / Activities	1st Year												2nd Year												3rd Year												4th Year												5th Year													
	2017												2018												2019												2020												2021												2022		
	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1 Innovative technical measures to control *Striga* are developed by Sudan-Japan collaboration																																																											
1 Development and verification of suicidal germination agents on *Striga* and *Orobanche*																																																									
2 Development of germination inhibitors for root parasitic weeds																																																									
3 Demonstration of microorganisms to control germination of *Striga*																																																									
4 Verification of stability and durability of *Striga*-resistance in sorghum and rice																																																									
2 Useful substances that will encourage farmers to weed and utilize are identified in *Striga*.																																																									
5 Identification of useful substances in *Striga* that will encourage farmers to weed and utilize																																																									
3 The improved cultural practices to control *Striga* are being disseminated.																																																									
6 Dissemination of *Striga* control measures through Farmer Field Schools																																																									
4 A structure, encompassing relevant ministries and institutions, is functioning to forward the coordinated actions for *Striga* control.																																																									
7 Establishment of a functional implementation structure to forward *Striga* control measures																																																									

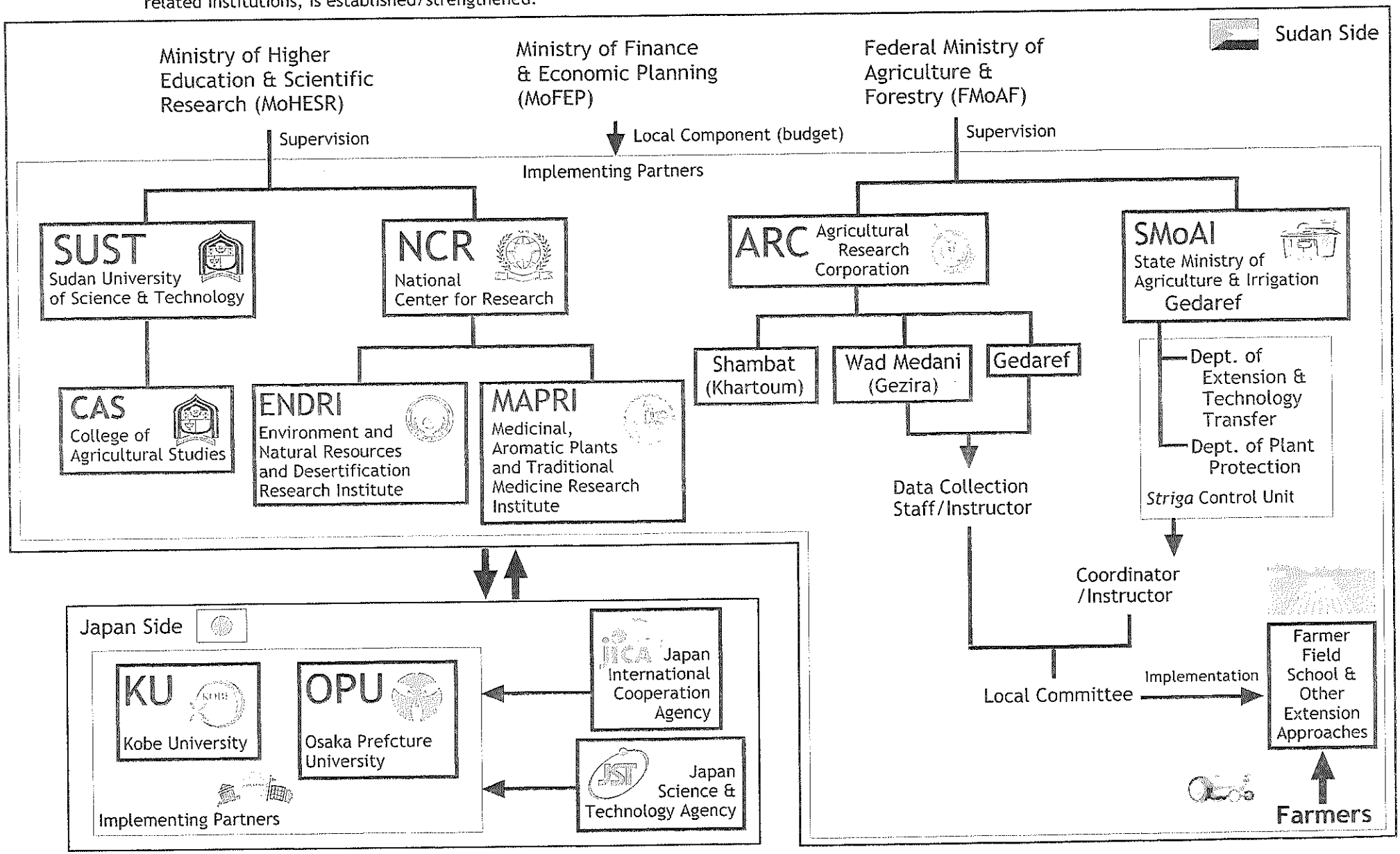
(Legend) ▬ Core operation period
Preparatory period

Annex 2

ProjectOrganization Chart:

Project for Developing Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan

Project Purpose: The extension system for effective control technologies against the *Orobanchaceae* weeds including *Striga*, developed in collaboration with the Sudanese related institutions, is established/strengthened.



Annex 4

Tentative List of Proposed Members of Joint Coordination Committee (JCC)

1. FUNCTION

The Joint Coordination Committee (JCC) will meet at least once a year and whenever necessity arises. The main functions of JCC are as follows:

- Formulate annual operational work plan of the Project based on the tentative schedule of implementation within the framework of the Record of Discussions (R/D);
- Review overall progress and achievements of the Project;
- Examine major issues arising from or in connection with the Project;
- Work out modification of activities depending on the necessity;
- Ensure smooth implementation of the Project and secure ministerial coordination, guidance and supervision, information sharing, as well as draw expertise from other ministries, departments, and organizations.

2. COMPOSITION

JCC will be composed of the following members.

(1) Co-Chairpersons
- Representative of NCR and Leader of JICA Expert Team

(2) Sudanese Side:
- Project Director
- Project Manager
- Other representative(s) of NCR
- Representative of ARC
- Representative of SUST's College of Agricultural Studies (CAS)
- Representative of Federal Ministry of Finance and Economic Planning (FMoFEP)
- Representative of Federal Ministry of International Cooperation (FMoIC)
- Representative of Federal Ministry of Agriculture and Forestry (FMoAF)
- Representative of State Ministry of Agriculture (Gedaref)

(3) Japanese Side:
- JICA Experts (including the Leader, Coordinator, and other experts)
- Representative of JICA Sudan Office

(4) Observer:
- Representative of State Ministry of Agriculture (Khartoum)
- Representative of State Ministry of Agriculture (River Nile)
- Representative of State Ministry of Agriculture (Gezira)
- Representative of State Ministry of Agriculture (Northern State)
- Official(s) from the Embassy of Japan
- Representative of Japan Science and Technology Agency (JST)
- Other person(s) appointed by Co-Chairpersons

Annex 5

DRAFT

RECORD OF DISCUSSIONS
ON
DEVELOPMENT OF COUNTERMEASURES AGAINST *STRIGA* TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN
AGREED UPON BETWEEN
NATIONAL CENTER FOR RESEARCH
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Khartoum, date

Hiromi Motomura
Chief Representative
JICA Sudan Office
Japan International Cooperation Agency

Migdam E. Abdelgani
Director General
National Center for Research
The Republic of The Sudan

Witnessed by:

Representative's Name
Designation
Ministry of Agriculture and Forestry
The Republic of The Sudan

Representative's Name
Designation
Ministry of Higher Education and Scientific Research
The Republic of The Sudan

Representative's Name
Designation
Ministry of International Cooperation
The Republic of The Sudan

Based on the Minutes of Meetings on the Detailed Planning Survey on Development of Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan (hereinafter referred to as "the Project") signed on 26th September 2016 between the National Center for Research (hereinafter referred to as "NCR") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with NCR and relevant organizations to develop a detailed plan of the Project.

Both parties agreed the details of the Project and the main points discussed as described in the Appendix 1 and the Appendix 2, respectively.

Both parties also agreed that NCR, the counterpart to JICA, will be responsible for the implementation of the Project in cooperation with JICA, coordinating with other relevant organizations, and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of the Republic of the Sudan (hereinafter referred to as "Sudan").

The Project will be implemented within the framework of the Note Verbales exchanged on (the actual date will be inserted) between the Government of Japan (hereinafter referred to as "GOJ") and the Government of Sudan (hereinafter referred to as "GOS").

Appendix 1: Project Description
Appendix 2: Main Points Discussed (to be prepared)

PROJECT DESCRIPTION

Both parties confirmed that there is no change (or mention the change agreed) in the Project Description in the Minutes of Meetings for the Detailed Planning Survey on the Project signed on 26th September, 2016.

I. BACKGROUND

The Agriculture sector of Sudan has some 30% share in the GDP. It contributes about 80% to the non-oil export earnings, and provides 60% of the jobs. While agriculture in Sudan is practiced under both irrigated and rain-fed conditions, 90% of the cultivated are is under rain-fed. Sorghum, a staple food for the majority of people, also providing feed stuff to livestock, is one of the most important crops. However, its yield (0.44-0.78 ton/ha) is largely lower than the international average (1.28 ton/ha) and is declining further. It is reported that the yield decline is more obvious with the mechanized rain-fed system (where water shortage prevails) than the irrigated system, and the issue is a serious one since Sudan derives some 85% of sorghum production from that production system. Researchers also report that the decline in the yield is largely due to the increase of *Striga*, a root parasitic weed. Therefore, the management of *Striga* is of an urgent importance for Sudan in terms of livelihoods of subsistence farmers and the national food security. To deal with the problem, the Government of Sudan (GOS) requested for JICA's technical cooperation, and the project titled Improvement of Food Security in Semi-Arid Regions of Sudan through Management of Root Parasitic Weeds, supported by JICA and Japan Science and Technology Agency (JST), was carried out in 2010-2015 by Sudan University of Science and Technology (SUST) and Kobe University as lead institutes. That project achieved results such as findings of a new chemical agent to induce suicidal germination of *Striga*, cultural practices to decrease the weed population and selection of *Striga* tolerant sorghum and rice varieties.

To further the achievements, the GOS requested the Government of Japan for JICA's technical cooperation by a new project with the National Center for Research (NCR) as the implementing agency, supported by Agricultural Research Corporation (ARC), SUST and other relevant bodies from the Sudan side, and Kobe University as the lead institute from the JICA side. In response, JICA dispatched a detailed planning survey team for discussion and planning of the Project in August-September 2016.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Project Design Matrix (PDM) (Annex 1) and the Plan of Operation (Annex 2).

1. Input
   (1) Input by JICA
      (a) Dispatch of Experts

- Long-term expert: 1 Project Coordinator
- Short-term expert: Researchers of relevant subjects (including 1 Leader, Natural Product Chemistry, Synthetic Chemistry, Plant Physiology, Crop Science, etc.)

(b) Training in Sudan and Japan as adequate

(c) Materials, Machinery and Equipment necessary for the Project

In case of importation, the materials, machinery and equipment under II-1 (1) (c) above will become the property of Sudan upon being delivered C.I.F. (cost, insurance and freight) to the Sudanese authorities concerned at the ports and/or airports of disembarkation.

(2) Input by NCR

NCR, in cooperation with relevant organizations, will take necessary measures to provide the following at its own expense:

(a) Services of counterpart personnel and administrative personnel as referred to in II-2 (Implementation Structure);
(b) Suitable office space with necessary equipment;
(c) Support for obtaining official resident permit;
(d) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
(e) Facilitation for transport of the JICA experts for official travel within Sudan, such as issuing travel permit;
(f) Information as well as facilities in obtaining suitable furnished accommodation for the JICA experts and their families;
(g) Information as well as support in obtaining medical service;
(h) Credentials or identification cards;
(i) Available data (including maps and photographs) and information related to the Project;
(j) Running expenses necessary for the implementation of the Project;
(k) Expenses necessary for transportation within Sudan of the equipment referred to in II-5 (1) as well as for the installation, operation and maintenance thereof; and,
(l) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Sudan from Japan in connection with the implementation of the Project.

2. Implementation Structure

The project organization chart is given in the Annex 3. The roles and assignments of relevant organizations are as follows:

(1) NCR

(a) Project Director

As the implementing agency of the Project, NCR assigns the Director General as the Project Director responsible for overall administration and implementation of the Project.

(b) Project Manager

The Research Professor (Weed Science) of NCR will be responsible for managerial and technical matters of the Project.

(c) Other personnel for implementing of the Project

Researchers to collaborate with JICA experts for the Activities shown in PDM, and other support staff, etc.

(2) ARC

As collaborating institute, ARC assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(3) SUST

As collaborating institute, SUST assigns researcher(s) and other support staff to collaborate with JICA experts and project experts in the relevant subject.

(4) Gedaref State Ministry of Agriculture and Irrigation (GSMAI)

As collaborating agency, GSMAI assigns Extension Staff for activities including Farmer Field School to collaborate with JICA experts and ARC researchers in the relevant subject.

(5) Ministry of Higher Education and Scientific Research (MoHESR)

As supervising Ministry for NCR and SUST, MoHESR provides advice and necessary supports for the Project, including assignment of a member to the SC explained in II 2. (7).

(6) Ministry of Agriculture and Forestry

As supervising Ministry for ARC and GSMAI, MoAF provides advice and necessary supports for the Project, including assignment of a member to the SC explained in II 2. (7).

(7) Steering Committee

A Steering Committee (SC) encompassing relevant ministries and organizations is set up by NCR's initiative to collectively address important weed problems including *Striga*. The SC also facilitates smooth implementation of the Project and promotes dissemination of technologies developed by the Project to farmers. In the Joint Coordination Committee (JCC) explained in II 1. (9), it works as Sudanese part of it. The SC will continue to function even after the Project. NCR will also set up a Technical Committee (TC) for Sudanese side to discuss technical matters.

(8) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to NCR and relevant organizations on matters pertaining to the implementation of the Project. The JICA experts will be researchers of Kobe University, Osaka Prefecture University and other supporting research institutes.

(9) Joint Coordination Committee

A Joint Coordination Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will review the progress, revise the overall plan when necessary, approve an annual work plan, conduct evaluation of the Project, share relevant information, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex 4.

3. Project Sites and Beneficiaries

Project Sites: Khartoum (laboratories, experimental farms, training facilities and other related facilities of NCR, MoAF, ARC and SUST), and Gadaref State (farming communities for extension approaches including Farmer Field Schools);

Direct Beneficiaries: Sudanese *Striga* researchers in NCR, ARC and SUST; extension staff of GSMAI for dissemination of improved technologies; and farmers who participate in the Farmer Field School, other extension approaches and experiments.

Indirect Beneficiaries: Farmers in Gedaref

4. Duration

Five (5) years from 2017 to 2022 (tentative)

5. Environmental and Social Considerations

NCR will abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF NCR AND GOS

1. NCR and GOS will take necessary measures to:

(1) ensure that the technologies and knowledge acquired by the Sudan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Sudan, and that the knowledge and experience acquired by the personnel of Sudan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and,

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-5 above and their families, which are no less favorable than those granted to experts and members of the missions and their families of third countries or international organizations performing similar missions in Sudan.

2. NCR and GOS will take necessary measures to:

(1) provide security-related information as well as measures to ensure the safety of the JICA experts;

(2) permit the JICA experts to enter, leave and sojourn in Sudan, wherever relevant, for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees;

3. Other privileges, exemptions and benefits will be provided in accordance with the Note Verbales exchanged on (the actual date will be inserted) between the GOJ and the GOS.

4. NCR, in coordination with relevant organizations of Sudan, will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. MONITORING AND EVALUATION

JICA and NCR will jointly and regularly monitor the progress of the Project through the Monitoring Sheets based on the Project Design Matrix (PDM) and Plan of Operation (PO). The Monitoring Sheets will be reviewed every six (6) months. Also, Project Completion Report will be drawn up one (1) month before the termination of the Project.

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, NCR will take appropriate measures to make the Project widely known to the people of Sudan.

VI. MISCONDUCT

If JICA receives information related to suspected corrupt or fraudulent practices in the implementation of the Project, NCR and relevant organizations will provide JICA with such information as JICA may reasonably request, including information related to any concerned official of the government and/or public organizations of Sudan.

NCR and relevant organizations will not, unfairly or unfavorably treat the person and/or company which provided the information related to suspected corrupt or fraudulent practices in the implementation of the Project.

VII. MUTUAL CONSULTATION

JICA and NCR will consult each other whenever any major issues arise in the course of Project implementation.

VIII. AMENDMENTS

The Record of Discussions may be amended by the minutes of meetings between JICA and NCR. However, PO may be amended in the Monitoring Sheets.

The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

Annex 1 Project Design Matrix (PDM) (see Minutes of Meetings)
Annex 2 Tentative Plan of Operation (see Minutes of Meetings)
Annex 3 Project Organization Chart (see Minutes of Meetings)
Annex 4 List of Proposed Members of Joint Coordination Committee (see Minutes of Meetings)

Minutes of Meeting

The 1st Joint Coordinating Committee

of

The Project on Development of Countermeasures against STRIGA to Conquer Poverty and Improve Food Security in Sudan sponsored by JICA &Japan Science and technology Agency (JST) which is implemented under the Science and Technology Research Partnership and Sustainable Development(SATREPS)

The 1st Joint Coordinating Committee was organized on December 26th, 2017 and as the result, both parties confirmed and agreed upon the contents in the document attached hereto. This meeting was held to review the work progress, approve an annual work plan, share relevant information and approve new participants

Khartoum, December 26th, 2017

Prof. Elgasim Ali Elgasim
Director General
National Centre for Research
(Project Director)

Prof. Yukihiro Sugimoto
Graduate School of Agricultural Science
Kobe University, Japan
(Project Leader)

Points of presentation and discussion:

1- **Introduction of the project(Prof. Sugimoto):**
   - Process leading to the project implementation
   - Scheme of SATREPS
   - Outline of the project and targets to manage Striga in view of its life cycle

2- **Input by the Sudanese side(Prof. Babiker):**
   - Thirteen scientists from the NCR & ARC are cooperating in this project
   - Providing laboratory space for equipment introduced by JICA (purchased locally or imported from a broad)
   - Providing office space with basic necessary equipment

3- **Input by the Japanese side(Mr. Masuda):**
   - Visits of Japanese researchers to Sudan before the start of the project.
   - Dispatch of Japanese researchers after the start of the project
   - Long term office members
   - Procurement of equipment
   - Business trip of Sudanese researchers to Japan

4- **Dr. Randa & Dr. Somaya's trip to Japan(Dr.Randa):**
   - **Duration:** 4th- 10th October 2017
   - **Purpose**:
     - Discussion with the project leader and SATREPS II members regarding JICA procedures for training, scientific visits and equipment.
     - Visit to the laboratories to be acquainted with the advanced equipment
     - General discussion about ongoing project research activities.
   - **Output:**
     - Selection of equipment based on priority, prices and if they can be sent to Sudan.
     - Detailed plan of collaborative work.
     - The first monitoring sheet should be submitted to JICA in March.
     - Short training organization

5- **Achievements in 2017 & Plan for 2018 for each activity:**

Activity 1(Prof. Babiker):

- **Ongoing experiments :**

- Germination inducing activity of T-010 on broomrapes
- Influence of cultivar and soil fertility on production of *Striga* germination stimulants by soybean and cowpea

- **Screen house:**
  - Germination inducing activity of T-010 as influenced by rate and seed placement in soils
  - Effects of seed bank on efficacy of T-010 on *Striga* and sorghum growth and yield
  - Effects of seed bank on efficacy of T-010 *on O. crenata* and faba bean growth and yield
- **Plan for 2018 to conduct field experiments:**
  - Effects of T-010 on *Striga* infection and sorghum growth and yield (3 sites continuous)
  - Effects of T010 on *Orobanche crenata* and faba bean growth and yield (other leguminous crops may be considered based on results of ongoing experiments)

Activity 2(Dr. Somaya):

- **Germination inhibitors based on metabolome analysis**:
  - Based on identification of metabolic pathways required for germination, screening and development of chemical inhibitors for *Striga* seed germination in order to design selective control method.
- **Cytokinin oxidase inhibitors and cytokinin producing microorganisms:**
  - Determination the role of cytokinin producing bacteria as a source of continuous supply of exogenous cytokinin to trigger germination of *Striga* in the absence of the host
  - Inhibitation of cytokinin oxidation so as to break seed dormancy and make maximum use of indigenous cytokinin.

Activity 3(Dr. Hassan):

- Control Striga by using micro-organisms
- Combination between Tricoderma with bacteria strains and herbicides
- Two field experiments in Shambat and Shendi to control Orbanchae
- Plan for 2018:
  - Survey soil to prohibit Striga, advanced screening, study the impact of micro organisms

Activity 4(Dr. Samejima):

- **Verification of stability and durability of *Striga*-resistance in rice:**
  - The field should be occupied exclusively for 4 years
  - In the first year (2018), *Striga* seeds are mixed into each plot (100,000 seeds m^{-2})
  - Varieties
    - A: Umgar (*Striga*-resistant)

- B: NERICA5 (*Striga*-resistant)
- C: NERICA4 (*Striga*-susceptible)

- **Searching new *Striga*-resistant rice varieties:**
  - Field evaluation of World Rice Core Collection (69 accessions)
  - Identification of *Striga*-resistance mechanisms of the selected resistant varieties based on germination experiment and rhizotron experiment .
  - Adaptability analysis of the 69 accessions to Sudanese growth conditions and seed multiplication of them

Activity 5(Prof. Kuse):

- **Isolation and purification of secondary metabolites**
- **Structure determination of biologically active compounds**
- **Plan for 2018:**
  - Fractionation of Striga metabolites by using various solvents for Soxhlet extraction for isolation, purification, and structure determination.
  - Analysis of metabolites of different growth stages of Striga: young, before flowering, and matured.
  - Making lists of *Striga* and *Orobanche* usages as traditional medicine regarding State or Province.

Activity 6(Prof. Dafalla):

- **Dissemination of Striga measures through Farmers Field School:**
  - **<u>Activities in 2017</u>**
  - **2 meetings at NCR on 21th Nov and at Gedarif at 13 Dec. The meetings agreed to:**
  - **Gedarif area is to be divided into 3 districts according to rainfall (North= low, Central=middle & South= high rainfall area).**
  - **Two locations in each district (gender divided) (5 feddan each).**
  - **Demonstration fields, FFS, Field days, Field visits and media program.**
  - **Criteria for selection of demonstration fields were identified.**
  - **Base line survey was suggested before beginning of the above activities.**
  - **Inputs & operation costs for the above activities was estimated.**
  - **Packages to be tested in each district were identified.**

- **Integrated Striga Management Packages (ISM) at Gedarif:**
  - Gedarif district is divided into 3 regions according to amount of rainfall, crop rotation of sorghum with trap crop will be practice in all regions, then the following ISM will be demonstrated:

- 1- North Gedarif (low rainfall): the package consisted of water harvest by chisel plow followed by tied ridges, sowing of drought and striga tolerant sorghum variety Arfagadamak , application preemergence herbicide (atrazine), nitrogen fertilization with urea at 1N/fed and post emergence herbicide Glean. Crop rotation with sesame
- 2- Central Gedarif (medium rainfall): the package consisted of chisel plow, sowing of drought and striga tolerant sorghum variety Arfagadamak, application preemergence herbicide (Gardoprim plus Gold), nitrogen fertilization with urea at 1 N/fed and post emergence herbicide Glean. Crop rotation with sesame.
- 3- Southern Gedarif (high rainfall): the package consisted of zero tillage with post emergence application of Glyphosate to control weeds before sowing followed by sowing of late maturing high yielding striga tolerant sorghum variety Wadahmed, application of preemergence herbicide (Gardoprim plus Gold), nitrogen fertilization with urea at 2N/fed and post emergence herbicide Glean. Crop rotation with groundnut.

Activities in 2018

- Base line survey at the selected sites
- 3x2 demonstration fields (gender divided)
- 3 FFS (one in each district)
- 3 field days at crop maturity (one in each district)
- 3x2 field visits (at crop establishment & maturity)
- 3 exchange visits
- Mass media programs at different crop growth stages.
- brochures

6- Recommendations of new members of the JCC:

- **The following 13 individuals have been approved by all JCC members:**

1-	Prof. Tetsuro Mimura	(Prof. Sugimoto)
2-	Dr. Takatoshi WAKABAYASHI	(Prof. Sugimoto)
3-	Dr. Khogali Izzeldin Idris	(Dr. Samejima)
4-	Dr. Hanaa Hassab Elrasoul Abdelkareem	(Prof. Awatif)
5-	Dr. Mohamed Babiker	(Prof. Awatif)
6-	Rania Alrasheed Abakeer Abdalla	(Dr. Hassan)
7-	Magdoline Mustafa Ahmed Osman	(Dr. Hassan)
8-	Dr. Mohamed Ahmed Mohamed Adlan	(Dr. Hassan)
9-	Dr . Abdelmagid Adlan Hamed Babiker	(Dr. Hassan)
10-	Ms. Rihab Eshag	(Dr. Somaya)

11- Prof. Dr. Abbas Elsir Elamin Bousati (Prof. Dafalla)
12- Dr. Khalafalla Ahmed Ali (Prof. Dafalla)
13- Ms. Hagir Ahmed Ibrahim Ahmed (Prof. Dafalla)

7- Other business:

- **Note: Professor Sugimoto suggested that the project designates the original participants as core members. For the smooth implementation of the project, only the Core members should be responsible for reporting activities in the monitoring sheet, attending the JCC meetings and participating in the midterm evaluation (expected in Sept. 2020) and the final evaluation (expected in March 2020).**
- **NOTE: Professor Elgasim & Professor Migdam made a suggestion for next JCC meeting; The JCC members might present only what was achieved and what would be done in the JCC meeting. A scientific symposium, workshop or seminar might be held independent of the JCC meeting so that the participants have enough time to present achievements, exchange ideas and discuss future plans.**

8- Closing Speech by Chief Representative of JICA Sudan Office:

- **1-** Importance of agriculture in Sudan
- **2-** Request to maximize utilization of inputs provided in the former SATREPS project with SUST.
- **3-** Request for the budget of 2018 and after, in addition to completion of the main lab rehabilitation(without delay), before arriving of equipment at the end of January.
- **4-** Expectation to promote international strategies to manage root parasitic weeds

9- Group photo outdoor.

10- Visit to the main lab under refurbishment.

Participants

- Sudanese Side (NCR)
  - Prof. ElGasim Ali Elgasim, Project Director, D.G. NCR
  - Prof. Migdam E. Abdelgani, Former Project Director, former D.G. NCR
  - Prof. AbdelGabar Eltayeb Babiker, Project Manager
  - Prof. Awatif Siribel, Project Member
  - Dr. Randa Hassan Elsalahi Osman, Project Member
  - Dr. Somaya Sir Elkhatim Mohamed Salih, Project Member
  - Dr. Mohammed Mahgoub Hassan, Project Member
  - Dr. Ehssan Moglad, NCR –MAPRI

- Sudanese Side (ARC)
  - Prof. Dafalla Ahmed Dawoud, Project Member
  - Dr. Ayman Abdel Maged Awad, Project Member

Sudanese side (Ministries):

  - Mr. Hussein Mohamed Gabir, Ministry of Agriculture
  - Mrs. Ihsan Mohamed Yousif, Ministry of Agriculture and Forestry (MoAF)
  - Mrs. Hajir Ahmed Ibrahim, Gedaref State Ministry of Agriculture and Irrigation (SMoAI-Gedaref)

- Sudanese Side (Observer)
  - Mr. Arafa Mahmoud Ahmed, Gezira State Ministry of Agriculture & Irrigation (SMoAI-Gezira)
  - Dr. Mohamed Babiker, NCR Medicinal aromatic plants
  - Dr. Khogali Izzeldin Idris, Associate professor at ARC Shambat

- Japanese Side (Project team)
  - Prof. Yukihiro Sugimoto, Project Leader, Kobe University
  - Prof. Masaki Kuse, Project Member, Kobe University
  - Prof. Shuji Tani, Project Member, Osaka Prefecture University
  - Dr. Hiroaki Samejima, Project Member, Kobe University
  - Mr. Ryoichiro Masuda, Project Coordinator
  - Mr. Siddig Omer, Project Assistant

- JICA Sudan Office (JCC Members)
  - Mr. Hiromi Motomura, Chief Representative
  - Mr. Tomoharu Miyamoto, Project Formulation Advisor
  - Mr. Mohammad Omer, Program Officer

- Embassy of Japan in Sudan (Observer)
  - Mr. Hiroyuki Kumagai, Councilor, Deputy Chief of Mission

Minutes of Meeting

The 2nd Joint Coordinating Committee

of

The Project on Development of Countermeasures against STRIGA to Conquer Poverty and Improve Food Security in Sudan sponsored by JICA & Japan Science and technology Agency (JST) which is implemented under the Science and Technology Research Partnership for Sustainable Development (SATREPS)

The 2nd Joint Coordinating Committee was organized on September 18th , 2018 and as the result, both parties confirmed and agreed upon the contents in the document attached hereto. This meeting was held to review the progress of the 1st year, share relevant information and approve new participants.

Khartoum, September 18th 2018

Prof. Elgasim Ali Elgasim

Director General
National Centre for Research
(Project Director)

Prof. Yukihiro Sugimoto

Graduate School of Agricultural Science
Kobe University, Japan
(Project Leader)

Welcome Speech (Prof. Elgasim):

- Welcoming and thanking everyone.

Speech by Chief Representative of JICA Sudan Office (Mr. Takahashi):

- Information sharing of the project achievements to beneficiaries and decision makers is important for public promotion of our activities.
- Self-checking our current situation to know the way forward.
- Lab construction and local component are the challenges we are facing.
- Special appreciation to Prof. Elgasim for his strong leadership and understanding..

Points of presentation and discussion:

1- General progress of the project (Prof. Sugimoto):

- Equipment from Japan has arrived.
- Consumables request form to be used by Sudanese side in order for JICA to proceed with the procurement.
- Sudanese researcher's business trips to Japan.
- Japanese government scholarship for Ms. Hanaa (NCR-MAPRI).

2- Input by the Sudanese side (Prof. Babiker):

- Provide laboratory space for equipment introduced by JICA (purchased locally or from abroad).
- Facilitate release of equipment from customs.
- Pay for Sudanese labors and technicians.

3- Input by the Japanese side (Mr. Masuda):

- Business trips by Japanese researchers to Sudan.
- Assignment of Japanese coordinator, Sudanese assistant and drivers.
- Business trips of 4 senior Sudanese researchers to Japan.
- Procurement in Japan (Lab equipment).
- Procurement in Sudan (Vehicles, generator, Office equipment, consumables etc).
- Plan of Oct 1st 2018 – Mar 31st 2019 which includes Japanese researchers visit to Sudan and training of young Sudanese researchers in Japan.

4- Japan Business trip report:

1) Dr. Khojali (Dr. Khojali)

- Duration: 7th – 13th May 2018.
- Practical explanation of rice cultivation in Japan.
- Rice planting process and operation of a rice seeder for preparation of seedlings for transplanting.
- Visit a seedlings nursery where rice germinates and the seedlings grow.

2) **Dr. Hassan (Prof. Migdam):**
   - Duration: 7th- 14th May 2018.
   - Observing the use of new technologies for *Striga* control (new technology) by a number of key universities working in the area, which were already partnering with the SATREPS project.
   - Discussions with Japanese experts Kobe University and Osaka prefectural University about the project activities especially microbial control (activity 3).
   - Uses of NMR spectroscopy.

5- **Achievements in 2017 & 2018 for each activity:**

Activity 1: Development and verification of suicidal germination agents on *Striga* and *Orobanche* (Dr.Khojali):

Three experiments were conducted and the conclusion is as below

- For *S. hermonthica* control, the amount of suicidal germination inducers would be reduced to practical level.
- T-010 did not induce germination of *O. crenata* indicating that other suicidal germination inducers need to be found.
- T-010 stimulated germination of *P. ramosa*. The effects of T-010 on growth of tomato and *P. ramosa* should be studied in pot experiments.

Activity 2: Development of germination inhibitors for root parasitic weeds (Prof. Okazawa):

Development of germination inhibitors for root parasitic weeds

- Planteose is accumulated in the dry seeds of root parasitic weeds as a storage carbohydrate. Nojirimycin (NJ) contained in culture of *Streptomyces ficellus* was shown to inhibit the germination process by perturbing planteose metabolism.

Culture of *Streptomyces* spp. for screening of germination inhibitors

- The effective culture of *Streptomyces ficellus* for high NJ production has been established. 40 *Streptomyces* species have been collected. Preparations for evaluation of the effect of those cultures on *Striga* germination are ongoing.

A new target enzyme was cloned and inhibitors of the target were screened

- The enzyme involved in the first step of planteose metabolism had not been clear. We tried to identify the enzyme and evaluate the effect of enzymatic inhibitors (PIs) on germination.

Screened inhibitors suppressed the radicle elongation of *Orobanche minor*

- Tested PIs significantly inhibited the radicle elongation of *Orobanche minor*. After we get more amounts of PI compounds, actually we have

to synthesize them, we want to do some pot experiments to evaluate their effects on *Striga*.

Activity 3: Could not attend due to a personal emergency (Dr. Hassan):

Prof. Kuse proposed that Dr. Hassan presents in the next JCC which was approved by all JCC members.

Activity 4: Verification of stability and durability of *Striga*-resistance in rice (Dr. Samejima):

- The four-year continuous field experiment just started this year, to validate durability of resistance of *Umgar* and *NERICA 5* and aggrevation of susceptibility of *NERICA 4*.
- Candidates of new *Striga*-resistant rice varieties were selected in lab experiments.

Activity 5: Identification of useful substances in *Striga* that will encourage farmers to weed and utilize (Prof. Kuse):

Establishment of isolation and purification procedures of secondary metabolites

- Structure determination of biologically active compounds.
- Obtain plenty amount of *Striga*, different stages of *Striga*: young, before flowering, matured was collected thanks to many collaborators.

Future plans

- Fractionation of metabolite by using various solvents for Soxhlet extraction.
- Isolation, purification, and structure determination
- Analysis of metabolites of different stages of *Striga*: young, before flowering, and matured.
- Collection of *Striga* at Seleit and Soba.
- Anti-flatulent activity.
- Biological activity guided purification, isolation, and structure determination of *Striga* metabolite.

Activity 6: Dissemination of *Striga* control measures through Farmer Field Schools (Prof. Dafalla):

- Due to the delayed start of activity 6, the location of Southern Gedarif was not planted this season.
- Work was done with hired tractors and other implements; however, a lot of difficulties were faced running the work as planned due to high competition for the implements and coincidences of the work with the rainy season.
- The project manager together with activity 6 leaders (Sudanese and Japanese) and JICA representative (Mr. Siddig) made three visits to the sites (one at crop sowing for three days, for post emergence herbicides application and a third one for one day for follow up of the activity).

Activity 7: Establishment of a functional implementation structure to forward *Striga* control measures (Prof. Babiker):

- In general, weeds are problematic with negative socioeconomic and environmental impact.
- Noxious weeds are special category. They are normally invasive, hard to kill and tend to become dominant in the ecosystems.
- The NCR is to form a collaborative entity (body) comprising of universities, research institutions, relevant federal and States ministries with the objectives of:
    1. Increasing awareness about noxious and invasive weeds and available management tactics.
    2. Initiate research programs, solicitor funds for research aiming at development of cost-effective and eco-friendly management tactics.
    3. Disseminate research results through FFS.
    4. Entice universities and relevant education institution to include weeds science as part of their curricula.

6- Recommendations of new members of the JCC (Prof. Babiker):

- The following three individuals for Activity 3 have been recommended and approved by all JCC members
    1- Dr. Hanan Ibrahim Modawi.
    2- Dr. Nadia Yaseen Osman.
    3- Dr. Suha Hassan Ahmed.

7- Other business:

(Prof. Dafalla)

- Availability of FFS running cost by Sudanese side is not enough.
- For successful implementation of FFS, the following is required to be purchased and stationed at Gedarif.
    1. A tractor with its attachments.
    2. A double cabin car (4WD) to enable smooth follow up of FFS activities during the season.
    3. 3 digital cameras for documentation in each district (1 has already been provided).

(Prof. Sugimoto and Mr. Masuda)

- Please make a request of the necessities with detailed explanation, which will be forwarded to JICA Sudan office and will be approved by JICA HQ-Tokyo.

Participants

- **National Centre for Research, Sudan**
  - Prof. Elgasim Ali Elgasim, Project Director, Director General
  - Prof. Migdam E. Abdelgani, former Director General
  - Prof. AbdelGabar Eltayeb Babiker, Project Manager
  - Prof. Awatif Siribel
  - Dr. Randa Hassan Elsalahi Osman
  - Dr. Somaya Sir Elkhatim Mohamed Salih

- **Agricultural Research Corporation, Sudan**
  - Prof. Dafalla Ahmed Dawoud
  - Dr. Khogali Izzeldin Idris

- **Sudan University of Science & Technology (SUST)**
  - Prof. Abdelaziz Makawi

- **Gedaref State Ministry of Agriculture and Irrigation (SMoAI-Gedaref)**
  - Dr. Hajir Ahmed Ibrahim

- **JICA Sudan Office**
  - Mr. Makoto Takahashi, Chief Representative
  - Mr. Tomoharu Miyamoto, Project Formulation Advisor
  - Mr. Mohammad Omer, Program Officer

- **Japanese Project Members**
  - Prof. Yukihiro Sugimoto, Project Leader, Kobe University
  - Prof. Atsushi Okazawa, Project Sub-leader, Osaka Prefecture University
  - Prof. Masaki Kuse, Project Member, Kobe University
  - Dr. Hiroaki Samejima, Project Member, Kobe University
  - Dr. Takatoshi Wakabayashi, Project Member, Kobe University
  - Mr. Ryoichiro Masuda, Coordinator
  - Mr. Siddig Omer, Assistant Coordinator

Total: 20 attendants

MINUTES OF MEETINGS ON THE 3rd JOINT COORDINATING COMMITTEE MEETING FOR THE PROJECT ON DEVELOPMENT OF COUNTERMEASURES AGAINST STRIGA TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN SPONSORED BY JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) & JAPAN SCIENCE AND TECHNOLOGY AGENCY (JST) WHICH IS IMPLEMENTED UNDER THE SCIENCE AND TECHNOLOGY RESEARCH PARTNERSHIP AND SUSTAINABLE DEVELOPMENT (SATREPS)

The 3 rd Joint Coordinating Committee was organized on June 10th, 2021 and as the result, both parties review the work progress, share relevant information and approve new participants.

Khartoum, 10 June, 2021

Professor Zeinab Osman	Professor Yukihiro Sugimoto
Director General National Centre for Research (Project Director)	Graduate School of Agricultural Science Kobe University, Japan (Project Leader)

N ame of M eeting: The 3 rd Joint Coordinating Com mittee M eeting

Name of the Project: Project on D eveloping Counterm easures against Striga to Conquer Poverty and 1m prove Food Security in Sudan

D ate: . June 10, 2021

Ti m e: 9:00 - 11:30 (Sudan ti me)

16:00 - 18:30 (Japan ti me)

Place: M eeting roo m , N C R / O nline Zoom M eeting

Attendance: : 9 persons from N C R (Sudanese) side, 12 persons fro m JICA & JST (Japan) side.

Attach ment: Annex 1. List of Attendants

Annex 2. Agenda

Agenda

- 1. Overview and Activity Report of the Project

2. N o mination of new mem bers Activity 1: D r. D aisuke M oriyama (Kobe U niversity) Activity 2: M s. Inas Ishag Ah med (N c R) Activity 6: D r. H anan Abdel Tawab Sul man (AR C) D r. M ohamed Ah med Abdalla (AR C)

3. D iscussion on Project Extension and 2 nd Batch Equip m ent

D iscussion:

N C R requested Project Extension and 2 nd Batch Equip ment because of the project pause and delays for the revolution in Sudan and a pandemic in the world. JICA pointed out that Activity 7 which is the role of Utilization of the project research outco mes have not been i m plemented and advised that it is i m portant to consider those activities in the future for social and economic benefits in Sudan using newly obtained knowledge and technology by the project.

The 3rd JCC Meeting Attendant List

<Sudanese Side>

★ National Centre for Research, Sudan

1 Professor Zeinab Osman, Project Director, Director General, NCR
2 Professor Abdel Gabar Eltayeb Babiker, Project Manager
3 Professor Somaya Sir Elkhatim Mohamed Salih, Deputy NCR
4 Professor Randa Hassan Elsalahi Osman
5 Professor Mohammed Mahgoub Hassan

★ Agricultural Research Corporat ion , Sudan

6 Professor Dafalla Ahmed Dawoud
7 Dr. Hanan Abd Eltawab
8 Dr. Khogali Izzeldin Idris

★ Sudan University of Science & Technology (SUST)

9 Professor Abas Elshikh

<Japanese Side>

★ Japanese Project Members

1 Professor Yukihiro Sugimoto, Project Leader,Kobe University
2 Professor Atsushi Okazawa, Project Sub-leader, Osaka Prefecture University
3 Professor Masaki Kuse, Kobe University
4 Professor Shuji Tani, Osaka Prefecture University
5 Ms. Hanaa
6 Ms. Noriko Endo, Coordinator
7 Mr. Ismael Ibrahem, Technical Assistant

★ JICA Sudan Office

8 Mr. Koji Sakane, Chief Representative
9 Ms. Eriko Nagano, Project Formulation Adviser

★ JICA HQ

10 Mr. Toshiki Fujimoto

★ JST (Japan Science and Technology Agency)

11 Professor Tsukasa Nagamine, SATREPS Research Supervisor in charge of the Striga project
12 Dr. Masahiro Hatsu, Senior Associate Research Supervisor

MINUTES OF MEETINGS
ON
THE 4th JOINT COORDINATING COMMITTEE
OF
THE PROJECT ON DEVELOPMENT OF COUNTERMEASURES AGAINST STRIGA TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN

The Project on Development of Countermeasures against STRIGA to Conquer Poverty and Improve Food Security in Sudan (hereinafter referred to as "the Project") sponsored by Japan International Cooperation Agency (hereinafter referred to as "JICA") & Japan Science and Technology Agency (hereinafter referred to as "JST") which is implemented under the Science and Technology Research Partnership and Sustainable Development (SATREPS)

The 4th Joint Coordinating Committee was organized on July 19th, 2022 and as the result, both parties review the work progress, approve an annual work plan, share relevant information.

Khartoum, 25 July, 2022

Professor Zeinab Osman	Professor Yukihiro Sugimoto
Director General National Centre for Research (Project Director)	Graduate School of Agricultural Science Kobe University, Japan (Project Leader)

Minutes of Meeting

The 4th Joint Coordinating Committee

The project on Developing Countermeasures against STRIGA to Conquer Poverty and Improve Food Security in Sudan

Date: July 19th (Tue), 2022 9:00 – 12:00
Venue: Online (Zoom meeting)

Participants:

Sudanese side

- National Centre for Research (NCR)
  - Prof. Zeinab Osman, Director General
  - Prof. Mohamed Mahgoub Hassan, Project Member
  - Prof. Randa Hassan, Project Member
  - Dr. Hanaa hassab Elrasoul, Project Member
  - Dr. Ehssan Moglad, Project Member
  - Prof. Awatif Siribel, Project Member
  - Ms. Hanan Mudawi, Project Member

- Agriculture Research Center (ARC)
  - Prof. Dafalla Ahmed, Project Member

Japanese side

- Project Team
  - Prof. Yukihiro Sugimoto, Project Leader, Kobe University
  - Prof. Atsushi Okazawa, Project Sub-Leader, Osaka Municipal University
  - Prof. Shuji Tani, Project Member, Osaka Municipal University
  - Prof. Masaki Kuse, Project Member, Kobe University
  - Ms. Noriko Endo, Project Coordinator
  - Mr. Ismael Ibrahim, Project Assistant

- JST
  - Prof. Tsukasa Nagamine, Research Supervisor, JST
  - Dr. Masahiro Hatsu, Senior Associate Research Supervisor, JST

- JICA

  Headquarter
  - Mr. Fumihiko Suzuki , Director of Economic Development, Agri.& Rural Dev.G.2
  - Mr. Yusuke Matsubara, Deputy Director, Economic Development, Agri.& Rural Dev.G.2

  Sudan Office
  - Mr. Koji Sakane, Chief Representative
  - Mr. Hiroto Tsukada, Assistant Representative
  - Ms. Omnia Ali, Program Officer

Total: 21 Attendants

Opening Remarks (Prof. Zeinab)

- Extending welcomes and appreciations to everyone for the STRIGA project
- condolence message to the late Prof. Babiker
- NCR appointed Prof. Somaya as a new Project Manager, but unfortunately, she had a car accident with her family a few days ago and may resume work after three weeks (in August), therefore she is absent from this JCC.

Report on the Dubai Meeting (Prof. Sugimoto)

- Training in Japan: from Sep to Dec 2022 at Osaka Municipal University (Ms. Rihab and Ms. Inas must submit their passport copies by 24th July)
- Technical transfer: due to security situation in Sudan, Japanese University staff is not permitted to travel to Sudan, but coordination will continue through online, and the trainees above are also expected to support technical transfer between Sudanese and Japanese researchers.
- Senior Researchers' visit to Japan is not recommended, as it would not be very beneficial.
- Terminal evaluation of the project: Schedule and process is explained including visit to Sudan in Jan 2023 and holding an international symposium in Khartoum

Procurement of the Equipment (Ms. Endo)

- Protected House fixed and Lab maintenance conducted (3 lab rooms)
- Equipment and consumables purchased by Project
- Sharing Schedule to receive equipment procured by JICA Sudan
- Agreement for Equipment management by NCR

Comments from participants:

Ms. Omnia

- Informed that further delay may occur in some equipment

Mr. Sakane

- Shared information on challenges faced by Sudanese suppliers to import equipment to Sudan; JICA Sudan office is doing their best to meet deadlines.
- Encourages NCR to secure future budget for spare parts, consumables and maintenance.
- Understands current challenges with MoFEP and can support meetings with MoFEP if necessary.

Prof. Zeinab

- Advised that some of the budget is already secured and NCR is planning to make a contract for regular maintenance after the delivery of the equipment within this year.
- If most of Equipment arrive by Oct, NCR can request for budget from MoFEP (local component) but also NCR will try to find alternative financial sources.

Report on Activities

Reports regarding each activity are presented by project members. The details are in the presentations attached.

Report for Activity 1 (Dr. Hassan presented on behalf of Dr. Khogali)

Report for Activity 2 (Prof. Okazawa)

Report for Activity 3 (Prof. Tani)

Report for Activity 3 (Prof. Randa)

- Due to political instability in Oct 2021, they could not follow up progress in the field, however experiments will be carried out for the coming season of 2022

Report for Activity 4 (Dr. Hassan presented on behalf of Dr. Khogali)

Report for Activity 5 (Dr. Hanaa)

Report for Activity 6 (Prof. Dafalla)

- Purchase of tractor and other agriculture equipment by JICA supported in the farmer filed schools FFS
- FFS is important to transfer knowledge and technology to farmers, significant difference in productivity between traditional farmers and those applying Striga control measurements

Report for Activity 7 (Prof. Zeinab)

- National Seminar conducted in Oct 2021, agreed with Japanese side to name it (symposium) in the next Dubai meeting they will discuss the content of upcoming symposium in Jan 2023, including target of participants (researchers, government officials, practitioners and farmers) and deliverable messages

<u>Comments from participants:</u>

Prof. Randa

- Emphasis on the need for low-cost control measurement of Striga to be applicable to small farmers

Prof. Zeinab

- The project measured impact on farmer's income by productivity and now a socioeconomic study will take place to see the actual change in farmers' lives. It is scheduled to finalize the result within this year.
- In the international conference, how to show the results of the research is important. These should be easy not only for researchers but also for farmers to understand.

Ms. Endo

- (Regarding the request above about sharing the results of the research to farmers) In the next field day, activities and presentations about results of research targeting farmers will be conducted

Mr. Fumihiko Suzuki

- The output of Activity 6 is impressive, a cost-benefit analysis can be done and it would be interesting to see the result of the socioeconomic study

Mr. Sakane

- Appreciates the efforts in FSS as it is the core of JST and JICA collaboration (how research outputs can be applied in development activities)
- Preparation for socioeconomic study is important to make impact of activities measurable and deliverable, and to be able to share the results in international conferences.

Plans for overall goal and purpose achievement (Prof. Zeinab)

- They will form a steering/standing committee within August (Minister of Higher Education has been briefed and a meeting is to be held with him for approval)
- Agreement was already signed between NCR, ARC and SUST for the activities of STRIGA control.
- Request for amendment in PDM: to change the second indicator for Project Purpose from Medium-term budgetary plans to Three years Action plans

Discussion about change of indicator request by NCR:

Mr. Suzuki: agrees on the change in indicator of PDM to support completion of the project purpose; in after three years ex-post evaluation will be conducted to evaluate achievement of the overall goal and project purpose. Procedure is usually done through monitoring sheet but can also be done through different methods.

Prof. Nagamine: concerned of the ability of project to achieve the purpose and don't support the change in PDM, as only 6 or 7 months is remaining in the project.

Prof. Sugimoto: do not support but have no objection on the change; procedure should be through Meeting of Minutes (similar to RD) and not Monitoring sheet.

Prof. Zeinab: advised that the change only in the wording not the content and it would be achieved within the remaining period of the project, she also agrees on both procedures

Mr. Sakane: understand JST concerns and explained that change is suggested at this time due to the new situation in Sudan after the political turmoil in 25th Oct 2021, as the economic situation in Sudan become worse and the currently Sudan Government suffer from severe budget deficit. Hence, the change of the indicator is recommendable in order to make the indicator more practical, fitting to the current situation and to guide us in the right direction to achieve the project purpose.

Conclusion: All parties agree on the change of indicator from 'Medium-term budgetary plans' to 'Three years Action plans' and the change will be conducted through signing Minutes of Meeting.

JST Terminal Evaluation (Prof. Nagamine)

- Covid-19 affected the progress of the project, and it was extended for one year, now around 6 months remain and collaboration from all is needed
- Sharing Points of Review by JST Evaluation Committee

- Sharing Points of Terminal Evaluation

Closing Remarks (Mr. Sakane)

- Appreciate the Sudanese side efforts as they are faced by many challenges due to the political situation since last Oct (suspension of communication with Japanese side, frequent change in government staff and budget deficit)
- Appreciated Japanese side as well, for conducting Dubai meeting under travel restriction and strengthening collaboration with Sudanese side.
- Reiterating the significance of this Striga project, as Striga causes serious damages on agricultural products in Sudan as well as neighboring countries.
- The importance of dissemination of the results and application to agricultural practices is very clear. An international conference and FFSs are very important for this purpose.
- Committed to cooperate with all stakeholders to achieve our common Project Purpose.
- Thanked all stakeholders involved for their efforts conducting project activities and looking forward for successful completion of the project.

End

Form 3-1 Monitoring Sheet Summary

TO CR of JICA SUDAN OFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.1 (Term: July, 2017–March, 2018)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 23 March, 2018

I. Summary from 31 July, 2017 to 23 March, 2018

1 Progress

1-1 Progress of Inputs

1) Short term experts (period of stay in Sudan)

Samejima H.	16 August to 12 October (58 days)	
Sugimoto Y.	26 August to 14 September (20 days)	
Kuse M.	3 September to 15 September (13 days)	
Tani S.	3 September to 15 September (13 days)	
Kuse M.	28 October to 3 November (7 days)	
Samejima H.	18 November to 27 December (40 days)	
Okazawa A.	18 November to 22 November (5 days)	
Sugimoto Y.	18 November to 23 November (6 days)	
Sugimoto Y.	22 December to 27 December (6 days)	
Kuse M.	23 December to 28 December (6 days)	
Tani S.	23 December to 28 December (6 days)	
Samejima. H	18 January to 26February (40days)	
Kuse M.	27January to 1 February (6 days)	
Tani S.	27January to 1 February (6 days)	
Samejima. H	19 March to 24 March (6 days)	
Sugimoto Y.	19 March to 24 March (6 days)	Total 244 days

2) Equipment 1 (Shipped on 9 February, arrived at Khartoum AP on 15 February, however, not reached the project site as of 23 March)

Laminar Hood, Refrigerator, Lab Bench Surface (x4), Ultrasonicator Large, Ultrasonicator Small, Drying Shelf (x2), Erlenmeyer Flasks with baffle (x20), Binocular Microscope (x3), Fraction Collector (x2), Water Purifier, Drying Oven, Rotary Evaporator (x2), Autoclave, Temperature Controlled Shaker (x2), Temperature Controlled Centrifuge (x2).

3) Research Visitors: (period of stay in Japan)

Randa H. E. O.	5 to 9 November (5 days)	
Somaya S. M. S.	5 to 9 November (5 days)	Total 10 days

4) Middle Term Training:

none

5) Long Term Training:

none

1-2 Progress of Activities

General

1) Field used for experiments were secured and prepared in Shambat and Gezira Research Stations, ARC.
2) Seeds of rice, sorghum and *Striga* were collected for the implementation of the activities.
3) Pots and fertilizes necessary for the activities were secured.

Activity I

1) Permission of T-010 import for scientific research purpose was approved by the Plant Protection Directorate. (8 Aug)
2) Through the thorough discussion, field experiments to be conducted at Shambat and Gezira were designed to evaluate effects of continuous application of T-010 on growth of *S. hermonthica* and its host. (10 Jul)
3) Preliminary evaluation for the safety of T-010 is going on by a collaborative Japanese company. (October-)
4) Appropriate doses of T-010 toward *S. hermonthica* was studied. (October-December)
5) Efficacy of suicidal germination approach using T-010 in the faba bean–*O. crenata* system is under evaluation. (November-February)

Activity II

1) Discussion was made on the ongoing experiments related to germination control of root parasitic weeds by microbial metabolites. (5-9 Nov, 18-22 Nov)
2) Some cytokinins were shared with the Sudanese counterpart. (5-9 Nov)
3) Cloning of a gene encoding planteose hydrolyzing enzyme was done, and the enzyme, OmAGAL, was expressed in *E. coli*.
4) Inhibitors of OmAGAL were screened using a chemical library composed of ca. 15,000 compounds revealing 28 inhibitors.
5) Mode of action of nojirimycin is under investigation.

Activity III

1) On site discussion was made on the ongoing experiments related to potential microbes which can promote or inhibit *Striga* germination. (5 Sep)
2) Isolation and identification of microorganisms (864) from suppressive soils and evaluate their competence in suppressing early stages of *Striga* and *Orobanche*

parasitism were studied.

3) Promising microbes from the laboratory experiments, each alone and in combinations, where relevant, were further validated in screen house using potted plants.
4) Promising treatments comprising mycorrhiza (introduced and indigenous), alone and in combinations with phosphorus solubilizing bacteria, nitrogen fixing bacteria or *Trichoderma* fungi is under investigation.
5) Microorganisms capable of increasing soil fertility, suppressing *Striga* and *Orobanche* infection and improving crop growth and grain yield are under investigation.
6) Training to extract active compounds from a microbial culture with organic solvent has been done.
7) Isolation and identification of the active ingredients are under investigation.
8) Four out of 990 isolated microorganisms from Japanese soil inhibited the seed germination of *Orobanche minor*, but not the growth of *Trifolium pratense* (the host of *O. minor*), *Escherichia coli* (bacteria), and *Aspergillus oryzae* (fungi).

Activity IV

1) Through the thorough discussion, field experiments conducted at Shambat were designed to evaluate durability of resistance and enhancement of susceptibility in rice varieties against *S. hermonthica*. (10 Jul)
2) On site discussion was made at ARC HQ to expand the designed experiment to the multi-locational trials in Wad Medani and Gadaref. (10 Sep)
3) Screening of rice varieties for *S. hermonthica* was conducted using the world rice core collections supplied from NARO gene bank (September-November).
4) Screening of rice and wheat varieties for *S. hermonthica* is ongoing using the world rice core collections supplied from NARO gene bank (December-).

Activity V

1) Through the intimate discussion, field experiments conducted in Shambatwere designed to evaluate efficacy of hand weeding on *S. hermonthica* control. (10 Jul)
2) On site discussion was made at ARC HQ to expand the designed experiment in Wad Medani and Gadaref. (10 Sep)
3) Immature *Striga* plants were collected for the purification of major ingredients in Khartoum (7 Sep) and in Wad Medani (11 Sep).
4) Chlorophyll derivatives were isolated as major compounds from a crude material obtained by extraction of *Striga* by methanol.

Activity VI

1) On site discussion to determine suitable Integrated *Striga* Management (ISM) packaes for each district at Gedarif was made.
2) Use of FFS and related activities were identified as tools to disseminated ISM measures.
3) Requirements for implementation of FFS were identified.

Activity VII

1) Discussion was made at ARC HQ in Wad Medani to deepen mutual understanding on the importance of dissemination of *Striga* control measures. (10 Sep)

1-3 Achievement of Output

Activity I

1) The in-depth strategy for long-term (4 years) field experiments was devised.
2) The results in a pot experiment suggest that reduction in T-010 doses (to less than 100 g a.i. ha^{-1}) would be possible.
3) Application of T-010 at 100 g a.i. ha^{-1} as a suicidal germination inducer did not reduce *O. crenata* emergence.

Activity II

1) Genetic information on planteose hydrolyzing enzyme, OmAGAL, was obtained.
2) 28 OmAGAL inhibitors were identified.

Activity III

1) Screening strategy has been developed to isolate candidate microorganisms to suppress *Striga* diseases.

Activity IV

1) The in-depth strategy for long-term (4 years) field experiments was made. (10 Sep).
2) A Striga resistant rice variety was selected through germination test, rhizotron experiment and pot experiment.

Activity V

1) The in-depth strategy for long-term (4 years) field experiments was made. (10 Sep).
2) It found the place for stable collection of *Striga* in Khartoum; further isolation of metabolites will be proceeded smoothly.

Activity VI

1) Preparation to start FFS was ready.

Activity VII

1) The project made a start to establish a functional implementation structure.

1-4 Achievement of the Project Purpose

General

1) Accumulation of scientific knowledge would help to adapt and innovate technologies for *S. hermonthica* management which would be accepted by the inter-ministerial structure (Steering committee).
2) Accumulation of scientific knowledge would present a valid reason for formulation of Medium-term budgetary plans among several research organizations.

Activity I

1) Application method of T-010 was introduced to Sudanese scientists and technicians.

Activity II

1) Knowledge on nojirimycin production using microorganism was introduced to Sudanese scientists

Activity III

1) The candidate microorganisms to suppress *Striga* diseases were identified from Actinomycetes and filamentous fungi that traditionally provide useful lead compounds for medicine.

Activity IV

1) Knowledge on candidates of new *S. hermonthica* resistant rice varieties in the world rice core collection was introduced to Sudanese scientists.

Activity V

1) *Striga* does have its commercial value, because isolated chlorophylls are attractive chemicals in cosmetic industry and have high commercially value.

Activity VI

1) Interaction among stakeholders (farmers, extension workers, government workers, researchers, etc.) commenced.

Activity VII

1) Talks for *Striga* control in Sudan has already started.

1-5 Changes of Risks and Actions for Mitigation

1) Construction of the main laboratory are behind schedule though completion was estimated around end of December 2017.

1-6 Progress of Actions undertaken by JICA

1-7 Progress of Actions undertaken by Gov. of Sudan

1-8 Progress of Environmental and Social Considerations (if applicable)

Permission to import T-010 for experimental purposes was granted by the National Pesticide Council. Further, the consent of the ARC to undertake field experiments on the product at Shambat and Gezira Research Stations has been granted.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

1) Overcoming poverty and improvement of food security through *Striga* management are the main goals of the project. Activities VI and VII will be designed in line with the goals. The discussion was made at the 2nd Steering Committee before the official start of the project (11 July).
2) After acceptation of new members in JCC on 26 December, 2017, percentage of female members became more than 40% (9 female and 13 male members) on the Sudanese side.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

Visit of the JICA and JST delegates, Mr. Kato, Aoki, Nemoto, Ohkawa, Ms. Kawasaki from JST, and Ms. Kishimoto from JICA, to Kobe University. (29 Sep).

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

The project was designed to start by the middle of May. However, it started on 31 July, 2017, with two and a half months delay due to delay of the coordinator's assignment and arrival at the project site. Accordingly, parts of field activities designed for 2017 growing season were postponed by one year.

2-2 Cause

2-3 Action to be taken

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

II. Project Monitoring Sheet I & II *as Attached*

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.2（Term: April, 2018–September, 2018）

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 30September, 2018

I. Summaryfrom1April, 2017 to 30September, 2018

1 Progress

1-1 Progress of Inputs

1) Short term experts (period of stay in Sudan)

Samejima H.	19April to 7 May (19 days)	
Sugimoto Y.	28 April to 2May (5 days)	
Okazawa A.	12 May to 15 May (4 days)	
Samejima H.	24 June to30 September (99 days)	
Kuse M.	14July to 19July (6 days)	
Sugimoto Y.	28 July to 3 August (7 days)	
Sugimoto Y.	15 September to 27 September (13 days)	
Okazawa A.	15 September to 19 September (5 days)	
Wakabayashi T.	15 September to 19 September (5 days)	
Kuse M.	15 September to 20 September (6 days)	
Mimura T.	22September to 27September (6 days)	Total 175 days

2) Equipment shipped on the 9th of February, arrived at Khartoum AP on the 15th of February, and reached the project site on the 25th of June

Laminar Hood, Refrigerator, Lab Bench Surface (x4), Ultrasonicator Large, Ultrasonicator Small, Drying Shelf (x2), Erlenmeyer Flasks with baffle (x20), Binocular Microscope (x3), Fraction Collector (x2), Water Purifier, Drying Oven, Rotary Evaporator (x2), Autoclave, Temperature Controlled Shaker (x2), Temperature Controlled Centrifuge (x2).

3) Research Visitors: (period of stay in Japan)

Khogelil. I. E.	8 to 12May (5 days)	
MohamedM. H.	8 to 13May (6 days)	Total 11 days

4) Middle Term Training:
none

5) Long Term Training:
none

1-2 Progress of Activities

General

1) Equipment provided by JICA was carried into the main laboratory under refurbishment.
2) A PhD candidate won a MEXT scholarship specially allocated to SATREPS members.
3) Latest literatures published in 10 years were surveyed to extract useful information to combat root parasitic weeds.
4) A request form for consumables was formulated and has been put into effect.
5) The 1st symposium of the project was held on 18th of September at Conference Hall, Ministry of Higher Education, Sudan.
6) A seminar entitled Phosphorus Status in Plants was held on 23rd of September at Sudan Academy of Science Hall.

Activity I

1- Preliminary evaluation for safety of T-010 is ongoing.

2- A long term plant box experiment to evaluate the effects of repetitive dosage of T-010 on *Striga* emergence and sorghum growth has been started.

3- Suicidal germination: In view point of the predominantly low input agriculture in the rain fed area where Striga is pandemic an alternative approach focusing on trap and catch cropping and chemical manipulation of germination stimulants is adopted.

i) Trap and catch crops. Laboratory screening of sesame, groundnut, guar and cowpea for production of *Striga hermonthica* (sorghum, pearl millet and wheat strains and/or variants), *Phelipanche ramosa* and *Orobanche crenata* germination stimulants as influenced by genotype, time after sowing and soil fertility (ongoing).

ii) Laboratory screening of sorghum genotypes for stimulant production as influenced by genotype, time after sowing, fertilizers and microbes (ongoing).

iii) Chemical manipulation of germination stimulants using carotenoids inhibiting herbicides as seed dressing (ongoing laboratory and greenhouse).

Activity II

1) Work on thiodiazuron (TDZ), a cytokinin oxidase, Striga germination inducer and premature haustorium inducer is ongoing.
2) Filtrate of*Streptomyces ficellus*culture containing nojirimycin was brought from Japan to Sudan. (12-15 May)
3) Marine broth for high NJ production by *Streptomyces* spp. was brought from Japan to Sudan. (15-19 Sep.)
4) Fourty *Streptomyces* spp. were isolated from various points in Sudan for evaluation of germination inhibitor production.

5) Enzymatic characterization of OmAGAL revealed that OmAGAL is an acidic α-galactosidase.
6) Inhibitors of some OmAGAL suppressed radicle elongation in *Orobanche minor.*

Activity III

1) Development Integrated management of broomrape (*Orabanche crenata* Forsk.) in faba bean (*Vicia faba* L.) using *Trichoderma* Spp. in combinations with arbuscular mycorrhizal fungi, phosphorus releasing bactetia and herbicides (ongoing at field stage).
2) Work on AMF commercial formulation and local isolates alone and in mixtures with phosphorus releasing bacteria, nitrogen fixers, mycorrhizal helpers and low dosages of chemical fertilizers (laboratory and green house experiments on going).
3) Susceptibility of elite sorghum cultivars to AMF (ongoing).
4) Application of bio-agents using the toothpicks techniques started.
5) Screening of microbes for stimulating germination of *Orobanche minor* seeds (on going)
6) Isolation and purification of compounds inhibiting and/or stimulating germination of *Orobanche minor seeds* from microbes.

Activity IV

1) Long term field experiments to evaluate durability of *Striga* resistance in rice varieties on going.
2) Evaluation of *Striga* resistance of 65 and 79 F_3 population derived from a cross between NERICA 4 and Umgar and between NERICA 4 and NERICA 1, respectively, on going.
3) Work on resistance/tolerance of selected sorghum cultivars to Striga started.

Activity V

1) A long term field experiment to evaluate the effect of hand-weeding on Striga control started.
2) Striga infested areas in the suburbs of Khartoum located.
3) An efficient extraction method for biologically active compounds in Striga developed.
4) Compounds of curative properties viz flavonoids and terpenoids as well as a vermfuges identified.
5) Work on isolation and identification of anti-flatulent active compounds from Striga started.

Activity VI

FFSs started at three sites in Gedarif state. In each site the land is divided into two sub-plots with the intention of establishing a two course rotation as a prelude to an integrated Striga management (ISM) package. At each site one sub-plot was sown to sorghum and the other to sesame. Urea and phosphorus fertilizers and the herbicide Gardoprime were applied to sorghum at planting followed by chlorsulfuron 3 weeks later. However due to an outbreak of sesame midge, sesame was ploughed down in one location which was subsequently sown to water melon as alternative rotational crop suitable to the area and acceptable to the farmer.

Activity VII

Parasitic flowering plants including root parasitic Orobanchaceae *viz Striga hermonthica*, *Orobanche crenata* and *Phelipanche ramosa,* shoot parasitic Loranthaceae *viz Tipnanthus globiferus* and convolvulaceae *viz cuscuta campestris*, together with the common reed (*Phragmites australis*) and mesquite (*Prosopis juliflora*), which are invasive and hard to kill weeds, constitute a threat to agriculture and food security in East and Central Africa (ECA) including Sudan. Despite the voluminous literature on their biology ecology and control in developed countries no universal and economical method for their management in developing countries, particularly in the ECA region, have been developed. The National Center for Research is planning to set up a committe comprising of universities, research institutions and relevant ministries with the objectives of i) consolidating available global information pertaining to the biology, ecology and management of the weeds, ii) increase farmers and policy makers awareness on the importance and devastating nature of the weeds, ii) adapt and tune available control measures to contain and curtail the spread of the weeds iii) promote collaborative regional and international research on biology, ecology and management of the weeds and iv) develop and disseminate cost effective, technically feasible and environmentally eco-friendly management methods suitable for adoption in the Sudan and the ECA region.

1-3 Achievement of Output

General

1) Useful information to combat root parasitic weeds was collected into a review article and published as follows.

   Hiroaki Samejima and Yukihiro Sugimoto; Recent Research Progress in Combatting Root Parasitic Weeds, Biotechnology and Biotechnological Equipment, 32 (2), 221-240, 2018 Mar.

   DOI:10.1080/13102818.2017.1420427

2) The systematic request system facilitates procurement of consumables by the JICA

coordinator.

3) Eight presentations were delivered at the 1st symposium to more than 70 participants.
4) General and advanced knowledge on phosphorous status in plants was shared by 30 participants at the seminar.

Activity I

1) GR24, *N*-Me-T-010 and a benzoate analogue of strigolactone were subjected to preliminary safety evaluation.
2) A plant box method was introduced to the counterpart scientists.
3) A soil based screening strategy for assaying root exudates germination inducing activity of crops has been developed.

Activity II

1) Culture of *Streptomyces ficellus* containing high amount of nojirimycin was prepared.
2) Fourty *Streptomyces* spp. were isolated from various localities in Sudan.

Activity III

1) Screening strategy has been developed to isolate candidate microorganisms that suppress *Striga* infection.
2) Counterpart scientists learned methods to extract active ingredients from microbes with organic solvent and DNA from filamentous fungi.

Activity IV

1) The idea of long term field experiments was introduced to the counterpart scientists.
2) Handling breeding materials was experienced by the counterpart scientists.

Activity V

1) The idea of long term field experiments was introduced to the counterpart scientists.
2) Soxhlet extraction from matured Striga afforded crude extracts efficiently.

Activity VI

1) For the first time in four years, FFS for Striga management in Gadarif commenced.

Activity VII

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1-4 Achievement of the Project Purpose

General

1) The information published in Biotechnology and Biotechnological Equipment, 32 (2), 221-240, 2018 will be shared among researchers working in the relevant fields and contribute to the progress of the related works conducted all over the world.
2) Several questions about ABS related issues prepared by JST were submitted to the focal point in Sudan.
3) MOU is to be signed between Sudan Academy of Science and Kobe University, to tighten the connection between the two institutes and promote collaboration between Sudan and Japan.
4) Through the 1st symposium, not only the project members but other researchers who are interested in the project activities shared ideas and deepened understandings on the Striga management.
5) Through the seminar, the participants gained knowledge on phosphorus status in plants.

Activity I

1) The evaluation technique of suicidal germination inducers was improved.

Activity II

1) A method to evaluate the effect of *Streptomyces* culture on *Striga* was discussed and fixed.

Activity III

1) The candidate microorganisms to suppress *Striga* infection were identified from Actinomycetes and filamentous fungi that traditionally provide useful lead compounds for medicine.
2) One microbe was identified to produce compound inhibiting seed germination of Orobanche minor, but has no adverse effects on growth of the *Escherichia coli*, the eukaryotic microbe *Aspergillus oryzae*, and*Trifolium hybridum*.

Activity IV

1) Knowledge and technique of selection and evaluation of rice varieties in terms of Striga resistance was improved.

Activity V

1) A foundation for evaluating the effect of hand-weeding was constructed.
2) The most abundant compounds, found in the crude extracts of Striga, were

chlorophylls.

Activity VI

1) A foundation for disseminating *Striga* control techniques to farmers was constructed.

Activity VII

1) Contact with selected local universities and research institution has been established

1-5 Changes of Risks and Actions for Mitigation

1-6 Progress of Actions undertaken by JICA

1-7 Progress of Actions undertaken by Gov. of Sudan

1-8 Progress of Environmental and Social Considerations (if applicable)

Safety check of T-010 has to be barefully examined before field release.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

The project leader is invited by JST to participate in Workshop on Japan-Africa equalpartnership in Science, Technology and Innovation for Sustainable Development, which will be held in Senegal in December, 2018, co-organized by JST and Ministry of Higher Education, Research and Innovation, Senegal.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

The main laboratory was to be extended by the end of 2017. However, the construction has been suspended since November, 2017. Unavailability of the main laboratory delays the utilization of equipment provided by JICA.

2-2 Cause

Insufficient supply of the local component from the Ministry of Finance, Sudan.

2-3 Action to be taken

The manager on the Sudanese side has been negotiating with the ministry officials to urge the supply of the local component.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan,etc.)

The fund to the project was promised by the Ministry of Finance. Sudan, in September, 2017.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

A committee to promote management and knowledge transfer on noxious weeds is to be established.

II. Project Monitoring Sheet I & II *as Attached*

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.3 (Term: October, 2018–March, 2019)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 31 March, 2019

I. Summary from 1 October, 2018 to 31 March, 2019

1 Progress

1-1 Progress of Inputs

1) Short term experts (period of stay in Sudan)

Samejima H.	1 October to 24 October (24 days)	
Kuse M.	10 November to 15 November (6 days)	
Samejima H.	23 November to 3 December (11 days)	
Sugimoto Y.	28 November to 3 December (6 days)	
Samejima H.	8 December to 14 December (7 days)	
Samejima H.	26 January to 25 February (31 days)	
Kuse M.	26 January to 31 January (6 days)	
Tani S.	26 January to 31 January (6 days)	
Okazawa A.	2 March to 5 March (4 days)	
Sugimoto Y.	8 March to 14 March (7 days)	
Samejima H.	8 March to 14 March (7 days)	Total 113 days

2) Short Term Training:

Magdoline M. A.O.	3 to 16 November (14 days)	
Rania A. A.A.	3 to 16 November (14 days)	Total 28 days

3) Middle Term Training:
none

4) Long Term Training:
Hanaa H. E. A., a PhD candidate, joined Kobe University on 1 October as a research student.

1-2 Progress of Activities

General

1) Refurbishment of the main laboratory was almost completed and the equipment and tools provided by JICA and NCR were installed.
2) A PhD candidate has finished the half-year training course at Kobe University and now she is ready to start her PhD studies in the university.
3) Two young Sudanese members visited Kobe University and Osaka Prefecture University. They participated in a program to learn fundamental technique in microbiology and natural product chemistry.
4) Procurement of consumables is progressing smoothly through the usage of the request form.
5) MTAs on ABS were signed between NCR and Kobe University, and NCR and Osaka Prefecture University.

Activity I

1) Preliminary evaluation for safety of T-010 was completed.
2) A long term plant box experiment to evaluate the effects of repetitive dosage of T-010 on *Striga* emergence and sorghum growth is ongoing as scheduled.
3) Non-carbamate-type strigolactone mimics were designed and synthesized. Their germination inducing activity was evaluated.
4) Effect of phosphate priming on germination inducing activity of sorghum root exudates was examined.

Activity II

1) The effect of nojirimycin (NJ) containing culture medium on *Striga* germination was evaluated.
2) The effects of culture media of some *Streptomyces* spp. isolates on *Striga* germination were evaluated.
3) *Streptomyces* spp. isolated in Sudan were tested for NJ production using medium containing marine broth.

4) Evaluation of *Streptomyces ficellus* culture filtrate containing NJ, received from Japan, on *Orobanche crenata* and *Phelipanche ramosa*, germination, radicle extension and haustorium initiation is ongoing
5) Methods of extraction and detection of NJ in *Streptomyces* culture by TLC are in place.
6) Transient expression analysis suggested that OmAGAL localizes at cell wall (apoplasts).
7) A synthesis route was established for an OmAGAL inhibitor, PI-1, in collaboration with Dr. Kuse.
8) The contents of training course for two Sudanese young researchers at Osaka Prefecture University were discussed.

Activity III

1) Results of ongoing experiments on induction/suppression of germination of root parasitic weeds by microbes and their metabolites were discussed.
2) Isolation and identification of microorganisms from suppressive soils and evaluation of efficacy on *Striga, Orobanche* and *Phelipanche* are ongoing.
3) Green house validation of efficacy of microbes demonstrating adequate efficacy under laboratory conditions is ongoing.
4) Promising treatments comprising mycorrhizal fungi alone or in combinations with *Trichoderma* fungi, phosphorus solubilizing bacteria, nitrogen fixing bacteria and herbicides are ongoing.
5) Microorganisms capable of increasing soil fertility, suppressing *Striga* and *Oroba nche* infection and improving crop growth and grain yield are under investigation.
6) Isolation, identification and evaluation of active metabolites from potential microbes on root parasitic weeds are ongoing.
7) Several microbes were screened for ability to inhibit or promote germination of seeds of root parasitic Orobanche spp.
8) Streptomyces strains producing compounds that inhibit or promote seed germination of *Orobanche minor* were isolated.
9) Isolation and purification active compounds (7 and 8) and assessment of their activity against other parasitic weeds are planned.
10) Different application methods of *Trichoderma* fungi (seed coating, dressing and priming) on *Orobanche crenata* in faba bean were evaluated in green house.
11) Effects of *Bacillus sphaericus* and NP alone or in combination on *Striga hermonthica* in sorghum are under investigation.
12) A greenhouse experiment to study the efficacy of *Trichoderma* spp. and compost,

each alone or in combination, on *Orobanche crenata* in faba bean was conducted.

13) Field experiments, at two sites Shambat and Shendi, to evaluate efficacy of *Trichoderma* spp. and bacterial strains, each alone or in combination with NP or chlorsulfuron on *Orobanche crenata* incidence in faba bean were conducted.
14) For logistic and economic reasons, seed treatment with the mycoherbicide is underway.
15) Effects of selected fungisides on mycorrhizal colonization of sorghum roots were studied.
16) Application of bio-agents using the toothpicks techniques is ongoing.

Activity IV

1) The first year of the 4-year rice cultivation experiment was completed as scheduled. The purpose of this experiment is to evaluate durability of resistance to *Striga*.
2) Field evaluation of adaptability to the growth conditions in Sudan and *Striga* resistance of 65 and 79 F_3 population derived from a cross between NERICA 4 and Umgar and between NERICA 4 and NERICA 1, respectively, was completed.
3) Laboratory evaluation of *Striga* resistance of world rice core collection was completed.

Activity V

1) A convenient method for separation of lead chemical ingredients from *Striga* was established using liquid-liquid partitioning with various organic solvents.
2) Training course for a candidate of PhD student started in Japan.

Activity VI

1) FFSs were conducted at three sites in Gedarif state (Abunaga in North Gedarif and Kumshita and Kagara in Central Gedarif) during 2018 sorghum cropping season.
2) Researchers from Khartoum and Wad Medani visited Gedarif once a month from April to November, except May.
3) The package consisted of appropriate land preparation, *Striga* tolerant sorghum variety Arfagadamk, fertilizer and herbicides. In Abunaga, chisel plowing was followed by disc harrowing and ridging. Sorghum seeds were sown at the bottom of tied ridge. In Kumshita, sorghum seeds were sown on flat field after chisel plowing or disc harrowing. In Kagara, sorghum was sown on flat without the plowing and harrowing as the site was prepared to replace the one Kumshita which had soil erosion by hard rains just after sowing. However, later on, sorghum at Kumshita recovered. Fields at all sites were sown sorghum cv Arfagadamk using a row planters. The fertilizers urea at 40 kg per fed and TSP at 10 kg per fed were applied at sowing. The herbicide Gardoprim

Plus Gold 500SC (a ready mix of S-metolachlor + terbuthylazine), at 1.5 L per fed was applied at sowing using a tractor mounted sprayer for controlling weeds other than *Striga*. The herbicide chlorsulfuron at 1 g a.i. per fed was applied 3 weeks after sowing for *Striga* control using knapsack sprayers.

4) A field day was held on 7th of November.
5) Sesame, a rotational crop included as part of the *Striga* management package for next season was replaced by water melon at Kumshita due to a problem of sesame midge.

Activity VII

1) The activity was suggested to be a body comprising of researchers, and extension workers to be responsible for continuity of Striga management technology transfer. The project leader explained to the representative of JICA Sudan on Dec 2, 2018, who was assigned after the start of the project, the process of negotiations made between JICA and the project members about the activity VII before the Japanese detailed planning survey team made a visit to Sudan in September, 2016. The leader also shared the information with the JICA officer who has been taking care of the project since October 28th, 2018.

1-3 Achievement of Output

General

1) Completion of refurbishment of the main laboratory has made it possible to combine analytical studies in the laboratory and verification experiments in the greenhouse and field at Shambat and Gedarif.
2) Young Sudanese researchers had opportunities to improve their capacity through the experience in Japan.
3) Using the plain request system for consumables, the leader of each activity and his/her collaborators can easily explain what they need to the JICA coordinator.

Activity I

1) The non-carbamate-type strigolactone mimics with appreciable germination inducing activity were subjected to preliminary safety evaluation.
2) T-010 delayed and decreased *Striga* emergence in the plant box experiment. This is prerequisite for the long term experiment to evaluate the effects of repetitive dosage of T-010.
3) The plant box is to be utilized as a newly introduced technique for Activity I to Activity III.

Activity II

1) Inhibitory or promotive activities of *Streptomyces* culture media were confirmed.
2) Methods of extraction and detection of NJ in *Streptomyces* cultures by TLC have been acquired
3) Substantial amount of PI-1 for biochemical analysis was synthesized by Dr. Kuse.
4) The contents of training course for two Sudanese young researchers were fixed.

Activity III

1) Potential microbial control viz *Trichoderma* fungi, bacterial strains alone or in combination with fertilizers (NP) or herbicide can be used to alleviate *Striga*, *Orobanche* and *Phelipanche* menace under field conditions.
2) The impact of *Trichoderma* enriched biofertilizer enhanced when supplemented with N P fertilizers. Superior and significant increase in faba bean growth grain yield and dry matter production were realized.

Activity IV

1) *Striga* resistant rice varieties supported less number of emerged *Striga* plants than a *Striga* susceptible variety did. This is prerequisite for the long term experiment to evaluate durability of resistance and enhancement of susceptibility in rice against *Striga*.
2) Several candidates of new *Striga* resistant rice varieties and lines were selected.

Activity V

1) Collection of *Striga* at various growth stage was performed at Integrate Agriculture Research at Soba area.
2) Extraction of secondary metabolites from *Striga* was achieved by using Soxhlet apparatus.
3) Chlorophylls and flavonoids were identified.

Activity VI

1) Activities in FFS were carried out in Gedarif throughout sorghum cropping season for the first time in four years, though delayed by 1month from the original schedule.
2) About 25 farmers participated in each school and about 450 farmers indirectly received the information.
3) At Abunaga, North Gedarif, sorghum yield per fed in the demonstration fields of FFS (*Striga* management package) was 618 kg of grains and 7.5 t of straw, compared to 340 kg and 5.3 t in neighboring farms (traditional production methods), respectively. At

Kumshita, Central Gedarif, sorghum grain and straw yield in the demonstration fields of FFS was 1266 kg of grains and 11.8 t of straw, compared to 260 kg and 4.5 t in neigbouring farms, respectively.

4) Watermelon was demonstrated as an alternative rotational crop suitable to the area and acceptable to the farmer.

Activity VII

1) Practical ideas applicable to Activity VII are under consideration.

1-4 Achievement of the Project Purpose

General

1) By improving the laboratory, installing equipment, training young Sudanese researchers, and establishing a consumable purchasing system, the overall ability of the project team to conduct researches on parasitic weeds has increased.
2) NCR, Kobe University, and Osaka Prefecture University signed the MTA on ABS on 4th of March.
3) MOU was signed on 29th of November, 2018, between Sudan Academy of Science and Kobe University, to tighten the connection between the two institutes and promote collaboration between Sudan and Japan.
4) Schedule of the mid-term evaluation from 8th to 13th of September, 2019, was agreed. The seminar and JCC will be held on 12th of September.

Activity I

1) Experimental technique in the study of suicidal germination inducers was improved and knowledge about this field was accumulated.
2) Phosphate priming of sorghum seeds considerably reduced germination inducing activity of sorghum root exudates with a persistent effect for at least a month.

Activity II

1) A method to evaluate the effect of *Streptomyces* culture on *Striga* germination was established.
2) Structure activity relationship study becomes feasible for PI-1 related OmAGAL inhibitors.

Activity III

1) Isolation and purification of compounds inhibiting and/or stimulating germination of

Striga hermonthica and Orobanche spp. seeds from microbes ongoing.

2) Isolation and identification of microorganisms from suppressive soils and evaluation of efficacy on *Striga, Orobanche* and *Phelipanche* are ongoing.
3) Microorganisms capable of increasing soil fertility, suppressing *Orobanche and Striga* infection and improving crop growth and grain yield were studied.
4) Streptomyces strains producing compounds that inhibit or promote seed germination of *Orobanche minor* were isolated.
5) Isolation and purification active compounds and assessment of their activity against other parasitic weeds are ongoing.
6) Different application methods of *Trichoderma* fungi on *Orobanche crenata* in faba bean were validated in green house.
7) The fungicides raxil apron star and thiram reduced arbuscular mycorrhiza fungi colonization of sorghum roots. Thriam was the least suppressive and its suppressive effects at the recommended rate was not significant.

Activity IV

1) Knowledge and technique of selection and evaluation of rice varieties in terms of *Striga* resistance was improved.

Activity V

1) Long term training for a Sudanese researcher started by joining PhD course in Japan.
2) Valuable secondary metabolites such as flavonoids were identified in the ingredients of *Striga*.

Activity VI

1) The foundation for disseminating *Striga* control techniques to farmers has been strengthened.
2) Three FFSs were established with participation of 75 farmers, 50 of which were women.
3) More than 450 farmers visited the sites.
4) Yield data indicated the effects of the management package on growth and yield of sorghum in comparison to neighboring farmers' fields are significant.

Activity VII

1) JICA personnel and project members have deepened mutual understandings of Activity VII.

1-5 Changes of Risks and Actions for Mitigation

Demonstrations have been occurring frequently in Sudan since December 2018. It restricts the Japanese members' activities in Sudan. The researchers are following the instruction of JICA Sudan Office to avoid risks to be involved into the demonstrations.

1-6 Progress of Actions undertaken by JICA

JICA Sudan Office promptly gives safety instruction to Japanese members, based on the situation of demonstrations, which was grasped through its own source of information, reports in newspapers, television, and SNS, and contacting with UN and embassies of Japan and other countries.

1-7 Progress of Actions undertaken by Gov. of Sudan

Although no specific action was taken by Gov. of Sudan to this project, the NCR administration is fully aware of the situation. So far no negative impact or jeopardy on the research and/or safety of project workers or equipment have been realized or anticipated.

1-8 Progress of Environmental and Social Considerations (if applicable)

Safety check of germination stimulants has been carefully examined.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

The project leader participated in a "Workshop on Japan-Africa equal partnership in Science, Technology and Innovation for Sustainable Development", from 5th to 7thDecember, 2018 in Dakar, Senegal. The workshop was co-organized by JST and Ministry of Higher Education, Research and Innovation, Senegal.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

The extension part of the main laboratory has been suspended since November, 2017.

2-2 Cause

Insufficient supply of the local component from the Ministry of Finance, Sudan.

2-3 Action to be taken

The researchers on the Sudanese side decided to start using the main laboratory before the completion of the extension part. At the same time, they are keeping to negotiate with the ministry officials to urge the supply of the local component.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan,etc.)

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

II. Project Monitoring Sheet I & II *as Attached*

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.4 (Term: April, 2019–September, 2019)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 30 September, 2019

I. Summary from 1 April to 30 September, 2019

1 Progress

1-1 Progress of Inputs

1) Short term experts (period of stay in Sudan)
No Japanese expert visited Sudan because the safety level of Khartoum was hiked to 2 by the Ministry of Foreign Affairs, Japan, on April 11, 2019. It was further hiked to 3 on June 3, and then lowered to 2 on September 5.
2) Short Term Training:
Nadia Y. G. O. 2 April to 30 May (59 days)
Rihab M. L. A. 2 April to 30 May (59 days) Total 118 days
3) Middle Term Training:
none
4) Long Term Training:
Hanaa H. E. A., a PhD student at Kobe University from 1 April to 30 September.
Total 183 days

1-2 Progress of Activities

General

1) A Japanese Government Scholarship (SATREPS) student started her PhD studies at Kobe University in April.

2) Two young Sudanese members visited Osaka Prefecture University in April and May to participate in a program to learn fundamental techniques in molecular biology.

Activity I

1) Preliminary evaluation for safety of strigolactone analogues and mimics was completed.
2) A long term plant box experiment to evaluate the effects of repetitive dosage of T-010 on *Striga* emergence and sorghum growth started in July.
3) Evaluation of cotton cultivars root exudates for stimulation of Striga seed germination accomplished.
4) Effects of fertilizers on germination inducing activity of potential rotational crops under investigations.

Activity II

1) Screening of some *Streptomyces* isolates for effects on *Striga* seed germination is ongoing.
2) Time course evaluation for production of *Striga* germination inhibitors by *Streptomyces* culture is ongoing.
3) Effects of pre-treatment exposure to *Streptomyces* cultures exudates on inhibition of *Striga* seed germination were determined and standardized.
4) Evaluation of inhibitory effects of *Streptomyces ficellus*, obtained from NCIMB, culture exudates on germination of *Striga* seeds is ongoing.
5) Evaluation of effects of hormonal balance on parasitism is ongoing.
6) Effect of nojirimycin on profiles of phosphorylated proteins in *Orobanche minor* germinating seeds was confirmed.
7) Activation of α-galactosidase activity at pH 5 in *O. minor* germinating seeds was confirmed.
8) Training course for two Sudanese young researchers at Osaka Prefecture University was completed.

Activity III

1) Isolation and identification of *Trichoderma* spp (18 isolates) and mycorrhizal spp (15 isolates) from suppressive soils and evaluation of their efficacy on *Striga* and *Phelipanche* are ongoing.
2) Green house validation of efficacy of *Trichoderma* spp. capable of reducing parasitic weeds infestation and improving crop growth are ongoing.
3) Isolation, purification, identification and evaluation of active metabolites from potential microbes on root parasitic weeds are ongoing.

4) Effects of *Bacillus spp., Trichoderma* and chemical fertilizers and their combination on *Striga hermonthica* in sorghum growth under green house conditions were examined.
5) Evaluation of potential microbes on *Orobanche crenata* control in faba bean and verify performance under farmers field conditions is ongoing.
6) Compounds promoting or inhibiting seed germination of *Striga* and *Orobanche* are at the stage of purification from culture broth of the *Streptomyces* strains isolated from soil, respectively.

Activity IV

1) The second year of the 4-year rice cultivation experiment started on 25th of July, with the purpose of evaluating durability of resistance of rice to *Striga*.
2) Evaluation of crosses (BC2F3) resulting from crosses between Striga resistant lines (mainly low stimulants producers) and elite Sudanese sorghum cultivars for field resistance to the parasite under rain-fed and irrigated environments ongoing.
3) Elucidation of mechanisms of resistance under laboratory conditions using rhizotron techniques planned (pending availability of facilities).

Activity V

1) Synthesis of some compounds found in *Striga* started.
2) PhD course of a MEXT scholarship student started in Japan.

Activity VI

1) FFS demonstration farms were established at two sites in Gedarif state at the end of July and the beginning of August. Visits for researchers from Khartoum and Wad Medani to Gedarif, scheduled once a month from August to November, to interact with researchers, extension workers and farmers are ongoing.

Activity VII

1) JICA HQs proposed a revised action plan in Japanese related to Activity VII, the direct translation of which in English is "Effective countermeasures to manage *Striga* are proposed by NCR and its Sudanese collaborators".

1-3 Achievement of Output

General

1) Young Sudanese researchers had the opportunity to improve their capacity through training in Japan.

Activity I

1) Very weak, but statistically significant, mutagenicity was observed in strigolactone analogues and mimics.
2) The finding suspended further development of germination stimulants and restricted experiments usingT-010 in the semi-closed conditions, *viz* plant boxes and bathtubs.
3) The experiment in the bathtubs was carried out as discussed in March between Sudanese and Japanese researchers. *Striga* emergence was delayed by T-010 as expected, however, too many late *Striga* killed the host plants completely.
4) Root exudates of sesame and wheat induced germination of *S. hermonthica* and *Phelipanche ramosa*, but not *Orobanche crenata*.
5) The cotton cultivar Hamid is selected for further evaluations as a rotational crop under greenhouse and field conditions.

Activity II

1) Optimum time for production of *Striga* germination inhibitors by *Streptomyces* cultures was determined.
2) Optimum pre-treatment exposure period for inhibition of *Striga* seed germination by *Streptomyces* cultures exudates was determined.
3) Basic molecular biology techniques were transferred to two Sudanese young researcher through the training course at Osaka Prefecture University.

Activity III

1) Development and testing of a control package (*Trichoderma* spp. + bacterial strains+ chlorsulfuron) for *Orobanche crenata.*
2) Methods of extraction and detection of nojirimycin in *Streptomyces* cultures by TLC have been acquired.
3) Substantial amount of PI-1 for biochemical analysis was synthesized by Dr. Kuse.
4) M. Sc. Students (awarded). Rani Al Rasheed Abakeer (2019). Effects of seed priming and bacteria on Striga hermonthica (Del.) Benth. infestation in sorghum cultivars, Sudan Academy of Sciences (SAS).
5) The combination of *Trichoderma* fungi plus bacterial strains plus herbicide can be used to alleviate *Orobanche menace* under field conditions.
6) Purification of active compounds on seed germination of *Orobanche* and *Striga* was continued.

- Publications

1) Yahia M.Y.A., Hassan M.M., Elamien M.A.M., Abdalla N.K., Rugheim A.M.E., Abusin

R.M.A., Abakeer R.A., Ahmed M.M., Osman A.G., Abdelgani M.E. and Babiker A.G.T. (2019). Counteracting the effect of *Orobanche crenata* infestation on faba bean (Vicia faba l.) by soil microorganisms and chemical fertilizers. International Journal of Agriculture and Environmental Research, 5 (4): 469- 484.

2) Hassan M.M, Azrag M.A., Rugheim A.M. E., ElNasikh M.H., Modawi H.I., Ahmed M.M., Abakeer R.A., Abusin R.M.A., Osman A.G., Abdelgani M.E. and Babiker A.G.E. (2019). Potential of *Trichoderma harzianum* as a biocontrol agent against *Striga hermonthica* in sorghum, Int. J. Curr. Microbiol. App. Sci. 8(3), 195-206.

Activity IV

1) The experiment is ongoing as discussed in March between Sudanese and Japanese researchers.
2) No *Striga* has emerged yet even in the plots of a *Striga* susceptible rice variety. The emergence is expected early October.
3) Of the fourty two crosses (BC2F3 progenies) 35.7% displayed some degree of resistance and/or tolerance to Striga under filed conditions in both the rain-fed and irrigated environments, while 54.8% of the total showed resistance in the irrigated environments. Two papers have been accepted and one is under preparation.

Activity V

1) Extraction and isolation of secondary metabolites from *Striga* ongoing.
2) Chlorophylls and flavonoids were identified.

Activity VI

1) The FFS farmers, mostly females, attended all operations demonstrated by the Sudanese researchers in collaboration with participating researchers of Gedarif Research Station, ARC, and extension officers of Gedarif State Ministry of Agirculture.
2) The Striga demonstration field at Koom Shita was visited on 19th of August by H.E. Gedarif state Governor accompanied by leaders of the state ministry of agriculture, farmers' leaders, leaders of private companies working in the agricultural sector at Gedarif state.

Activity VII

1) Sudanese and Japanese researchers have been waiting for chances to discuss the revised action plan of Activity VII.

1-4 Achievement of the Project Purpose

General

1) Due to turmoil in Sudan and restrictions imposed by the Japanese government, Japanese experts had no chance to visit Sudan. To keep researcher exchange opportunities, the project decided to allocate the Kobe University budget flexibly.

Activity I

1) The designed experiments are being carried out by the Sudanese researchers.
2) The dosage of T-010 applied did not control *Striga hermonthica* and needs to be revised.
3) Germination inducing activity of some potential rotational crops accomplished.

Activity II

1) A method to produce recombinant OmAGAL2 proteins for structure activity relationship study of the inhibitors was established.
2) Basic molecular biology protocols which should be established at National Centre for Research, Sudan were determined.

Activity III

1) Crude extracts from *Streptomyces* spp. promoted or inhibited the seed germination of not only *Orobanche minor* but also *Striga hermonthica*.
2) Combinations of herbicides, biofertilizers and/or mineral fertilizers are being carried out by Sudanese researches.

Activity IV

1) The designed experiments are being carried out by Sudanese researchers.

Activity V

1) Long term training for a Sudanese researcher started by joining PhD course in Japan.
2) Valuable secondary metabolites such as flavonoids and chlorophylls were identified in *Striga*.

Activity VI

1) The FFS farmers were shown how to calibrate a row planter and a tractor mounted sprayer. Discussion with farmers was made on importance of row planting, crop rotation, sorghum varieties suitable to the area and the importance of good husbandry practices and water harvest for Striga management and improvement of sorghum growth and yield. Further the importance of fertilizers and chlorsulfuron as

complementary treatments in integrated Striga management was discussed.

Activity VII

1) A substantial action plan of Activity VII was proposed by JICA HQs, who added the activity to the original proposal made by the project after the proposal had been approved.

1-5 Changes of Risks and Actions for Mitigation

On April 11, the president Bashir was overthrown by the military after prolonged protests outside the ministry of defense in Khartoum. The demonstrators stayed outside the ministry and insisted on a swift transfer of authority to a civilian administration. However, on 3 June they were dispersed by force and many were killed.

The Japanese Ministry of Foreign Affairs raised the 'Sudan's safety level from Level 1 (Please be careful) to Level 2 (Advice against all, but essential travels) in April and further to Level 3 (Advice against all travels) in June. Since then, visits of the Japanese STRIGA Project researchers to Sudan have been officially barred.

1-6 Progress of Actions undertaken by JICA

JICA Sudan Office, based on the situation of demonstrations grasped through its own source of information, reports in newspapers, television, SNS, and contacts with UN and embassies of Japan and other countries, continuously provided safety instruction to Japanese members. In April, all Japanese volunteers evacuated Sudan, and in June, all JICA Experts and Japanese staff of JICA Sudan Office, except for 2 senior representatives, evacuated Sudan. JICA is trying to operate from its headquarters at Tokyo and neighboring Ethiopia. JICA HQs asked Kobe University to keep minimum activities so that the project can move quickly when the Japanese members are allowed access to Khartoum. In response to the request, Kobe University decided to allocate its budget flexibly to invite Sudanese researchers to Japan or send Japanese researchers and invite Sudanese researchers to Dubai.

1-7 Progress of Actions undertaken by Gov. of Sudan

Sudan's ruling generals and an alliance of opposition groups, after weeks of negotiations, signed an accord on July 17th creating a transitional power-sharing body.

1-8 Progress of Environmental and Social Considerations (if applicable)

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if

applicable)

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

A meeting at Dubai to hold the JCC and keep researchers exchanges was proposed by the Japanese leader. Due to difficulties of necessary arrangements, however, the meeting was relinquished and the JCC is to be held after the security situation in Sudan improves.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

The extension part of the main laboratory has been suspended since November, 2017.

2-2 Cause

Devaluation of the Sudanese currency and insufficient supply of extra budget from the Ministry of Finance, Sudan.

2-3 Action to be taken

NCR decided to allocate existing laboratory space for equipment, which are to be provided by the project when the security situation in Khartoum improves and the Japanese members allowed access to Khartoum. The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the extra budget.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

The project appreciate i) the devoted support by the JICA Sudan office, which periodically update the project members in terms of the situations in Sudan and suggest what the project can do in spite of the difficult situations and ii) the cooperation of the NCR administration who provided budget for the ongoing experiments and for the FFS at Gedarif.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities,

and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

II. Project Monitoring Sheet I & II *as Attached*

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga* to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.5 (Term: 1 October, 2019 – 31 March, 2020)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 23 March, 2020

I. Summary from 1 October, 2019 to 31 March, 2020

1 Progress

1-1 Progress of Inputs

1) Short term experts (period of stay in Sudan)

Sugimoto Y.	14 to 19 March, 2020 (6 days)	cancelled due to COVID-19
Kuse M.	14 to 19 March, 2020 (6 days)	cancelled due to COVID-19
Okazawa A.	25 to 27 March, 2020 (3 days)	cancelled due to COVID-19

Total 0 day

2) Short Term Training: none
3) Middle Term Training: none
4) Long Term Training: Hanaa H.E.A., a PhD student at Kobe University
   1 September, 2019 to 31 March, 2020. Total 183 days
5) Meetings at Dubai

Sugimoto Y. (with Dafalla A.D.A)	27 and 28, November, 2019 (2 days)
Tani S. (with Mohammed M.H.A.)	16 and 17, December, 2019 (2 days)
Okazawa A., Wakabayashi T. (with Somaya S.M.S., Mohammed M.H.A., Nadia Y.G.O.)	2 and 3, February, 2020 (2 days)

6) Short Term Invitation (period of stay in Japan)

Abdelgabar E.B.E.	6 to 8 October, 2019 (3 days)	
Khogali I.I.E.	12 to 15 December, 2019 (4 days)	
Somaya S.M.S.	12 to 15 January, 2020 (4 days)	
Randa H.E.O.	12 to 15 January, 2020 (4 days)	
Ismael I.E.A.	27 February to 1 March, 2020 (4 days)	Total 19 days

1-2 Progress of Activities

General

1) The Japanese Government Scholarship (SATREPS) student is continuing her PhD studies at Kobe University.
2) Researchers exchange was promoted during the absence of JICA coordinator in Khartoum by holding meetings at Dubai and inviting Sudanese researchers to Japan.

Activity I

1) A long term bathtub experiment to evaluate the effects of repetitive dosage of T-010 on Striga emergence and sorghum growth is continued.
2) Experiments on germination inducing activity of root exudates of selected cotton, sesame, millet, ,rice and tomato cultivars and local land races as influenced by organic, inorganic and biofertilizers are ongoing.
3) Effects of plant density on germination inducing activity of cotton (cv Hamid) root exudates *in situ* were studied.
4) Germination inducing activity of cotton roots exudates as influenced by time after sowing was studied.
5) Germination inducing activity of cotton (cv Hamid) root residues in soil as influenced by amount of root powder was studied.
6) Persistence of germination inducing activity of cotton (cv Hamid) was studied.
7) Experiments on influence of carotenoids inhibiting herbicides on response of *S. hermonthica, P. ramosa* and *O. crenata* to natural and synthetic germination stimulants are ongoing.
8) Experiments on further examination of germination inducing activities of cotton, sesame and pearl millet as influenced by genotype are ongoing (acceptable rotational crops in the rain-fed areas).

Activity II

1) Identification of the protein involved in the mode of action of nojirimycin is continued.
2) Characterization of the α-galactosidase, OmAGAL2, is continued.

3) Evaluation of the inhibitory effects of the potential *Streptomyces* isolates on *Striga* seeds germination during and after conditioning was carried out.
4) Re-evaluation of germination inhibiting activity of *Streptomyces* culture filtrates through raising concentration of active substances by liquid-liquid partitioning is ongoing.

Activity III

1) Bathtub experiment on mycorrhiza management using sesame, groundnut and soybean is ongoing.
2) Further experiments with emphasis on sorghum, pearl millet and sesame are ongoing.
3) Purification and Identification of the compounds promoting or inhibiting seed germination of *Striga* and *Orobanche* are continued.
4) Isolation, identification and evaluation of the potential microbes on *Striga*, *Phelipanche* and Orobanche are ongoing
5) Greenhouse experiments to study the efficacy of *Trichoderma* spp. and bacterial strains, herbicide and their combination, on *Phelipanche ramosa* in tomato were conducted.
6) Field experiments, at two sites Kareema and Shendi, were conducted to evaluate efficacy of potential microbes, herbicide, and resistant variety on *Orobanche crenata* in faba bean.

Activity IV

1) The second year of the 4-year rice cultivation experiment was conducted, with the purpose of evaluating durability of resistance of rice to *Striga*.
2) The study was undertaken to transfer *Striga* resistance genes from 13 *Striga* resistant parents to four elite Sudanese sorghum cultivars, Wad Ahmed, Tabat, Butana and Arfagadamek-8 as recurrent parents with the objectives of securing high grain yield, reducing *Striga* seed bank, estimating genotypic performance and magnitude of genetic variance controlling *Striga* resistance traits in the engendered sorghum crosses. The experiment was undertaken in two consecutive seasons at three sites constituting six environments representing the irrigated sector (Gezira Research Station Wad Medani and El suki Research Station) and the rain-fed sector (Gedarif Research Station). The F_1 plants were backcrossed (BC_1F_1) to the recurrent cultivars to obtain BC_2F_1 families, which were subsequently salved for two successive generations to generate BC_2F_3 progenies.

Activity V

1) Synthesis of some compounds found in Striga is in progress.

2) A MEXT scholarship student is continuing her PhD course in Japan

Activity VI

1) FFS activities were conducted at two sites in Central Gedarif in Koom Sheta and Kajara.

Activity VII

1) A revised action plan proposed by JICA HQs was discussed by the Japanese leader and the Sudanese project manager.

1-3 Achievement of Output

General

1) The PhD student had the opportunity to improve her capacity through practice in Japan.
2) Mutual understanding among Japanese and Sudanese researchers was strengthened through meetings at Dubai and Japan.

Activity I

1) T-010 application in bathtubs reduced Striga emergence by 70 to 80% and increased sorghum dry weight by 104% to 171%.
2) Root exudates of cotton, sesame, millet, rice and wheat stimulated germination of *Striga* and *Phelipanche* seeds, but not their *Oronanche crenata* congener, millet stimulated germination of *O. crenata*.
3) Root exudates extracted from soil planted to cotton (cv Hamid) grown at 3, 6 and 9 plants showed similar germination inducing activity.
4) Germination inducing activity of cotton roots exudates increased with time, reached a peak at 15 days after sowing (DAS) and subsequently declined to a minimum at 60 DAS.
5) Germination inducing activity of cotton (cv Hamid) root residues increased with amount and subsequently decreased. At 0.3 mg/g soil low germination was affected (ca 20%). Germination increased to over 60% at 0.6-1.25 mg/g soil and subsequently declined to about 40% at 5mg/g soil.
6) *Striga* seeds placed immediately after treatment on soil treated with cotton (cv Hamid) root powder at 1.25 and 0.5 mg/g soil displayed 35 and 40% germination, respectively. The corresponding germination for seed placed at 6 and 12 h were 60 and 40% and 36 and 58%, respectively. Seeds placed 18h after treatment displayed about equal germination (20%). Seeds placed 24 h after treatment with 1.25 and 5 mg/g soil

displayed 5 and 20% germination, respectively.

7) GR24 at 10^{-4} ppm induced 19.7 and 7.2% germination in *Striga* seeds harvested in 2014 and 2019, respectively. Fluridone at 10 and 15 μM increased germination response by to 2- and 4-fold, respectively.

Activity II

1) Local expression of α-galctosidase in peri-/endosperm during seed germination of *Orobanche minor* was confirmed.
2) Inhibitory effect of *Streptomyces* culture filtrates on *Striga* seed germination during and after conditioning was determined.
3) The contents of next training course for a young Sudanese researcher were fixed.

Activity III

1) The contents of next training course for a Sudanese researcher in Japan was discussed.
2) The combination of the potential microbes, herbicide and resistant variety reduced *Orobanche crenata* infestation by 100% and increased faba bean growth, yield and yield components under field conditions.

Activity IV

1) Due to fluctuating power supply, water could not be supplied sufficiently to the experimental field, where both rice and *Striga* wilted. Accordingly, no information was obtained from the experiment.
2) Forty three crosses (BC_2F_3) were obtained. A considerable proportion of them (30%) combined both resistance and high yield compared to their maternal parents in *Striga* infested fields.

Activity V

1) Extraction and isolation of secondary metabolites from *Striga* is continued.
2) Glycosylated flavonoids were identified.

Activity VI

The FFS farmers, mostly females, attended all operations held during sorghum growing season. The Sudanese researchers in collaboration with participating researchers of the Gedarif Research Station, ARC, and extension officers of the Gedarif State Ministry of Agriculture demonstrated to farmers how to calibrate a row planter and apply the pre-emergence herbicide Gardoprim using a tractor mounted sprayer at crop planting on

the 29th of July to the 1st of August 2019. On 21 -23 of August, 2019, farmers were trained on broadcasting of urea fertilizer and calibration of knapsack sprayers and soil directed application of the post-emergence herbicide chlorsulfuron for *Striga* management. FFS sessions continued during the crop growth cycle on which discussions with farmers were made on importance of row planting, crop rotation, sorghum varieties suitable to the area and the importance of good husbandry practices and water harvest for *Striga* management and improvement of sorghum and subsequent crops growth and yield. Further a field day was conducted on the 28th of October 2019. The field day was attended by most of the stakeholders related to sorghum production. The most prominent among the attendees, beside farmers, extension officers and research scientists, were policy makers represented by the director general of the Gedarif State Ministry of Agriculture, funding authorities represented by the Sudan Agricultural Bank at Gedarif State and funding companies for small scale farmers, seed companies represented by the Arab Company for Seed Production and agricultural services providing companies, such as Central Trading Company, that provides land preparation equipment, fertilizers and pesticides. The positive impact of the project intervention, through transfer of the ISM package, on *Striga* management, improvement of sorghum and subsequent sesame yields, the needs to sustain and promulgate the project findings to other areas where *Striga* is pandemic both within the Gedarif State and across the country, were discussed and stressed.

Activity VII

1) A team of Sudanese experts including biologists, weed scientists, extensionists, agronomists, microbiologists and breeders is being formed. The team, each being an expert in his specialty, are to pursue research and extension for generation, tuning and promulgation of technologies pertinent to ISM within the context of an ICM. Arrangements to involve the media, on national level are in progress.

1-4 Achievement of the Project Purpose

General

1) Japanese experts had no chance to visit Sudan until the end of February, 2020 because the JICA coordinator in Khartoum was absent. During this period, the project decided to allocate the Kobe University budget flexibly to keep researchers exchange.

Activity I

1) Usefulness of suicidal germination strategy in reducing *Striga* incidence was confirmed.

2) Root exudates of several cotton, sesame, wheat, soybean, millet and rice cultivars were screened for germination inducing activity on *Striga hermonthica* and *Phelipanche ramose.* All tested entries showed considerable activity on *S. hermonthica* and *P. ramosa*. Among screened entries only millet showed activity on *O. crenata.*
3) Out of 43 sorghum crosses between *Striga* resistant lines 27 crosses showed high level of resistance

Activity II

1) Validity of OmAGAL2 as a target of control for parasitic weeds was shown from the viewpoint of its subcellular localization.

Activity III

1) The compounds inhibiting seed germination of *Striga* and *Orobanche* was purified.
2) The combination of the potential microbes, herbicide and resistant variety, reduced *Orobanche crenata* infestation by 100% and increase faba bean yield under field conditions (on farm).

Activity IV

1) Necessity of fundamental facilities for implementing experiment was confirmed.

Activity V

1) Long-term training for a Sudanese researcher started by joining PhD course in Japan.
2) Valuable secondary metabolites such as flavonoids and chlorophylls were identified in *Striga*.

Activity VI

1) Sorghum yield in Koom Sheta was 1158.9 kg/ha in the field adopting the ISM package whereas the yield was 75.4 kg/ha in the neighboring field. The yield in Kajara was generally low due to attack by sorghum midge. Sorghum grain yield of ISM package was 104.4 kg/ha and that of the neighboring field was 39.3 kg/ha. The dramatic increase in sorghum production convinced farmers of the effectiveness of integrated Striga management.

Activity VII

1) The concept of the activity was shared between Sudanese and Japanese researchers.

1-5 Changes of Risks and Actions for Mitigation

Throughout the period from the beginning of October, 2019 to the end of March, 2020, the Japanese Ministry of Foreign Affairs kept the Sudan's safety level at Level 2 (Advice against all, but essential travels).

1-6 Progress of Actions undertaken by JICA

JICA HQs asked Kobe University to keep minimum activities so that the project can move quickly when the Japanese members are allowed access to Khartoum. In response to the request, Kobe University decided to allocate its budget flexibly to invite Sudanese researchers to Japan or send Japanese researchers and invite Sudanese researchers to Dubai. In spite of the safety level kept at 2, JICA HQs assigned and dispatched a new coordinator in the middle of February, 2020 considering the improvement of the situation in Sudan. Following the establishment of a new support team in Khartoum, the Japanese researchers were supposed to resume visits to Sudan in March 2020. However, all the visits planned in March were canceled due to the Coronavirus outbreak all over the world.

1-7 Progress of Actions undertaken by Gov. of Sudan

1-8 Progress of Environmental and Social Considerations (if applicable)

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

In addition to a female student who is doing a PhD on natural products at Kobe university (Japan), the project has 1) nominated two female students (NCR employees) for PhD to matriculate in home universities, 2) provide partial financial support to a female student to work on mycorrhization as means of *Striga* management, 3) two female members are to participate in a training course in Montpellier in France (23 March- 2 April 2020), 4) a female member of the project is to spend one year as postdoc at Montana University USA through support by Islamic Development Bank.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

Professor Babiker AG gave a lecture on parasitic weeds biology and management, as part of an FAO consultancy to a group of Plant Protection officers. Further professor Babiker is to be scheduled for an interview in the media (television) to speak about the project activities in the Gedarif State.

Professor Mohammed M.H.A. was interviewed by the media (radio and television) about the project activities in northern Sudan focusing on the new technology that control *Orobanche crenata* infection (complete suppression of emergemce) in faba bean and increased crop yield.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

The extension part of the main laboratory has been suspended since November, 2017. An existing building which is physically connected to the main laboratory has been assigned as an extension to the laboratory. The NRC is refurbishing the building and undertaking constructions of benches and electric wiring on its own budgets.

2-2 Cause

Devaluation of the Sudanese currency and insufficient supply of budget from the Ministry of Finance, Sudan. Budget is available now and the process of refurbishing, construction of benches and electric wiring is ongoing.

2-3 Action to be taken

The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget. Budget has been availed through the ministry of higher education and scientific research.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

The project appreciates the cooperation of the NCR administration and the ministry of finance who provided budget for the ongoing experiments and for the FFS at Gedarif.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

A team of researchers from the National Center for Research, The Agricultural Research Corporation and Sudan University of Science and Technology together with extension workers of the Gedarif State has been formed. The future plan is to include the departments of extension the federal government and relevant States.

II. Project Monitoring Sheet I & II *as Attached*

Form 3-1 Monitoring Sheet Summary

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of Countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.6 (Term: 1 April – 30 September, 2020)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 30 September, 2020

I. Summary from 1 April to 30 September, 2020

1 Progress

1-1 Progress of Inputs

Travel restrictions have been imposed on Japanese experts to Sudan and Sudanese researchers to Japan throughout the monitoring period, due to the worldwide outbreak of COVID-19.

1) Short term experts (period of stay in Sudan): none
2) Short Term Training: none
3) Middle Term Training: none
4) Long Term Training: Hanaa H.E.A., a PhD student at Kobe University
   1 April to 30 September, 2020. Total 183 days
5) Short Term Invitation (period of stay in Japan): none

1-2 Progress of Activities

General

1) The Japanese Government Scholarship (SATREPS) student is continuing her PhD studies at Kobe University.

Activity I

1) A long term bathtub experiment to evaluate the effects of repetitive dosage of T-010 on *Striga* emergence is ongoing.
2) Effects of fluridone applied during conditioning on *Striga* seeds response to low concentrations of GR24 is ongoing.

Activity II

1) Transcriptomics data of nojirimycin on germinating seeds of *Orobanche minor* was re-analyzed.
2) Characterization of OmAGAL2 was accomplished.
3) Localization of planteose in dry seeds of *O. minor* was analyzed.
4) Re-evaluation of germination inhibitory activity of potential *Streptomyces* isolates using gel agar techniques is ongoing.

Activity III

1) Isolation, identification, and evaluation of enzymes from *Trichoderma* spp. are ongoing.
2) Compounds promoting or inhibiting seed germination of *Striga hermonthica* and *Orobanche minor* have been, respectively, purified and their structures are under investigation.
3) An on farm experiment was conducted at two sites, Dongola and Shendi, during 2019/20 season to evaluate the efficacy of a combination of *Trichoderma* spp. and bacterial strains on *Orobanche crenata* incidence in faba bean.
4) Effects of preceding crops on mycorrhizal infection of a subsequent sorghum crop is ongoing.
5) An experiment on microorganisms capable of increasing soil fertility and improving crop growth and grain yield is ongoing.
6) A greenhouse experiment to study the efficacy of *Trichoderma* spp. on *Phelipanche* in tomato crop was accomplished.

Activity IV

1) The third year of the 4-year rice cultivation experiment is conducted, with the purpose of evaluating durability of resistance of rice to *Striga*.
2) Influence of sorghum genotype on germination and further development of *Striga hermonthica* using an *in vitro* system (the rhizotron technique) for sorghum and *Striga* co-culture ongoing. The sorghum genotypes used were Wad-Ahmed, *Striga* tolerant, and Tetron and Hakika, *Striga* resistant.

Activity V

1) A MEXT scholarship student is continuing her PhD course in Japan.
2) Synthetic studies are ongoing to deduce the structures of newly isolated natural products from selected Sudanese medicinal plants.

Activity VI

1) FFS activities are ongoing at two sites.

Activity VII

1) Impacts of COVID-19 infections on Sudanese farmers were surveyed.

1-3 Achievement of Output

General

1) The PhD student had the opportunity to improve her capacity through practice in Japan.

Activity I

1) *Striga* emergence in the untreated control was high, whereas, T-010 treatments reduced *Striga* emergence and improved sorghum growth.
2) In absence of fluridone, GR24 at 0.0001 and 0.01 ppm applied to seeds collected in 2014 and conditioned for 2 days induced 19.7 and 52.8% germination, respectively. However, in presence of fluridone at 10 μM the corresponding germination figures were 48 and 85.1%. Increasing fluridone to 15 μM increased germination to 78 and 90%. A further increase in fluridone to 20 μM resulted in insignificant repression of germination. In absence of fluridone, GR24 at 0.0001and 0.01 ppm applied to seeds collected in 2019 and conditioned for 2 days induced 7.2 and 9.1%, respectively. In presence of fluridone at 10 μM the corresponding germination figures were 13.1 and 29.5%. Increasing fluridone to 15 μM did not increase germination significantly. However, a further increase in fluridone to 20 μM increased germination to 25.7 and 41.2% at the higher and lower GR24 concentrations, respectively

Activity II

1) Hypothetical mode of action of nojirimycin was proposed.
2) Transgenic tobacco BY-2 cell lines expressing OmAGAL2 fused with mCherry fluorescent protein were constructed.
3) Localization of planteose in seed coat, perisperm, and endosperm was confirmed.

Activity III

1) A patent entitled "*Orobanche* control technology" has been officially registered by the Intellectual Property Office.
2) The *Streptomyces* strains producing promoters and/or inhibitors of *O. minor* or *S. hermonthica* germination had no adverse effects on host, *Trifolium pratense*, growth.

Activity IV

1) *Striga* germination progressively increased with time and was 66.9-92.1%, 61.1-85.5% and 52.6-74.1% for Wad-Ahmed, Tetron and Hakika, respectively. *Striga* seedlings affected comparable attachment (53.6-68.8%) to the roots of the three genotypes. However, development and survival of the seedlings were genotype dependent. At 1-3 weeks post-inoculation, *Striga* seedlings at stage 3 were 19.1-24.7%, 2.9-7.1% and 6.3-12.6% on Wad-Ahmed, Tetron and Hakika, respectively. Seedlings mortality was 0-1.2%, 3.0-8.1% and 2.5-29.6% on Wad -Ahmed, Hakika and Tetron, respectively.

Activity V

1) Analytical methods for *Striga* chemical ingredients were adopted for analysis of chemical ingredients of selected Sudanese medicinal plants.
2) Synthetic methodology was employed for the determination of structures of natural products from selected Sudanese medicinal plants.

Activity VI

1) Messages were broadcasted on local radio and a national TV station (Alshroog) reflecting the project activity in combating *Striga* and improving sorghum productivity.
2) An FFS site at Koomshita was visited by HE governor of Gedarif state accompanied by high local delegation representing local leaders, farmers, state ministry of agriculture and mass media representatives.

Activity VII

1) Questionnaire data collected from 10 farmers indicated that they were confined to homes and food prices at local markets have soared.

1-4 Achievement of the Project Purpose

General

1) No collaborative activity was achieved due to the worldwide COVID-19 outbreak. Throughout the period, travel restrictions were imposed on both Japanese experts and Sudanese researchers. However, individual experiments were conducted by the participants in Japan and Sudan.
2) Biosynthesis genes involved in the formation of 5-deoxystrigol and orobanchol have been identified. Regulation of the germination stimulant production by manipulating the genes was confirmed.

Activity I

1) Reducing Striga infection by repetitive application of T010 is feasible
2) Increasing sensitivity of *Striga* seeds to trap crops using low rates of fluridone is feasible.

Activity II

1) Disruption of sugar signaling in germinating seeds of *O. minor* by nojirimycin was suggested.
2) Role of planteose as storage carbohydrate and function of OmAGAL2 in its metabolism are being elucidated.
3) Role of *Streptomyces* as growth promoting rhizobacteria was suggested.

Activity III

1) Pot experiments to investigate if the *Streptomyces* strains producing the promoters and/or the inhibitors of *O. minor* seeds germination also inhibit attachment of the parasite to the *Trifolium pratense* roots were conducted.
2) Field experiments, in North Sudan, season 2020/21, were conducted to investigate the effect of a combination of *Trichoderma spp*, potential bacterial strains, and a herbicide on *Orobanche crenata* in faba bean.

Activity IV

1) The strong developmental arrest noted beyond stage 2, where xylem-to-xylem connection between the parasite and the host was established, coupled with the notable seedling mortality on Tetron and Hakika suggested that *Striga* resistance in these genotypes is attributed, in part, to impairment of diversion of nutrients, water and carbon compounds from the host to the parasite.

Activity V

1) Long term training for a Sudanese researcher had started by joining a PhD course in

Japan.

2) Research methods for analysis of *Striga* chemical ingredients were adopted for analysis of selected Sudanese medicinal plants.

Activity VI

1) ISM package implemented by the project greatly reduced *Striga* infestation and improved crop productivity compared to traditional farmers' production methods and thus found high acceptance among farmers.

Activity VII

1) none

1-5 Changes of Risks and Actions for Mitigation

Following the Sudanese political turmoil in 2019, the worldwide outbreak of COVID-19 seriously affected the project implementation. No action for mitigation can be taken because the virus outbreak is far beyond researches' capacity.

The Japanese Ministry of Foreign Affairs had kept the 'Sudan's safety level at Level 2 (Advice against all, but essential travels). It was further raised to Level 3 (Advice against all travels) on July 21, 2020. Revitalization of the project activities depends largely on how fast the world will overcome the pandemic.

1-6 Progress of Actions undertaken by JICA

JICA HQs and its Sudan Office returned the coordinator in the middle of April. Since then, little support could be provided to the Sudanese counterpart by JICA. The epidemic situation of COVID-19 in Japan has been fluctuating and that in Sudan has become worse.

1-7 Progress of Actions undertaken by Gov. of Sudan

The Sudan government is continuing its support to the project. However, the instability of the Sudanese pound and the recent rise in labour cost constitute difficult problems and may lead to further cuts in experiments.

1-8 Progress of Environmental and Social Considerations (if applicable)

People all over the world are expecting the development of effective countermeasures to the virus, such as vaccines and antiviral agents.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

Four coordinators joined the former and current projects. JICA selected and assigned a female coordinator for the first time, who joined the project in late February, 2020.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

Some NGOs are adopting, independently, some of our research findings in combating *Striga* at the field level.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

1) The extension part of the main laboratory has been suspended since November, 2017. An existing building which is physically connected to the main laboratory has been assigned as an extension to the laboratory.

2) Collaborative activities in Sudan have been suspended.

2-2 Cause

1) Devaluation of the Sudanese currency and insufficient supply of budget from the Ministry of Finance, Sudan.

2) The political turmoil in Sudan in 2019 and the worldwide outbreak of COVID-19 in 2020.

2-3 Action to be taken

1) The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

1) The project appreciates the cooperation of the NCR administration and the ministry of finance who provided budget for the ongoing experiments and for the FFS at Gedarif.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

4 Preparation of Gov. of Sudan toward after completion of the Project

A team of researchers from the National Center for Research, the Agricultural Research Corporation and Sudan University of Science and Technology together with extension workers at the Gedarif State has been formed. The future plan is to include the departments of extension, the federal government and relevant States.

II. Project Monitoring Sheet I & II *as Attached*

Form 3-1 Monitoring Sheet Summary

TOCR of JICA SUDAN OFFICE

PROJECT MONITORING SHEET

Project Title : Development of countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.7 (Term: 1 October, 2020– 31 March, 2021)

Name: Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 31 March, 2021

I. Summary from 1 October, 2020 to 31 March, 2021

1 Progress

1-1 Progress of Inputs

Travel restrictions have been imposed on Japanese experts to Sudan and Sudanese researchers to Japan throughout the monitoring period, due to the worldwide outbreak of COVID-19.

1) Short term experts (period of stay in Sudan): none
2) Short Term Training: none
3) Middle Term Training: none
4) Long Term Training: Hanaa H.E.A., a PhD student at Kobe University
   1 October, 2020 to 31 March, 2021. Total 182 days
5) Short Term Invitation (period of stay in Japan): none

1-2 Progress of Activities

General

1) The Japanese Government Scholarship (SATREPS) student is continuing her PhD studies at Kobe University.

Activity I

1) A long term bathtub experiment to evaluate the effects of repetitive dosage of T-010 on *Striga* emergence is continued.
2) Influence of fluoridone (0.1-20 µM) applied during conditioning on response of *Striga hermonthica, Phelipanche ramosa and Orobanche crenata* to natural and synthetic germination stimulants at normal and supra-optimal temperatures on going.

Activity II

1) Characterization of OmAGAL2 is continued.
2) Structure-activity relationship study of OmAGAL2 inhibitor has been started.
3) Evaluation of the effect of starch casein nitrate (SCN) medium on growth, metabolites released by potential *Streptomyces* isolates and their effect on *Striga* seeds germination is ongoing.

Activity III

1) Cycloheximide was identified as an inhibitor for *O. minor* seed germination.
2) Compounds promoting seed germination and haustoria formation in *O. minor* are under investigation.
3) Greenhouse experiments to study the effects of tomato cultivars, *Trichoderma* spp. and seed bank levels on *P. ramosa* in tomato crop are ongoing.
4) Field experiment to evaluate the effects of resistant cultivars and potential microbes on *O. crenata* in faba bean are under investigation.
5) Bathtub experiment on mycorrhiza management using sesame, groundnut and soybean concluded.
6) Effects of agricultural practices on mycorrhiza proliferation and combating *Striga* in subsequent sorghum ongoing.
7) Effects of mycorrhiza and seed bank size on *Striga* incidence and growth of subsequent sorghum ongoing.
8) On farm preparation of mycorrhiza inoculants planned.

Activity IV

1) The third year of the 4-year rice cultivation experiment was conducted, with the purpose of evaluating durability of resistance of rice to *Striga*.
2) Mechanisms of resistance in sorghum and pearl millet to *Striga* strains ongoing.
3) Laboratory, greenhouse and field validation of resistance of newly bred sorghum genotypes ongoing.

Activity V

1) A MEXT scholarship student is continuing her PhD course in Japan.
2) Synthetic studies of flavonoids are ongoing to deduce the structures of newly isolated natural products from selected Sudanese medicinal plants.

Activity VI

1) FFS activities were completed the previous locations at Central Gedarif in Koomshita and Kajara to demonstrate ISM package to increase sorghum productivity. In each location a demonstration field was established for field evaluation of ISM package by participating farmers.

Activity VII

No progress

1-3 Achievement of Output

General

1) The PhD student had the opportunity to improve her capacity through practice in Japan.

Activity I

1) T-010 treatments reduced *Striga* emergence and improved sorghum growth. The treatment reduced *Striga* emergence by 35 to 45%, and increased sorghum dry weight by 73 to 167%.
2) Conditioning in fluridone at 0.1-20 µM for 2-5 days increased germination of *S. hermonthica* in response to GR24 at 0.34 nM in a concentration dependent manner up to10 µM, but declined on further increase of fluoridone concentration to 15 and 20 µM. Freshly harvested seeds were less responsive than one year old seeds. One year old seeds conditioned in fluridone (10 µM) at a temperature of 40°C showed negligible germination (6%), in response to GR24 24 h after treatment. However, high germination 48.8 and 65% was attained 48 and 72 h after treatment. Seeds conditioned in water and treated with GR24 showed poor germination (0-23.9%). Plausibility of increasing efficacy of trap crops (cotton and sesame) by fluridone deserves further investigations.

Activity II

1) Transgenic Arabidopsis lines expressing OmAGAL2 fused with mCherry fluorescent protein were constructed.

2) Secretion of OmAGAL2 to apoplasts was clarified.
3) Nine derivatives of the OmAGAL2 inhibitor PI-28 were synthesized.
4) Effects of some *Streptomyces* isolates cultures grown on SCN medium on *Striga* seeds germination and radicle elongation were determined.

Activity III

1) A quantification method to evaluate the infection of *O. minor* of *Trifolium pratense* was established.
2) Two out of nine *Trichoderma* strains reduced *Striga* germination by 59-78% as compared to the corresponding control.
3) Sesame showed the highest root colonization. Bathtubs previously infested with mycorrhiza and planted to soybean or ground nuts, irrespective of subsequent simulated tillage operation (disturbing soil in bathtubs to simulate tillage) resulted in poor sorghum growth. Bathtubs previously infested with mycorrhiza and planted to sesame showed differential support to subsequent sorghum. Tilled soil in bathtubs supported poor sorghum growth while those with untilled soil supported lush growth of sorghum.

Activity IV

1) Since the Nile flood inundated the main pump, proper irrigation was not achieved. Accordingly, rice and *Striga* plants wilted.

Activity V

1) Analytical methods for ingredients obtained from *Striga* were adopted for analysis of chemical ingredients of a Sudanese medicinal plant to find some flavonoids.
2) Synthetic methodology was employed for the determination of structures of natural products from selected Sudanese medicinal plants.

Activity VI

1) The implemented ISM package increased sorghum productivity in comparison with the farmers' practice.
2) About 50 farmers (25 in each location) directly participated in FFS each location. Around 300 farmers indirectly benefited through direct contact with participating farmers. Many other farmers have the messages of ISM package through messages broadcasted in local mass media.

Activity VII

No progress was made.

1-4 Achievement of the Project Purpose

General

1) No collaborative activity was achieved due to the worldwide COVID-19 outbreak. Throughout the period, travel restrictions were imposed on both Japanese experts and Sudanese researchers. However, individual experiments were conducted by the participants in Japan and Sudan.
2) The project had a web gathering on November 2, 2020, in which five Sudanese and four Japanese researchers, the coordinator and her assistant participated. The participants confirmed smooth communication through the system.

Activity I

1) Reducing *Striga* infection by repetitive application of T010 is feasible.
2) Potentiating activity of the synthetic germination stimulants (GR24) by sub-toxic levels of fluridone.

Activity II

1) Role of OmAGAL2 in planteose mobilization during germination was suggested.

Activity III

1) Based on our preliminary data, the infection of *O. minor* to its host was reduced by 90% in 3 out of 6 pots with the inoculation of *Streptomyces* sp. no. 1721 to soil compared to the non-inoculation condition.
2) Based on laboratory experiments, 2 out of 9 of *Trichderma* strains reduced *Striga* germination by 59-78% as compared to the control.
3) Mycorrhiza proved to be effective in suppressing *Striga* infection in sorghum. Sesame is a major crop in the rain-fed area and is heavily colonized by mycorrhiza. Mycorrhization is detrimentally impacted by tillage. However, it could be promising under no-till planting. Further, other crops viz. cotton are to be evaluated for field sustenance of mycorrhizal fungi and spores to widen crop choice particularly in rain-fed areas where high rainfall precludes sesame cultivation. Moreover, the feasibility of promoting mycorrhiza proliferation under actual field conditions needs to be investigated.

Activity IV

1) No data was obtained because both rice and *Striga* plants wilted due to insufficient irrigation.
2) Beside the previously reported pre-attachment resistant mechanism based on low stimulant production by the sorghum genotypes Hakika and Tetron, post-attachment resistance mechanisms were identified. Further, a plausible role of non-canonical strigolactones has been suggested, based on rhizotron studies.

Activity V

1) Long term training for a Sudanese researcher has continued by joining a PhD course in Japan.
2) Research methods for chemical analysis of ingredients obtained from *Striga* were adopted for analysis of a Sudanese medicinal plant.

Activity VI

1) ISM package implemented by the project greatly reduced *Striga* infestation and improved crop productivity compared to traditional farmers' production methods and thus found high acceptance among farmers.

Activity VII

No progress was made.

1-5 Changes of Risks and Actions for Mitigation

Following the Sudanese political turmoil in 2019, the worldwide outbreak of COVID-19 seriously affected the project implementation. No action for mitigation can be taken because the virus outbreak is far beyond researches' capacity.

The Japanese Ministry of Foreign Affairs have kept the 'Sudan's safety level at Level 3 (Advice against all travels) since July 21, 2020. Revitalization of the project activities depends largely on how fast the world will overcome the pandemic.

1-6 Progress of Actions undertaken by JICA

JICA HQs and JICA Sudan Office re-dispatched the coordinator on January 10, 2021. Since then, the coordinator, in collaboration with her assistant and the driver, has secured close coordination among researchers in Sudan and Japan.

1-7 Progress of Actions undertaken by Gov. of Sudan

Due to delay in release of the local component of the project budgets, the NCR is locating

parts of its budgets for renovation of the new laboratory and is seeking an additional support from the Ministry of higher education to keep the project facilities running at a reasonable level.

1-8 Progress of Environmental and Social Considerations (if applicable)

People all over the world are expecting the development of effective countermeasures to the virus, such as vaccines and antiviral agents.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

Four coordinators joined the former and current SATREPS projects. JICA selected and assigned, for the first time, a female coordinator, who joined the project in February, 2020.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

1) The extension part of the main laboratory has been suspended since November, 2017. A new building has been assigned to the project and the NCR is refurbishing it to accommodate equipment to be provided by JICA.
2) Collaborative activities between Sudanese and Japanese researchers have been suspended.

2-2 Cause

1) Devaluation of the Sudanese currency and insufficient supply of budget from the Ministry of Finance, Sudan.
2) The worldwide outbreak of COVID-19 in 2020 and 2021.

2-3 Action to be taken

1) The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

1) The project appreciates the cooperation of the NCR administration and the ministry of

finance who provided budget for the ongoing experiments and for the FFS activities at Gedarif.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

Due to problems caused by COVID -19 epochs, the NCR has requested a two years extension of the project.

4 Preparation of Gov. of Sudan toward after completion of the Project

A team of researchers from the National Center for Research, the Agricultural Research Corporation and Sudan University of Science and Technology together with extension workers at the Gedarif State has been formed. The future plan is to include the departments of extension, the federal government and relevant States.

II. Project Monitoring Sheet I & II *as Attached*

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of countermeasures against *Striga*
to conquer poverty and improve food security in Sudan
Version of the Sheet: Ver.8 (Term: 1 April, 2021– 30 September, 2021)

Name: Yukihiro SUGIMOTO
Title: Professor, Kobe University
Submission Date: 30 September, 2021

I. Summary from 1 April, 2021to 30 September, 2021

1 Progress

1-1 Progress of Inputs

Travel restrictions have been imposed on Japanese experts to Sudan and Sudanese researchers to Japan throughout the monitoring period, due to the worldwide outbreak of COVID-19.

1) Short term experts (period of stay in Sudan): none
2) Short Term Training: none
3) Middle Term Training: none
4) Long Term Training: Hanaa H.E.A., a PhD student at Kobe University
   1 April, 2021to 30 September, 2021. Total 183 days
5) Short Term Invitation (period of stay in Japan): none

1-2 Progress of Activities

General

1) The Japanese Government Scholarship (SATREPS) student is continuing her PhD studies at Kobe University.
2) The 3rd JCC online meeting was held on the 10th of June after 24 months absence with 21 participants including five from NCR, three from ARC and one from SUST.

Activity I

1) A long-term bathtub experiment to evaluate the effects of continuous application of T-010 on *Striga* emergence is continued.
2) Improvement of germination inducing activity of root exudates of trap crops through employment of fluoridone at sub-toxic level is ongoing.

Activity II

1) Localization of planteose in dry seeds of *Orobanche minor* was revealed.
2) Structure-activity relationship study of OmAGAL2 inhibitors is continued.
3) The effect of some *Streptomyces* isolates cultures grown on SCN medium on *Striga* seeds germination is continued.

Activity III

1) Effects of *Trichoderma* spp., *Bacillus* spp. on *Striga* incidence on a susceptible and tolerant sorghum cultivar under greenhouse conditions is ongoing.
2) Studies on effects of seed bank size on *Striga* incidence and performance of selected sorghum cultivars under greenhouse conditions were accomplished.
3) Studies on effects of seed bank size on *Phelipanche ramosa* incidence and performance of selected tomato cultivars under greenhouse conditions were accomplished.
4) Effects of mycorrhizal fungi on *Striga* incidence on a susceptible and tolerant sorghum cultivar under greenhouse conditions is ongoing.
5) Effects of *Trichoderma*, bacterial strains and tomato cultivars on *Phelipanche ramosa* incidence and tomato performance under greenhouse conditions were accomplished.
6) Influence of agricultural practices on mycorrhization in sorghum is ongoing under greenhouse conditions.
7) Evaluation of mature technology (*Trichoderma* spp., bacterial strains and Imazethapyr) on *Orobanche* on faba bean, under farmer filed conditions, is ongoing.
8) Effects of *Streptomyces* isolate no. 1721 on infection of host plants by *O. minor* are under investigation.

Activity IV

1) NERICA 4 was grown at Shambat Research Station, in pots infested with *Striga* seeds collected from mature plants growing on sorghum. The *Striga* seeds from NERICA 4 will be used next season, if the project is extended, to evaluate changes of compatibility with NERICA4.

2) Seed multiplication of *Striga* resistant high yielding sorghum crosses is ongoing.
3) Plans for elucidating mechanisms of resistance of high yielding sorghum crosses previously identified as *Striga* resistance are set.

Activity V

1) A MEXT scholarship student is continuing her PhD course in Japan.
2) Synthetic studies of flavonoids are continuing to deduce the structures of newly isolated natural products from traditional Sudanese medicinal plants.

Activity VI

1) FFS activities are continued at North and Central Gedarif in 10 locations to demonstrate efficacy of an ISM package on sorghum productivity in *Striga* infested fields. In each location a demonstration field was established for field evaluation of the ISM package by participating farmers.

Activity VII

1) NCR is planning to create database to share the project outcomes with stakeholders across the country.
2) NCR is planning to promote project activities on the NCR website.
3) NCR, ARC and SUST are preparing a brochure on *Striga* management.
4) NCR is planning to organize and hold seminars to ensure sustainability and dissemination of knowledge-based integrated management strategies on national basis.

1-3 Achievement of Output

General

1) The PhD student had the opportunity to improve her capacity through practice in Japan.
2) The 3rd JCC started with opening remarks (Prof. Zeinab) and overview of the project (Prof. Sugimoto), followed by input reports (Prof. Babiker and Ms. Endo) and activity reports (Dr. Khogali, Prof. Babiker, Prof. Somaya, Prof. Okazawa, Prof. Hassan, Prof. Tani, Ms. Hanaa, Prof. Kuse and Prof. Dafalla). Before closing remarks (Mr. Sakane), requests for project extension (Prof. Babiker) and equipment (Prof. Somaya) were made.
3) Sorgomol synthase was identified, which catalyzes conversion of 5-deoxystrigol to sorgomol in sorghum.

Activity I

1) *Striga* emergence in the untreated control is high, whereas T-010 treatments, irrespective of application time or frequency, reduced *Striga* emergence.
2) Evaluation of sub-toxic levels of fluoridone as enhancer of germination inducing activity of trap crops under laboratory conditions is ongoing.

Activity II

1) Planteose accumulated in endosperm, perisperm and seed coats in dry seeds of *Orobanche minor*.
2) Twenty-seven derivatives of the OmAGAL2 inhibitor PI-28 were synthesized.
3) Efficacy of some *Streptomyces* isolates as *Striga* seed germination inhibitors was determined.

Activity III

1) Effects of seed bank size on *Striga* incidence and performance of selected sorghum cultivars under greenhouse conditions were accomplished.
2) Influence of *Trichoderma*, bacterial strains and tomato cultivars on *Phelipanche ramosa* incidence and tomato performance under greenhouse conditions were accomplished.
3) Evaluation of mature technology (*Trichoderma* spp, bacterial strains and Imazethapyr) on *Orobanche* on faba bean, under farmer filed conditions, is ongoing.
4) Evaluation of mycorrhizal fungi for efficacy on *Striga* on a tolerant and susceptible sorghum cultivars is ongoing.
5) Influence of agricultural practices on mycorrhization of sorghum is ongoing.
6) A new inhibitor on *O. minor* seed germination was identified from culture supernatant of *Streptomyces* isolate no. 1721.
7) A candidate compound promoting seed germination of *O. minor* was synthesized. Its activity is under investigation.

Activity IV

1) Effects of repeated planting on adaptability of *Striga* to NERICA4 is ongoing.
2) *Striga* resistant crosses were sown for seed multiplication and plans for elucidating their resistance mechanism using the agar jell assay were set.

Activity V

1) Analytical methods for ingredients of *Striga* were established and were adopted to other Sudanese medicinal plants.
2) Stereoselective synthetic studies are continuing to construct natural products found in a Sudanese medicinal plant.

Activity VI

1) FFS activities at 10 locations at North and Central Gedarif districts are ongoing.
2) A tractor with necessary attached implement together with protective wearing for pesticides application were received at Gedarif to improve scaling up of ISM practices through FFS

Activity VII

1) A national seminar is under arrangement.
2) A brochure is under preparation.
3) A meeting with the managing director Ministry of Agriculture River Nile State, scheduled first week of September, was realized. *Striga* problems on wheat and sorghum in the state and plausible means of management and collaboration were discussed.

1-4 Achievement of the Project Purpose

General

1) Through the presentations delivered at the 3rd JCC, researchers and officials involved in the project shared achievements attained and problems the project is facing.
2) Useful information about the biosynthesis of a germination stimulant produced by sorghum was obtained.

Activity I

1) Continuous treatment with T-010 seems to be necessary for combating and management of *Striga*.
2) Technical feasibility for T-010 as a suicidal germination stimulant for combating *Striga* in sorghum is to be determined.
3) Fluoridone increased sensitivity of *Striga* seeds to GR24. Verifications of the results using *in situ* trap crops roots exudates are ongoing.

Activity II

1) OmGAL2 seems to be a suitable target since it works extracellular and thus cell-membranes do not constitute ingress barriers.
2) Some PI-28 derivatives inhibited radicle elongation of *Orobanche minor*.
3) Efficacy of potentials *Streptomyces* isolates, based on laboratory results, needs to be validated in pot experiments.

Activity III

1) Effects of seed bank size on incidence and performance of selected sorghum cultivars under greenhouse conditions were accomplished.
2) Influence of *Trichoderma*, phosphorus solubilizing bacterial and tomato cultivars on *Phelipanche ramosa* incidence and tomato performance under greenhouse conditions were accomplished.
3) Evaluation of mature technology (*Trichoderma* spp, bacterial strains and Imazethapyr) on *Orobanche* on faba bean, under farmer filed conditions, is ongoing.
4) Evaluation of mycorrhizal fungi for efficacy on *Striga* on a tolerant and susceptible sorghum cultivar is ongoing.
5) Preliminary data suggested that *Streptomyces* sp. isolate no. 1721 reduced infection of *O. minor* on-host plant grown in plastic tubes.
6) Sorghum planted subsequent to groundnut or soybean, irrespective of soil disturbance, showed no differential growth. Sorghum planted subsequent to sesame showed no response on disturb soil, however, planting in non-disturb soil showed significantly better growth and better grain yield.

Activity IV

1) A molecular mechanism involved in low germination inducing activity in sorghum root exudates was elucidated. The finding will be applied to the analysis of *Striga* resistant crosses.

Activity V

1) Long term training for a Sudanese researcher has continued by joining a PhD course in Japan and is scheduled to be completed next March.
2) Established research methods (including organic synthesis) for the analysis of ingredients obtained from *Striga* were adopted for the analysis of other Sudanese medicinal plants.

Activity VI

1) Currently the number of FFS sites are increased from two to three in the past seasons to ten.
2) Production packages for *Striga* management and improvement of sorghum productivity were adopted by many farmers suffering from *Striga* infestation at Gedarif.

Activity VII

1) The design of a national seminar to be held in October is at its final stage.

2) Preparation of a brochure is at its final stages

1-5 Changes of Risks and Actions for Mitigation

Following the Sudanese political turmoil in 2019, the worldwide outbreak of COVID-19 seriously affected the project implementation. No action for mitigation can be taken because the virus outbreak is far beyond researches' capacity.

The Japanese Ministry of Foreign Affairs has kept the 'Sudan's safety level at Level 3 (Advice against all travels) since 21st of July, 2020. Revitalization of the project activities depends largely on how fast the world will overcome the pandemic.

1-6 Progress of Actions undertaken by JICA

1) Soon after the 3rd JCC, JICA started discussing the equipment provision and extension of the project period. After a long discussion about the equipment, the JICA officials asked the Japanese leader, who listened to the discussion as a third party, to summarize their ideas and opinions and explain them to the JICA official responsible for this project with additional information related to the discussion. JICA confirmed the appropriateness to provide the equipment through detailed explanation made by the Japanese leader on 26th of July and asked Kobe University the next day to procure and transfer equipment to NCR.
2) Regarding the extension of the project period, the project follows the regulations announced by JST/JICA SATREPS secretariat on 21st of July, 2020.The Japanese leader submitted a letter of request on 21st of June. JICA requested the Japanese leader on 25th of September to provide with more information about activities to be implemented if the project period is extended.

1-7 Progress of Actions undertaken by Gov. of Sudan

As a measure to reduce Covid-19 infections the Sudan governments reduced working days for government employees almost to half. To keep the work ongoing people have been advised to attend to work on alternate days.

1-8 Progress of Environmental and Social Considerations (if applicable)

People all over the world are expecting the development of effective countermeasures to the virus, such as vaccines and antiviral agents.

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

Four coordinators joined the former and current SATREPS projects. JICA selected and assigned, for the first time, a female coordinator, who joined the project in February, 2020.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

Several NGOs are adopting, at least in part, the results of the project developed technology as per the demonstration trials undertaken in farmers' fields at the Gedarif state. The project partner Dr. Hanan Abdel Tuwab acts as a consultant for the NGOs. Representatives of the respective NGOs are to be invited to the seminar and their active participation is to be sought.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

1) Extension of the main laboratory was achieved late in April 2021 by renovating rooms adjacent to the main laboratory, with three years delay. Accordingly, necessary procedures to provide the 2nd batch of equipment have started after the 3rd JCC, with three years delay.
2) Face-to-face collaborative activities between Sudanese and Japanese researchers have been suspended.

2-2 Cause

1) Devaluation of the Sudanese currency and insufficient supply of budget from the Ministry of Finance, Sudan.
2) The worldwide outbreak of COVID-19 in 2020 and 2021.

2-3 Action to be taken

1) The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

1) The project appreciates the cooperation of the NCR administration and the ministry of finance who provided budget for the ongoing experiments and for the FFS activities at Gedarif.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

Due to problems caused by COVID-19 epochs, the NCR has requested a two years extension of the project in February 2021. Following the SATREPS regulation, the Japanese leader submitted a request letter of extension to JST on 21st of June. JST approved one year extension of the project period. The project has been waiting for a decision to be made by JICA.

4 Preparation of Gov. of Sudan toward after completion of the Project

A team of researchers from the National Center for Research, the Agricultural Research Corporation and Sudan University of Science and Technology together with extension workers at the Gedarif State has been formed. The future plan is to include the departments of extension, the federal government relevant States and NGOs.

II. Project Monitoring Sheet I & II *as Attached*

Form 3-1 Monitoring Sheet Summary

TOCR of JICASUDANOFFICE

PROJECT MONITORING SHEET

Project Title :Development of countermeasures against *Striga* to conquer poverty and improve food security in Sudan

Version of the Sheet: Ver.9 (Term: 1 October, 2021 – 31 March, 2022)

Name:Yukihiro SUGIMOTO
Title: Professor, Kobe University

Submission Date: 31 March, 2022

I. Summary from 1 October, 2021 to 31 March, 2022

1 Progress

1-1 Progress of Inputs

Travel restrictions have been imposed on visits of Japanese experts to Sudan and Sudanese researchers to Japan throughout the monitoring period, due to the worldwide outbreak of COVID-19. Moreover, contact restrictions with the Sudanese counterparts had been imposed on the Japanese experts by JICA from 16 November, 2021 to 3 March, 2022.

1) Short term experts (period of stay in Sudan): none.
2) Short Term Training: none.
3) Middle Term Training: none.
4) Long Term Training: Hanaa H.E.A., a PhD student at Kobe University
   1 October, 2021to 30 March, 2022. Total 181 days.
5) Short Term Invitation (period of stay in Japan): none.

1-2 Progress of Activities

General

1) The Japanese Government Scholarship (SATREPS) student finished her PhD studies at Kobe University and got a PhD degree on 24 March, 2020.
2) Elucidation of the biosynthetic mechanisms of germination stimulants is ongoing.

Activity I

1) A long-term bathtub experiment to evaluate the effect of repetitive dosage of T-010 on *Striga* emergence is accomplished.
2) A long-term experiment on increasing sensitivity of *Striga* seed bank to root exudates of trap crops is ongoing (Post-graduate studies are being considered)

Activity II

1) Structure-activity relationship study for inhibitory activity of PI-28, an OmAGAL2 inhibitor, and its derivatives on *Orobanche minor* radicle elongation revealed several compounds with potent inhibitory activity.
2) Plant growth promoting phytohormones viz., IAA and GA produced by hundred rhizospheric bacterial isolates were determined using qualitative and quantitative assays.

Activity III

1) Long-term experiments on effects of agricultural practices on mycorrhizal proliferation and *Striga* infection of sorghum is ongoing.
2) Isolation and identification of microorganisms and associated active compounds from suppressive soils and their competence on *Striga*, *Orobanche* and *Phelipanche* germination is ongoing.
3) Effects of potential microbes on *Striga* incidence on a susceptible and tolerant sorghum cultivar under greenhouse conditions are ongoing.
4) Effects of cultivars, bacterial strains and *Trichoderma* spp. on *Phelipanche ramosa* incidence on tomato are ongoing.
5) Influence of mycorrhiza isolates on *Striga* spp. in sorghum is ongoing under greenhouse conditions.
6) Evaluation of mature technology, *Trichoderma* spp, bacterial strains and herbicides on *Orobanche crenata* in faba bean, under farmer filed conditions, is ongoing.
7) Effects of *Streptomyces* isolate 1721 on virulence of *Orobanche minor* on different host plants are under investigation.
8) A compound promoting haustorium formation is under purification.

Activity IV

1) A field experiment was undertaken for three consecutive seasons to evaluate sustainability of resistance to *Striga* in Umgar and NERICA 5 and increase of susceptibility to Striga in NERICA 4. NERICA 4 was grown at Shambat Research Station, in pots infested with *Striga* seeds collected from plants growing on sorghum.

The purpose was to collect *Striga* seeds from NERICA 4 to evaluate changes in virulence of the parasite in response to repeated planting.

2) Evaluation of the reaction of three rice cultivars to changing levels of Striga seed bank under greenhouse conditions is planned for next season.

Activity V

1) A MEXT scholarship student has completed her PhD course in Japan.
2) Synthetic studies to deduce the structures of newly isolated natural products (glycosylated flavonoiuds) from traditional Sudanese medicinal plants are almost completed.

Activity VI

1) FFS activities are continued at North and Central Gedarif.

Activity VII

1) Efforts to increase awareness of the project were designed and conducted.

1-3 Achievement of Output

General

1) The PhD student had the opportunity to improve her capacity through practice in Japan.
2) Carlactonoic acid (CLA) methyltransferase (CLAMT), the enzyme which catalyzes conversion of CLA to its methyl ester in plants, was isolated and identified.

Activity I

1) *Striga* emergence in the untreated control was high, whereas T-010 treatments, irrespective of time and/or frequency of application reduced *Striga* emergence and increased sorghum shoot dry weight.
2) The herbicide fluridone, a selective herbicide in cotton and groundnuts, increased sensitivity of *S. hermonthica* seeds to GR24.
3) Study on influence of fluridone on sensitivity of Striga seeds to GR24 and root exudates of cotton, sesame and groundnut as influenced by conditioning period and temperature is ongoing.

Activity II

1) A paper on characterization of OmAGAL2 and planteose metabolism in germinating *Orobanche minor* seeds was published.
2) More than twenty PI-28 derivatives were synthesized.

3) A number of rhizospheric bacterial isolates were identified as higher producers of IAA and GAs. The isolates are to be probed for CKs production using HPLC.

Activity III

1) An integrated technology for *Orobanche crenata* control in faba bean has been developed.
2) *Trichoderma harzianum* + BMP + TAL1399 + imazethapyr reduced *O. crenata* emergence on Masri 3 (resistant faba bean line) by more than 90% and increased grain yield by 500% in comparison to the corresponding controls.
3) The highest yield (4.38 ton/ha) was attained by Masri 3 receiving the full package.
4) A patent for *Orobanche* control (Tricobactin) has been issued, under the number 5572/2021.
5) A compound promoting seed germination of *O. minor* was identified.

Activity IV

1) Different reactions between rice varieties to Striga were confirmed.
2) No *Striga* emergence was observed in the second and the third season due to insufficient supply of water to the field due to Nile flood which inundated the main irrigation pump, and we were unable to gather information or data from the experiment.
3) *S. hermonthica* which parasitized and grew on NERICA4 did not produce seeds for unknown reasons.
4) Seeds multiplication of *S. hermonthica* resistance crosses was accomplished.

Activity V

1) Analytical methods for flavonoids of commercial value in *Striga* had been established and were adopted to probe, *Solenostemma argel,* another Sudanese medicinal plant.
2) Stereoselective synthetic studies were conducted by the Sudanese PhD student to delineate the stereochemistry of natural products found in *Solenostemma argel* another Sudanese medicinal plant.

Activity VI

1) FFS activities were conducted in ten sites at North and Central Gedarif. The implemented ISM practices were highly accepted by participating farmers.

Activity VII

1) A national seminar entitled 'INTEGRATED MANAGEMENT OF PARASITIC WEEDS' was held on

6 November, 2021, at Sharjah Hall, University of Khartoum. Ten presentations, including three video presentations contributed by Japanese researchers, were delivered to approximately 80 participants.

2) A project brochure and a souvenir pen were delivered to each participant.

1-4 Achievement of the Project Purpose

General

1) The PhD student will transfer techniques related to natural product chemistry to Sudan.
2) Biochemical information useful to suppress germination stimulant production in plants was obtained. By knocking-out the biosynthesis genes, increase in resistance of host plants to root parasitic weeds is possible.

Activity I

1) Continuous treatment with T-010 for three years was proven to be not enough to eradicate *Striga* in heavily infested soil. However, effectiveness of suicidal germination is confirmed. The knowledge is applicable to trap cropping.
2) Fluridone sensitized *S. hermonthica* seeds to the synthetic germination stimulant GR24. The knowledge is applicable to the natural gemination stimulants.

Activity II

1) OmAGAL2 was revealed as an important enzyme for *O. minor* germination. Thus, it is a suitable target for its control.
2) Some PI-28 derivatives inhibit radicle elongation of *O. minor* at less than 1 ppm, suggesting the compound can be used as a lead for designing a parasitic weed control agent.
3) Copious phytohormones producing rhizospheric bacterial isolates were obtained.

Activity III

1) *Trichoderma harzianum* + BMP + TAL1399 + imazethapyr reduced *O. crenata* emergence on Masri 3 (resistant faba bean line) by more than 90% and increased yield by 500% in comparison to the corresponding controls.

Activity IV

1) T010, albeit did not eradicate Striga, but reduced emergence and damge to the subsequent sorghum thus suggesting that induction of suicidal germination followed by denial of seed production by physical or chemical means may be more rewarding.

Activity V

1) Long term training for a Sudanese researcher (Ms. Hanaa) in Japan was accomplished. She received a PhD degree from Kobe University on March 24, 2022.
2) Research methods including organic synthesis had been established for the analysis of flavonoids obtained from *Striga*. The methods were adopted for the analysis of other Sudanese medicinal plants. The obtained compounds are ready to be tested for biological activity.

Activity VI

1) The number of FFS sites were increased from two to three in the past seasons and to ten last season thus facilitating wider distribution of the available knowledge and techniques to combat root parasitic weeds.

Activity VII

1) Five private TV stations reported the national seminar and made the project better known in Sudan.

1-5 Changes of Risks and Actions for Mitigation

Coup d'état arose in Sudan on 25 October, 2021. JICA requested the Japanese members on 14 November to refrain from contacting the Sudanese counterparts. JICA also requested Kobe University on 17 November to stop procuring equipment for the counterpart.

1-6 Progress of Actions undertaken by JICA

JICA announced the resumption of the binational technical corporation on 4 March, 2022.

1-7 Progress of Actions undertaken by Gov. of Sudan

The government of Sudan has been supporting the project as planned. Nevertheless, the researchers in compliance with JICA request are refraining from direct contact with politicians and ministers.

1-8 Progress of Environmental and Social Considerations (if applicable)

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

Four coordinators joined the former and current SATREPS projects. JICA selected and assigned, for the first time, a female coordinator, who joined the project in February, 2020.

1-10 Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

The project in collaboration with the Plant Protection Department of the River Nile State is to organize a seminar on weeds including parasitic ones.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

1) Extension of the main laboratory was completed late in April 2021 by renovating rooms adjacent to the main laboratory, with considerable delay.
2) Face-to-face collaborative activities between Sudanese and Japanese researchers have been suspended due to COVID-19 pandemic and instability in Sudan.

2-2 Cause

1) Devaluation of the Sudanese currency and insufficient supply of budget from the Ministry of Finance, Sudan.
2) The worldwide outbreak of COVID-19 in 2020 and 2021.

2-3 Action to be taken

1) The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan,etc.)

1) The project appreciates the cooperation of the NCR administration and the ministry of finance who provided budget for the ongoing experiments and for the FFS activities at Gedarif.
2) The NCR is appreciating the genuine efforts of the project leader and JICA for their cooperation and would like to register a strong vote of thanks to Ms Endo Noriko, the JICA coordinator, for her zealous efforts, self-denial and quick response whenever contacted

3 Modification of the Project Implementation Plan

3-1 PO

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s),

target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

1) Due to problems caused by COVID-19 epoch, the NCR has requested a two years extension of the project in February 2021.Following the SATREPS regulation, the Japanese leader submitted a request letter of extension to JST on 21 June. The project extension by 8 months was decided by JICA on 23 January, 2022.

4Preparation of Gov. of Sudan toward after completion of the Project

1) Several NGOs are adopting, at least in part, some of the components of the project developed technology.
2) The NCR in collaboration with local governments is to undertake seminars and demonstration farms.
3) The NCR, in collaboration with ARC and SUST, is seeking funds for post-graduate studies.

II. Project Monitoring Sheet I & II *as Attached*

Form 3-1 Monitoring Sheet Summary

TOCR of JICA SUDAN OFFICE

PROJECT MONITORING SHEET

Project Title: Development of countermeasures against *Striga* to conquer poverty and improve food security in Sudan

Version of the Sheet: Ver.10 (Term: 1 April, 2022 – 30 September, 2022)

Name: Yukihiro SUGIMOTO

Title: Professor, Kobe University

Submission Date: 30 September, 2022

I. Summary from 1 April, 2022 to 30 September, 2022

1 Progress

1-1 Progress of Inputs

Researcher exchanges had been suspended due to the worldwide outbreak of COVID-19. During the pandemic, mutual understanding between Sudanese and Japanese researchers was promoted through online meetings and face-to-face meetings held at Dubai. As reported in the 4th JCC held on 19 July, some laboratory equipment and consumables, FFS consumables, protected house and new laboratory maintenance were provided by JICA. Delivery of the other equipment is scheduled until October 2022. Since the Japanese government has eased restrictions on entry of foreign nationals to Japan, Sudanese researchers have joined Osaka Metropolitan University and are getting training.

1) Short term experts (period of stay in Sudan): none.

2) Short Term Training: two arrived at Tokyo on 6 September, quarantined for a week and

started training on 15 September at Osaka Metropolitan University.
Total 32 days as of 30 September.

3) Middle Term Training: none.
4) Long Term Training: none.
5) Short Term Invitation (period of stay in Japan): none.
6) Meetings at Dubai

Zeinab, Okazawa, Sugimoto	23 to 25 June (3 days)
Randa, Dafalla, Okazawa, Sugimoto	7 to 9 August (3 days)

1-2 Progress of Activities

General

1) Face-to-face meetings between Sudanese and Japanese researchers were held in Dubai after a long suspension due to the COVID-19 outbreak early in 2020.
2) The first training program since May 2019 has started for Sudanese young researchers at Osaka Metropolitan University.
3) Information about the terminal evaluation was shared among the project members.
4) Details on lab opening event, international symposium and future collaboration were discussed.

Activity I

A long-term bathtub experiment to evaluate the effects of continuous application of T-010 on *Striga* emergence in sorghum is ongoing.

Activity II

1) Structure-activity relationship (SAR) study on inhibitory activity of OmAGAL2 inhibitor, PI-28, and its derivatives toward *Orobanche minor* radicle elongation is ongoing.
2) The effect of cytokinin- and gibberellic acid-producing bacteria on *Striga hermonthica* seed germination is under investigation.

Activity III

1) Two field experiments were conducted to verify the efficacy of the potential microbes

(mycorrhizal fungi, *Trichoderma* fungi, Nitrogen (N) fixing bacteria, and phosphorous (P) solubilizing bacteria) and cowpea intercropping on *Striga* control in sorghum at Gedarif Research Station in collaboration with activity VI.

2) Two greenhouse experiments evaluating the effect of mycorrhizae isolates (alone or in combination) and resistant cultivars on *Striga* spp. in sorghum are ongoing.
3) Laboratory experiments to investigate the effects of *Trichoderma* isolates and strains on *Phelipanche ramosa*, *O. crenata,* and *S. hermonthica* germination and haustorium initiation are ongoing.
4) Evaluation of the compounds promoting germination or haustorium formation on *O. minor* is ongoing.

Activity IV

NERICA 4 is grown in pots infested with *S. hermonthica* for the purpose of collecting *Striga* seeds from NERICA 4 for future evaluation of changes in virulence of the parasite in response to repeated planting.

Activity V

1) The established method for isolating natural products has extended to other medicinal plants in Sudan.
2) Preparation has been initiated for the biological studies of natural products isolated from *Striga* and traditional Sudanese medicinal plants.

Activity VI

1) FFS activities are continued in10 locations at North and Central Gedarif districts.
2) Field verification experiment at one location in Gedarif to assess the effects of sorghum – cowpea intercropping and sorghum seeds inoculation with *Trichoderma* and/or mycorrhizae on *Striga* management and sorghum yield has been commenced.
3) Field verification experiment at one location in Gedarif to assess the impact of sorghum – cowpea intercropping and coating sorghum seeds with N fixing and P solubilizing bacteria and *Trichoderma* fungus on *Striga* management and sorghum yield is set up.

Activity VII

1) A discussion was held between NCR and JICA on amendment of the purpose of the project in PDM suggested by NCR.
2) A meeting was held at NCR to discuss progress of the project activities and the importance of dissemination of *Striga* control measures through farmers' field schools.

1-3 Achievement of Output

General

1) A face-to-face meeting was held on 23-25 June, 2022, at Dubai. Main issues discussed were 4th JCC meeting, project terminal evaluation, researcher visit to Japan, technical transfer, and future collaboration.
2) The 4th JCC was held online on 19 July. Following opening remarks (Prof. Zeinab), contents of the Dubai meeting were shared (Prof. Sugimoto). Inputs were reported (Prof. Zeinab and Ms. Endo) and progress in each activity was shared (Dr. Hassan, Prof. Okazawa, Prof. Tani, Prof. Randa, Prof. Kuse, Dr. Hanaa, and Prof. Dafalla). Amendment of a part of PDM was proposed by NCR. After an intensive discussion, the proposal was accepted and signed. Outline of the terminal evaluation was explained (Dr. Nagamine) before closing remarks (Mr. Sakane).
3) Another Dubai meeting was held on 7-9 August to discuss lab arrangement, international symposium, and future collaboration.

Activity I

1) The number of emerged S. *hermonthica* plants was high in the untreated control, however, T-010 treatments reduced the number of *Striga*.
2) Continuous treatment with T-010 seems to be necessary for *Striga* management to protect the sorghum crop from the early damage caused by the parasite.
3) Effectiveness of suicidal germination is confirmed.

Activity II

1) Several PI-28 derivatives exhibited higher inhibitory activity toward *O. minor* radicle elongation than PI-28.
2) Potentialities of some microbial isolates as *Striga* germination promoters were recorded.

Activity III

1) Greenhouse experiments were accomplished to evaluate the effects of potential microbes and resistant cultivars on *P. ramosa* in tomato.
2) Applications of the potential microbes and intercropping in *S. hermonthica* on sorghum at Gedarif area through FFS are ongoing
3) Pot experiment was accomplished to evaluate the effect of potential microbes on *O.* minor in *Triforium pratense*.

Activity IV

Striga plants are growing on NERICA4.

Activity V

1) Transfer of research technology in natural products chemistry has been accomplished to a young Sudanese researcher.
2) Ingredients of *Striga* were proven to include commercially valued compounds.

Activity VI

1) FFS activities at 10 locations at North and Central Gedarif districts are ongoing. Area and number of participants in each FFS site are varied from 4 to 10 feddan and from 13 to 25 farmers, respectively.
2) Approaches for the analysis of yield data obtained from FFS sites were discussed at the face-to-face meeting.
3) Laboratory results of treating sorghum seeds with micoorganisms (*Trichoderma*, N fixing bacteria, P solubilizing bacteria and mycorrhizae) were evaluated under field conditions at Gedarif.

Activity VII

1) Amendment in PDM to change the second indicator for project purpose from medium-term budgetary plan to three years action plan is accepted and signed by JICA Sudan office and NCR.
2) The project made a step forward towards establishing a functional implementing structure.

3) The plan and the contents of the international symposium to be held in Jan 2023 were discussed
4) The contents of seminar for farmers at Field Day in Gadarif were discussed.

1-4 Achievement of the Project Purpose

General

1) Through the presentations delivered at the 4thJCC, researchers and officials involved in the project shared information about progresses attained and the challenges.
2) Discussion about the terminal evaluation opened channels for future collaboration.

Activity I

1) Continuous treatment with T-010 for three years was proven to be not enough to eradicate *Striga* in heavily infested soil. However, effectiveness of suicidal germination is confirmed.
2) Effects of the further continuous treatment with T-010 on *Striga* incidence are under investigation.

Activity II

1) SAR study with PI-28 and 26 PI-28 derivatives revealed important structure requirements for the inhibitory effect towards *O. minor* radicle elongation.
2) Short-term training for two Sudanese young researchers (Ms. Rehab and Ms. Inas) started on 15 September at Osaka Metropolitan University.

Activity III

1) Evaluations of the promising microbes and intercropping in *S. hermonthica* on sorghum at Gedarif area through FFS are ongoing.
2) Evaluations of potential microbes and resistant cultivars in *P. ramosa* on tomato were achieved.

Activity IV

Most of the experiments designed in the Shambat field failed due to limited supply of water in the second and the third years.

Activity V

1) Long-term training for a Sudanese researcher as a Ph.D. student in Japan was over, and Ms. Hanaa received a Ph.D. degree from Kobe University on March 24, 2022.
2) Research methods including organic synthesis have been established to analyze ingredients obtained from *Striga*. The methods have been adopted for the analysis of other Sudanese medicinal plants. Amelioration of the research environment has been underway for the biological activity tests.

Activity VI

1) FFS activities are continuously run at 10 sites in Gedarif. Wider distribution of the available knowledge and techniques to combat root parasitic weeds are expected.
2) Microorganisms have been evaluated under field conditions to be included as integral components of ISM packages.

Activity VII

1) Interministerial committee is approved and issued by the minister of Ministry of Higher Education and Scientific Research.
2) Progress of project activities and proposed plans till the end of the project were shared between Sudanese and Japanese researchers.

1-5 Changes of Risks and Actions for Mitigation

Ministry of Foreign Affairs of Japan eased the Sudan's safety level on 24 August from Level 3 (Avoid all travel) to Level 2 (Avoid non-essential travel). Revitalization of the project activities depends largely on how fast the world will overcome COVICD 19 Pandemic.

1-6 Progress of Actions undertaken by JICA

Due to security situation and safety level in Sudan, travel restrictions have been imposed on visits of Japanese experts to Sudan. JICA appreciated Japanese researchers' suggestion and dispatched Sudanese researchers to Dubai to have face-to-face meetings with Japanese researchers. In response to alleviation of restrictions upon international travels by the Japanese government, the project resumed short term training in Japan.

1-7 Progress of Actions undertaken by Gov. of Sudan

1) The government of Sudan has been supporting the project as planned. Nevertheless, the researchers in compliance with JICA request are refraining from direct contact with politicians and ministers.
2) Agreement was signed between JICA and NCR to ensure responsibility of NCR towards equipment maintenance and management.
3) In addition, an existing room connected to the main laboratory is set up as a staff room so that more space is available for equipment.
4) Formation of a steering committee to discuss implementation of innovative technologies during the project duration and after completion has been proposed.

1-8 Progress of Environmental and Social Considerations (if applicable)

1-9 Progress of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

1) Four coordinators joined the former and current SATREPS projects. JICA selected and assigned, for the first time, a female coordinator, who joined the project in February, 2020.
2) More than half of the project core members on the Sudanese side are female, including project director and project manager.
3) Two female members are participating in a 3-months training course in Osaka Metropolitan University.
4) A socioeconomic study is taking place to see the actual impact of the applied technology on farmers' lives and poverty reduction.

1-10Other remarkable/considerable issues related/affect to the project (such as other JICA's projects, activities of counterparts, other donors, private sectors, NGOs etc.)

Prof. Abdel Gabar Babiker passed away on 8 June, who had been devoting himself to the project since its beginning. Prof. Somaya has taken over his roles as the project manager.

2 Delay of Work Schedule and/or Problems (if any)

2-1 Detail

1) Extension of the main laboratory was achieved late in April 2021 with three years delay. Due to political turmoil since 25 October 2021, JICA requested Kobe University on 17 November 2021 to stop procuring equipment for the counterpart. JICA announced the resumption of the technical cooperation on 4 March 2022 and hence start the local procurement of equipment with a considerable delay.
2) Researcher exchanges were also suspended during the period.

2-2 Cause

1) Political instability situation, devaluation of the Sudanese currency and insufficient supply of budget from Ministry of Finance, Sudan.
2) Challenges faced Sudanese suppliers to import equipment to Sudan.
3) The worldwide outbreak of COVID-19 since January 2020.

2-3 Action to be taken

1) The researchers on the Sudanese side are keeping negotiation with the ministry officials to urge the supply of the budget.
2) NCR secured budget for ongoing experiments and for the FFS.
3) Restrictions to enter Japan was eased, in part, in May, which enabled Japanese researchers to go overseas. The Japanese researchers made visits to Dubai to have face-to-face meetings with the Sudanese counterparts.
4) Two young researchers are getting practical training at Osaka Metropolitan University.

2-4 Roles of Responsible Persons/Organization (JICA, Gov. of Sudan, etc.)

1) The project appreciates the cooperation of the NCR administration and the Ministry of Finance who provided budget for the ongoing experiments and for the FFS activities at Gedarif.
2) The NCR appreciates the genuine efforts of the Japanese members and JICA for their cooperation.

3 Modification of the Project Implementation Plan

3-1 PO

3-2 Other modifications on detailed implementation plan

(Remarks: The amendment of R/D and PDM (title of the project, duration, project site(s), target group(s), implementation structure, overall goal, project purpose, outputs, activities, and input) should be authorized by JICA HDQs. If the project team deems it necessary to modify any part of R/D and PDM, the team may propose the draft.)

Amendment of PDM to change the second indicator for project purpose from medium-term budgetary plan to three years action plan was request by NCR. Based on discussion in the 4th JCC meeting which was held on 19 July 2022, NCR and JICA agreed to the amendment and was approved and recorded in a signed document.

4 Preparation of Gov. of Sudan toward after completion of the Project

1) Interministerial committee to enforce implementation of innovative technologies during the project duration and after completion is approved.
2) Three years action plan prepared by NCR, ARC and SUST is to be submitted to Ministry of Finance for budget.

II. Project Monitoring Sheet I & II *as Attached*

Tentative Plan of Operation

Version 10

Dated on 30 September, 2022

Project Title: Developing Counter-measures against Striga to Conqurt Poverty and Improve Food Security in Sudan

Inputs	Year	1st Year (2017)				2nd Year (2018)				3rd Year (2019)				4th Year (2020)				5th Year (2021)				6th Year (2022)				Remarks	Monitoring: Issue	Monitoring: Solution
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
Expert																												
Prof. Yukihiro SUGIMOTO	Plan																									1st JCC (26 Dec, 2017) approved participation of Mimura and Wakabayashi Samejima left the project on 31 March, 2019 3rd JCC (10 Jun, 2021) approved participation of Moriyama Prof. Abdel Gabar Babiker passed away on 5th of June, 2022. Dr. Somaya took over his role as the project manager.		
	Actual									D	D											D	D					
Prof. Atsushi OKAZAWA	Plan																											
	Actual											D										D	D					
Prof. Hirosato TAKIKAWA	Plan																											
	Actual					D stands for meetings held at Duba												D stands for meetings held at Dubai										
Prof. Masaki KUSE	Plan																											
	Actual																											
Prof. Shuji TANI	Plan																											
	Actual											D																
Prof. Yasuo YAMAUCHI	Plan																											
	Actual																											
Dr. Hiroaki SAMEJIMA	Plan																											
	Actual																											
Dr. Takatoshi WAKABAYASHI	Plan																											
	Actual											D																
Prof. Tetsuro MIMURA	Plan																											
	Actual																											
Dr. Daisuke MORIYAMA	Plan																											
	Actual																											
Equipment																										The international tender for advanced equipment was advertised by Kobe University on the Government Official Gazette on September 1st, 2021. JICA asked Kobe University to cancel the tender on November 17th, two weeks before opening the bid. Kobe University announced the cancel of the tender, which was officially advertised on the Government Official Gazetteon on December 6th. Procurement of the eauipment in Japan is no longer possible.		
Basic items	Plan																											
	Actual																											
Advanced items	Plan																											
	Actual																											
Sophisticated items (LC-MS, NMR)	Plan																											
	Actual																											
Training in Japan (Short term)																												
Update knowledge of researchers Lab practices for young researchers	Plan																											
	Actual																											
Training in Japan (Long term)																												
Hanaa H.E.A., PhD candidate	Plan																									Ms Hanaa finished her PhD studies and got the PhD degree from Kobe University on 24th March, 2022. She has left Japan on 30th March.		
	Actual																											
In-country/Third country Training																												
molecular biology	Plan																											
	Actual																											

Researcher exchange was not carried out due to the world wide outbreak of COVID-19

Strict restrictions on international travels have been in effect

Political instability in Sudan has made researchers exchanges more difficult since October, 2021

Ms Hanaa and Ms Nihad came to Japan on 5th of September, 2022. After a week of quarantine, they joined Osaka Municipal University to study molecular biology. The training period is

Activities / Sub-Activities	Year	1st Year (2017)				2nd Year (2018)				3rd Year (2019)				4th Year (2020)				5th Year (2021)				6th Year (2022)				Responsible Organization: Japan	Responsible Organization: Sudan	Achievements	Issue & Countermeasures
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV				
Output 1: Development and verification of suicidal germination agents on *Striga* and *Orobanche*																													
1.1 Suicidal germination inducers to control *Striga* are evaluated	Plan																									Kobe	ARC (Shambat)		
	Actual																												
1.2 Suicidal germination approach to control *Orobanche* is applied	Plan																									Kobe	ARC (Shambat)		
	Actual																												
Output 2: Development of germination inhibitors for root parasitic weeds																													
2.1 Planteose metabolism inhibitors and cytokinin oxidase inhibitors are developed	Plan																									Osaka	NCR (ENDRI)		
	Actual																												
2.2 The effects of the inhibitors on Striga control are examined	Plan																									Osaka	NCR (ENDRI)		
	Actual																												
Output 3: Demonstration of microorganisms to control germination of *Striga*																													
3.1 The performance of the microorganisms that influence *Striga* germination revealed by the previous project is verified	Plan																									Osaka	NCR (ENDRI)		
	Actual																												
3.2 Active metabolites of the microorganisms are identified	Plan																									Kobe Osaka	NCR (ENDRI)		
	Actual																												
3.3 Arbuscular mycorrhizal fungi species and isolatea are screened	Plan																									Osaka	NCR (ENDRI)		
	Actual																												

The sub-project was discontinued due to a faint but unfavorable side effect of T-010

ANNEX 5

Output 4: Verification of stability and durability of *Striga*-resistance in rice						
4.1 Stability and durability of resistance of the rice cultivars identified by SATREPS 1 are investigated	Plan / Actual	Kobe	ARC (Shambat)			
4.2 The effects of the Striga seed bank size on stability of resistance of the rice and sorghum genotypes are determined under the greenhouse condition	Plan / Actual	The activity was discontined due to extremely difficulty to export rice and sorghum seeds to Sudan	ɔbe	ARC (Shambat)		
Output 5: Identification of useful substances in *Striga* that will encourage farmers to remove and utilize the weed						
5.1 An ethnobotaniccal survey on indigenous knowledge on purported medicinal uses of *Striga* is undertaken	Plan / Actual		Kobe	NCR (MAPRI)		
5.2 A bioassay-guided fractionation for active ingredients is undertaken	Plan / Actual		Kobe	NCR (MAPRI)		
5.3 The active compounds are acharacterized	Plan / Actual		Kobe	NCR (MAPRI)		
5.4 The metabolites specifically accumulated in *Striga* before flowering are identified by conducting metabolome analyses of young and flowering *Striga* plants	Plan / Actual		Kobe	NCR (MAPRI)		
Output 6: Dissemination of *Striga* control measures through Farmers Field Schools						
6.1 Efficacy of rotation and intercropping with leguminous crops inoculated with microorganisms and treatd with acetolactate synthtase inhibiting herbicides is corroborated on farm	Plan / Actual		Kobe	ARC (WadMedani)		
6.2 The laboratory and greenhouse results on germination inducing crop residues, bacteria and fungi are corroborated on station and on farm	Plan / Actual	At Dongola and Shendi	Kobe	ARC (WadMedani)		
6.3 On-station results pertaining to suicidal germination, crop rotation and intercropping are corroborated on farm	Plan / Actual		Kobe	ARC (WadMedani)		
6.4 The adoption rate and socio-economic impact of the *Striga* management packages are measured	Plan / Actual		Kobe	ARC (WadMedani)		
6.5 Farmer awareness of the parasite is raised by transferring available Striga management strategies employing Farmer Field Schools and other media	Plan / Actual		Kobe	ARC (WadMedani)		
Output 7: Establishment of a functional implementation structure to forward *Striga* control measures by Sudan's lead						
7.1 Practical actions for the establishment of an effective implementation structure are taken under the initiative of the Sudanese side	Plan / Actual		Kobe	NCR HQ	presentation by a Sudanese member (Sep, 2018), discussion with JST and JICA (Nov, Jan, March, 2019)	Mr. Sakane visited NCR and had a fruitful discussion with Dr. Zeinab and Prof. Babiker on 16th Sep, 2021. Since then, activity 7 has been taking a shape
7.2 The established implementation structure for Striga control measures is functioning	Plan / Actual	An amendment to the activity was proposed by JICA in May, 2019. Accordingly, the amendment is to be discussed at JCC.	in collaboration with JICA SUDAN Office			
			Kobe	NCR HQ		
Duration / Phasing	Plan / Actual		In response to the request made by the Sudanese side at the 3rd JCC, JICA decided extension of the project period by 8 months and M/M was signed by DG of NCR and Chief Representative of the JICA Sudan office.			

Monitoring Plan	Year	1st Year (2017) I II III IV	2nd Year (2018) I II III IV	3rd Year (2019) I II III IV	4th Year (2020) I II III IV	5th Year (2021) I II III IV	6th Year (2022) I II III IV	Remarks	Issue	Solution
Monitoring										
Joint Coordination Committee	Plan / Actual							JCC was not held in 2019 due to the political turmoil in Sudan JCC was not held in 2020 due to the world wide outbreak of COVID-19		
Set-up the Detailed Plan of Operation	Plan / Actual							Annual Plan submission to JST in February, 2018, 2019, 2020, 2021 and 2022.		
Submission of Monitoring Sheet	Plan / Actual									
Monitoring Mission from Japan	Plan / Actual									
Joint Monitoring	Plan / Actual		Monitoring mission was not dispatched due to the political turmoil in Sudan							
Post Monitoring	Plan / Actual									
Reports/Documents										
Annual Report to JST	Plan / Actual									
Project Completion Report	Plan / Actual									
Public Relations										
Create and operate the project website	Plan / Actual							http://www.edu.kobe-u.ac.jp/ans-phytochem/SATREPS/2satreps%20top.html		
International Symposium	Plan / Actual							Kick Off Symposium (Khartoum, 29 Jan, 2017)	Binational Symposium (Khartoum, 18 Sep, 2018)	Binational Symposium (Khartoum, 6 Oct, 2021)

ANNEX 5