エジプト・アラブ共和国
ナイル流域における食糧・燃料の
持続的生産プロジェクト
終了時評価調査報告書

平成 27 年 11 月
（2015年）

独立行政法人国際協力機構
農村開発部

農 村
ＪＲ
15-062

序　　　　文

近年、わが国の科学技術を活用した地球規模課題に関する国際協力への期待が高まるとともに、日本国内でも科学技術に関する外交の強化や科学技術協力における ODA 活用の必要性・重要性が謳われています。このような状況を受けて、2008 年（平成 20 年）度より「地球規模対応国際科学技術協力プログラム」事業が新設されました。本事業は、環境・エネルギー、防災及び感染症等の分野において、わが国と開発途上国の共同での技術の開発・応用や新しい知見の獲得を通じて、わが国の科学技術力向上とともに、途上国側の研究能力向上を図ることを目的としています。

なお、本事業は、文部科学省、国立研究開発法人科学技術振興機構（JST）、外務省、独立行政法人国際協力機構（JICA）の 4 機関が連携するものであり、国内での研究支援は JST が、開発途上国に対する支援は JICA が行うこととなっています。

日本国政府は、エジプト・アラブ共和国政府からの地球規模課題対応国際科学技術協力（SATREPS）事業の要請に基づき、2009 年 6 月 1 日から 5 年 10 カ月間の予定で「ナイル流域における食糧・燃料の持続的生産プロジェクト」を実施しています。

今般、2015 年 3 月末のプロジェクト終了にあたり、当機構は、協力期間中の活動実績及び計画に対する達成度の検証を行い、評価 5 項目の観点から評価を行うとともに、本協力の提言及び教訓を抽出し、今後の対応方針を検討することなどを目的として、2015 年 1 月 10 日から同年 1 月 31 日にかけて、当機構国際協力専門員・佐藤武明を団長とする終了時評価調査団を派遣しました。本報告書は、同調査団の調査及び協議結果を取りまとめたものであり、今後、広く関係者に活用され、国際協力の推進に寄与することを願うものです。

最後に、本調査の実施にあたりご協力とご支援を頂いた内外の関係各位に対し、心より感謝の意を表します。

平成 27 年 11 月

独立行政法人国際協力機構
農村開発部長　北中　真人

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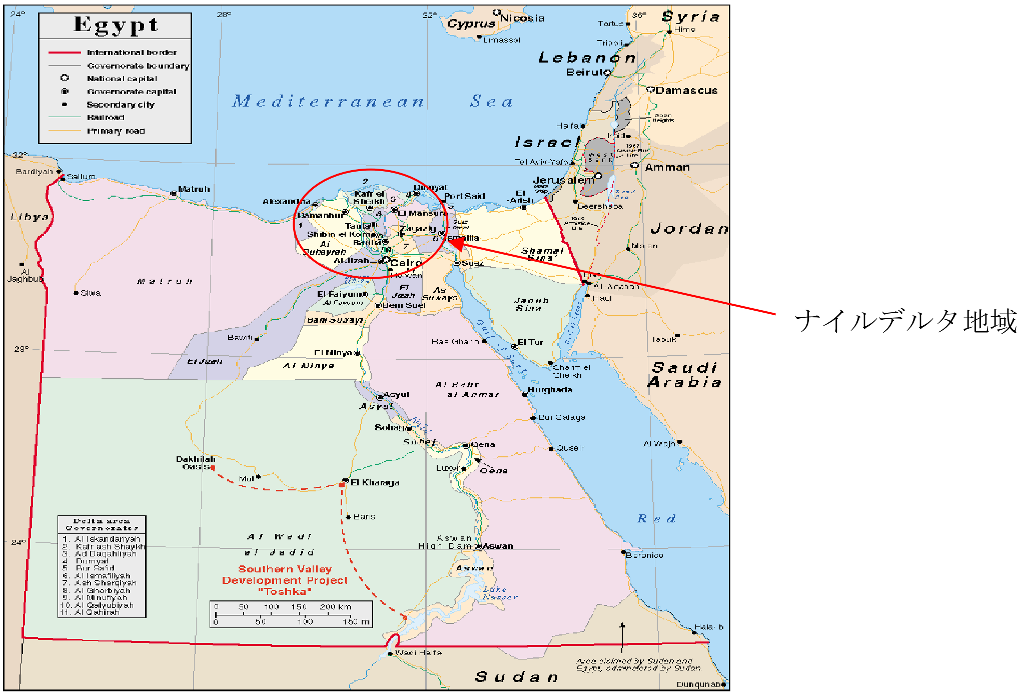
略　　語　　表

略語	英語	日本語
ADCP	Acoustic Doppler Current Profiler	超音波ドップラー流速計
ARC	Agricultural Research Center	農業研究センター
C/P	Counterpart Personal	カウンターパート
CU	Cairo University	カイロ大学
EC	Electric Conductivity	電気伝導度
EGP	Egyptian Pound	エジプトポンド
E-JUST	Egypt-Japan University of Science and Technology	エジプト日本科学技術大学
ET	Evapotranspiration	蒸発散
ICARDA	Sustainable Agriculture for the Dry Areas	国際乾燥地農業研究センター
IRD	Institut de Recherche pour le D?veloppement	開発研究所
ISMAP	Improving Small-Scale Farmers' Market-Oriented Agriculture Project	小規模農家の市場志向型農業改善プロジェクト
JICA	Japan International Cooperation Agency	独立行政法人国際協力機構
JSC	Joint Steering Committee	合同運営委員会
JST	Japan Science and Technology Agency	国立研究開発法人科学技術振興機構
MM	Man Month	人月
MP	Master Plan	マスタープラン
NWRC	National Water Research Center	国立水資源研究センター
MWRI	Ministry of Water Resources and Irrigation	水資源･灌漑省
NWRP	National Water Resources Plan	国家水資源計画
O&M	Operation and Maintenance	運転（操作）及び維持管理
PDM	Project Design Matrix	プロジェクト･デザイン･マトリックス
PMU	Project Management Unit	プロジェクト・マネジメント・ユニット
R/D	Record of Discussions	討議議事録
RRTC	Rice Research and Training Center	稲作研究研修センター
SATREPS	Science and Technology Research Partnership for Sustainable Development	地球規模課題対応国際科学技術協力
SWERI	Soil, Water and Environment Research Institute	土壌･水･環境研究所
SWMT	Project for Strengthening Water Management Transfer	水管理移管強化プロジェクト
TDR	Time Domain Reflectmetry	時間領域反射測定

WMIP2	Water Management Improvement Project 2	水管理改善プロジェクト・フェーズ 2
WMRI	Water Management Research Institute	水管理研究所

プロジェクト位置図

1）エジプト地図



2）ナイルデルタ及びプロジェクト地図

現 地 写 真

研究成果発表会における C/P による発表

研究成果発表会における合同評価団、C/P との協議

合同評価報告書への署名

サハ実験圃場に設置された ET タワー

合同調整委員会（JCC）における評価結果報告

終了時評価調査結果要約表（和文）

１．案件の概要	
国名：エジプト･アラブ共和国	案件名：ナイル流域における食糧・燃料の持続的生産プロジェクト
分野：農業･農村開発	援助形態：技術協力プロジェクト（地球規模課題に対応する科学技術協力）
所轄部署：農村開発部	協力金額（評価時点）：4 億円
協力期間 （R/D）：2009 年 6 月～2014 年 6 月 （延長 R/D）2009 年 6 月～2015 年 3 月（5 年 10 カ月）	先方関係機関：カイロ大学（CU）農学部、国立水資源研究センター（NWRC）、農業研究センター（ARC）
	日本側協力機関：筑波大学、鳥取大学
	他の関連協力：技術協力「水管理改善プロジェクト・フェーズ 2（WMIP2）」、技術協力「水管理移管強化プロジェクト（SWMT）」

１－１　協力の背景と概要

エジプト・アラブ共和国（以下「エジプト」という。）では、急激な人口増加（年率 2%）に対応するため、食糧生産の増大と農業分野での雇用の拡大が重要な開発課題として挙げられている。しかし、主要な農業地域であるナイルデルタ地域での農業生産量は限界に達していると考えられることに加え、同地域内で新たに農地を開発する余地は少ない。一方、同国の水資源の大部分を賄うナイル川からの取水はスーダンとの二国間の協定により年間555億tに制限されていること、エジプトの年間降水量が 25 ㎜程度（カイロ）であることから新たな水資源の開発も困難である。このため同国は、ナイルデルタ周辺の砂漠地域に灌漑農地を拡大し、食糧生産の増大を図ろうとしている。また、農業セクターでは就業人口の 3 割を抱え、その多くが小規模農地で貧困層であることから、これら周辺地域への新たな農地の開発・拡大を通じて、就業人口の増加に対応するとともに、農民の収入の増加を図ろうとしている。

エジプトの「第 6 次国家社会経済開発計画」（2007 年 8 月～2011 年 12 月）においては、新たな農地の拡大を通じた農業・灌漑開発が優先分野に挙げられているが、同計画や 2017 年を目標年に掲げる「国家水資源計画（National Water Resources Plan。以下「NWRP」という。）」の施策は具体性に乏しい。このため、アスワンハイダムの建設により洪水が排除されたあとの塩類集積による土壌への影響、塩類集積回避のために埋設された暗渠排水の効果、流域水収支や塩収支、食用作物の栽培に利用できていない排水の再利用の可能性等を把握したうえで、農業用水の有効利用を図るための包括的かつ具体的な水管理の方策を示す必要があり、大学等の研究機関がデータや知見に基づいて現状を分析し、改善策を提示することが求められている。このような背景の下、ナイルデルタ地域における節水的な水管理の方策を示す目的でエジプト政府はわが国に対して地球規模対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development。以下「SATREPS」という。）プログラムの実施要請を行った。これを受けて、日本側は 2009 年 6 月から 5 年 10 カ月間の予定で本プロジェクトを実施しており、これまで、「水・塩収支」「水管理」「土壌の肥沃性」「食糧・燃料作物生産」の 4 研究グループごとに、関連分野における共同研究が進められるとともに、エジプト側研究者への技術移転が行

われてきた。

１－２　協力内容

本プロジェクトは、アスワンハイダム建設から 50 年以上経ったナイルデルタ地域の農業の現状を把握するとともに、現在の水資源環境の下でのエジプトの持続的発展に向けて同地域における節水の実現可能性と効率的かつ持続的な灌漑・農業の将来像を検討、提言することを目的に日本側（筑波大学、鳥取大学）とエジプト側〔カイロ大学（Cairo University。以下「CU」という。）農学部、国立水資源研究センター（National Water Research Center。以下「NWRC」という。)、農業研究センター（Agricultural Research Center。以下「ARC」という。)〕が共同研究を実施してきたもの。

（1）上位目標

社会経済開発 5 カ年計画、NWRP 及び国家農業生産計画に記載されている農業生産の増大と雇用機会の拡大に貢献する。

（2）プロジェクト目標

急激な人口増加に対応するナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策を示す。

（3）成　果[i]

成果 1：ナイルデルタの各種条件下での水及び塩の収支に係る諸条件が明らかになる
成果 2：用水路レベルでの水配分及び水管理の合理化の方策が提示される
成果 3：圃場の塩害防止の方策が提示される
成果 4：適切な作物選択がなされ、圃場レベルの灌漑方法の改善手法が提示される

（4）投　入（評価時点）

日本側　総投入額　4 億円
研究者のエジプトへの派遣：18 名
長期専門家の派遣：業務調整 3 名
研修員受入（本邦）：21 名
供与機材：1 億 4,712 万 3,762 円
在外強化費：6,620 万 55 円

エジプト側　カウンターパート（Counterpart Personal。以下「C/P」という。)（研究者）：73 名
土地施設提供、執務室・実験室貸与
現地活動費：205 万 1,136 円

[i] 本プロジェクトのマスタープラン（Master Plan。以下「MP」という。）（PDM の替わりに作成したもの）では「アウトプット」としているが、本報告書文中では通常のログフレームと同様に「成果」を用いた。そのため調査団、プロジェクト等で作成した付属資料については「アウトプット」と標記されている。

２．評価調査団の概要		
＜日本側評価団＞ 佐藤 武明　団長/総括　JICA 国際協力専門員 東 太郎　協力企画　JICA 農村開発部 農業・農村開発第一グループ 第二チーム企画役 小笠原 暁　評価分析　株式会社 VSOC 事業部 コンサルタント （日本側評価団同行者） 井上　孝太郎　科学技術評価　国立研究開発法人科学技術振興機構（JST）[ii]上席フェロー（SATREPS）/研究主幹 高橋　美穂　科学技術評価　JST 地球規模課題国際協力室 調査員 佐藤　政良　研究代表　筑波大学 名誉教授 ＜エジプト側評価団＞ Prof. Abd El Alim Metwally　総括　CU 農学部 教授 Prof. Mohamed Fahmy Hussein　団員　CU 農学部 土壌科学 教授 Prof. Mohamed Lotfy Yousef Nasr　団員　NWRC, Water Management 水管理研究所（WMRI）水経済教授 Dr. Mohamed El Kholy　団員　ACR、土壌・水・管理研究所（SWERI）准教授		
調査期間	2015 年 1 月 10～31 日	評価種類：終了時評価調査
３．評価結果の概要		
３－１　実績の確認 ＜成果 1＞　達成されている パイロットサイトにおける水及び塩の収支の動態、灌漑方式による蒸発散（Evapotranspiration。以下「ET」という。）が量的に明らかにされ、長期間断灌漑[iii]に替わる灌漑方式として細溝灌漑[iv]、ドリップ灌漑[v]の有効性が示された。また、設定された指標以外に、防風林の ET について樹高の 10 倍の平面距離に対して、ET が大幅に減少されることが示された。 指標 1-1　長期間断灌漑が行われている試験圃場において、蒸散量及び蒸発量の変化が定量化される、指標 1-2　節水栽培と慣行栽培における水利用効率（単位灌水量当たりの作物収量）が定量的に比較される、指標 1-3　Casualina 及び Eucalyptus の防風林における間隙率と ET 量減少との関係が定量化される、指標 1-4　パイロット用水・排水路において水塩動態モデルが構築され、デルタ全域に適用される[vi]、のすべてが達成されている。		

[ii] 2015 年 4 月に国立研究開発法人科学技術振興機構と名称変更。
[iii] 用水路の上端に位置する取水ゲートを一定期間通水、止水することにより通水量を制御する灌漑方式。
[iv] 畝の間にできる溝の幅を細くし、本数を減らすことで灌漑水量を減らす方法。
[v] 穴をあけたチューブやパイプに水を通し、そこから作物の根に少しずつ水を共有する方法。
[vi] デルタ全体へのモデルの適用は活動計画の変更により行われなかった。

＜成果 2＞　達成されている

間断通水による取水時期の制限がある地区と、常時取水可能な水路近傍では、農家の行動が異なることが示された。その結果に基づき、節水の実施方法として、通水時間は現状のままとして水量を減らす方法と、水量を現状のままとして通水時間を減らす方法が示され、前者は下流部メスカに主に影響し、後者は相対的通水能力の小さいマルワ・メスカ[vii]に主に影響することが示された。また、支線用水路における反復利用の実施については、節水が下流部における排水再利用の頻度を上昇させるのに対して、上流部では影響がなく、影響が下流部に集中することが明らかにされた。この分析結果に基づき、幹線水路の上流部においても排水の反復利用を導入することが提案された。

指標 2-1　パイロットメスカ・マルワにおいて、水位変化及びポンプによる取水頻度・取水量のモニタリングデータが解析される、指標 2-2　マルワの水位変化とマルワの規模・農家数・農地面積の相互関係に係る理論が構築される、指標 2-3　パイロットメスカ・マルワにおいて、個別ポンプ及び共同ポンプについて、供給水当たりの燃費が比較される、指標 2-4　上の解明を前提に、水配分削減の方法による影響発現の仕方の違いが示される、はいずれも達成された。

＜成果 3＞　達成されている

ナイルデルタにおける塩類集積のデータから、①全体としてデルタ上流から下流に向かって塩類集積が進行していること、②上流部であっても、スポット的に集積土壌が存在することが示された。その結果、塩類集積は、取水管理上の有利不利、排水の反復利用に関係していることが示された。それに加え、稲作が有効な除塩効果があることを検証するとともに、耐塩性の強い作物の選定が有効であることを提示した。

指標 3-1　デルタ中央部の水田及び畑地における塩類集積の空間的分布と集積塩類の特徴が示される、指標 3-2　試験圃場において、暗渠排水の水位変化・流量変化・電気伝導度（Electric Conductivity。以下「EC」という。）値が示される、指標 3-3　上記数値に基づく暗渠排水の改善方法が提案される、指標 3-4　デルタ土壌の水・塩分・重金属等の移動特性を表すパラメーターが特定される、指標 3-5　試験圃場において畑地が水田に転換された際の水田耕作前後における塩分集積の比較値が示される、指標 3-6　排水を再利用した灌漑を行っている試験圃場において、カルシウム施用（Gypsum）及び籾殻鋤き込みによる土壌改良度（透水性、土壌物理性）が定量化される、指標 3-7　上記パラメーターに基づくシュミレーションモデルが試験圃場で構築され、同じ土壌条件下の地域で適用される、はいずれも達成された。

＜成果 4＞おおむね達成されている

導入の容易さと節水効果、収量増の観点から、将来的に有力な灌漑方法として細溝灌漑が示された。他方で、細溝灌漑が適用可能な作物と、更に研究が必要な作物が存在するため、後者については更なる研究、技術開発が必要なことが提言された。

指標 4-1　ポット苗栽培によって主要作物の耐塩性が定量化される、指標 4-2　用水管理

[vii] エジプトで用いられる。それぞれ「三次水路」「圃場内水路」の呼称。

調査地区において年間の作付け体系（作目選択、播種時期・収穫時期）が示され、将来の水供給予測に対応する作付け体系が提案される、指標 4-3　試験圃場において、灌漑方式ごとの作物収量及び品質が比較される、指標 4-4　試験圃場において、灌漑方式ごとの稲藁・麦藁・トウモロコシ茎の飼料価が示され、より飼料価の高い飼料の生産方法が提案されるは達成されている。指標 4-5　灌漑量・栽植密度の違いによる油料作物収量及び生育の違いが示され、適切な栽培方法が特定されるについてはおおむね達成されたが、燃料作物の異なる灌漑水量、栽植密度における生産量の比較による各作物の最適灌漑水量、栽植密度の分析については、2013、2014 年のデータを基に本プロジェクト終了までに解析作業を完了する必要がある。

＜プロジェクト目標の達成状況＞達成されている

指標 1　圃場レベルにおいて、現行方式を含め、異なる節水方法（灌漑方式・間作）による ET 量・作物収量の差異が比較される、指標 2　マルワ・メスカレベルにおいて、異なる灌漑方法（水供給頻度）による農民の水管理行動と水の動態が解明され、節水的かつ適切な水管理方法が示される、指標 3　パイロット排水路／ナイルデルタレベルにおいて用水反復利用の方法が示される、指標 4　各レベルにおける節水方法・用水反復利用方法が比較検討され、最適な節水・作付けオプションとその節水効果が示されており、プロジェクト目標は達成されている。また、当初計画にはないが、これらの本プロジェクトの研究成果に基づく政策提言・研究提言を策定し、プロジェクト終了までにエジプト側に提出するとともに、エジプト、日本で開催する終了時シンポジウムにて発表することが計画されている。

３－２　評価結果の要約

(1) 妥当性：高い

第 6 次国家社会経済開発計画のなかの長期農業開発戦略（2007 年）において「開発の持続と環境保全のための配分と資源の活用の経済効率性の実現を通した毎年3.9%の農業生産の増加」が第一の戦略目標として掲げられている。また 2006 年に策定された NWRP（2006～2017 年）においては、追加的な新たな水資源の開発、既存の水資源のより有効な活用、健康と環境の保護の三つの柱からなっており、本プロジェクトのめざす「ナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策」に合致している。またわが国の援助方針においても、「ナイルデルタ等の水利用・農業生産の効率化、小農の所得向上支援」プログラムにおいて、デルタ地域では特に水利用効率化を重点的に進め、効率的な水配分、水路の水質・環境改善、排水再利用を総合的に推進するとされており、本プロジェクトは同方針に合致している。

(2) 有効性：高い

各成果は達成されており、その結果としてプロジェクト目標も達成されている。各成果は、プロジェクト目標である「ナイルデルタ地域の農業分野の水利用の高度化と農業生産の効率化と持続性の確保を実現するための方策を示す」ためには必要な要件であることから、成果とプロジェクト目標の間の論理関係も認められる。

（3）効率性：中程度

日本側の投入（専門家派遣、供与機材、在外事業強化費、本邦研修）は、各研究分野に対して必要な質、量（数)、及びタイミングで投入されておりおおむね適切であったと判断された。研究内容に係る密なコミュニケーションをエジプト側と図るために、中間レビュー時に提言された日本側研究者の長期派遣については日本側研究機関側の事情により実現できなかったが、2013 年以降日本側の研究代表（プロジェクトマネジャー）の派遣期間を延長することで対応し、エジプト側との円滑な調整を図った。2011 年 1 月以降エジプトで発生した政変、同年 3 月に日本で発生した東日本大震災による日本側研究機関の被災により、一時研究活動を実施できない時期があったため、2013 年 3 月にプロジェクト期間を 10 カ月延長することで対応した。このプロジェクト期間延長は、政変、自然災害（外部要因）によるものであり、プロジェクトの効率性に起因するものではない。

【プロジェクトの効率性に貢献した要因】

1）灌漑用水の水質の土壌環境に与える影響を観測するためにアブシャン及びバハル・エル・ヌール地区を研究サイトとして選定した。同地区は、過去に JICA の技術協力プロジェクトが支援、改良した地域であり、既存の情報やデータを活用することができた。

【プロジェクトの効率性に負の影響を与えた要因】

1）研究機材の盗難が発生したことにより、観測活動の進捗へ影響を与えた。

2）エジプト側の投入には、各研究分野の研究員がおおむね適切に配置されたが、研究員の頻繁な交代がプロジェクトの円滑な進捗に影響を与えた。

3）エジプト側の複数の研究機関（CU、ARC、NWRC）が連携して共同研究を実施したエジプトで初めてのケースであったが、プロジェクトの運営・管理に不可欠な研究機関間の調整に予想以上の労力と時間を費やした。

（4）インパクト：おおむね高い

設定されている上位目標は多分に長期的な目標であるとともに、本プロジェクトによる貢献以外にも、その他の広範な要因も含めて達成される性格のものであるため不確定要素が多い。そのため、事後評価も含め上位目標を本プロジェクトの評価の対象とすることは必ずしも適当ではない。他方で、本プロジェクト実施により主に、以下の正のインパクトが認められた。

1）研究成果を踏まえてエジプト政府に対する政策、研究提言がプロジェクト終了までに策定される予定である。このような、科学的根拠に基づく提言が、今後の水資源計画や開発計画等に反映され研究成果が具現化されることが期待される。

2）プロジェクトで導入した ET システムによる Eddy Correlation（渦相関）が、エジプト側の研究代表である Dr. Rushidi El-Kilani の下、2 名の CU 農学部の大学院生が修士論文に着手しているとともに、CU 農学部のカリキュラムに ET システムによる Eddy Correlation が新設された。

3）研究成果を基に書籍「Irrigated Agriculture in Egypt－Past, present and future（2015 年 1 月時点での仮の表題)」を出版予定であり、本プロジェクトによる研究成果が農業分野及び

他の関連分野に従事する人々にも広く一般に発信される。

4）プロジェクト実施期間中にジャーナル 10 回、学会発表 6 回、口述発表 49 回、ポスタープレゼンテーション 12 回が実施され、研究成果を外部に発信した。

5）科学的な根拠に基づく水管理に係る知見が他の実施中の技術協力プロジェクト「水管理移管強化プロジェクト（Project for Strengthening Water Management Transfer。以下「SWMT」という。)」に提供され、プロジェクトの推進に貢献した。

6）本プロジェクトで有効性が確認された細溝灌漑及び間作技術について、実施中の技術協力プロジェクト「小規模農家の市場志向型農業改善プロジェクト」が関心を示しており、同プロジェクトによる試験圃場での試行が今後検討される予定である。

7）本プロジェクトの実施により、エジプトの研究機関に科学的根拠に基づく意思決定システムが導入されつつある。

なお、負のインパクトは観察されていない。

(5) 持続性：中程度

＜政策面の持続性＞

上述の「妥当性」のとおり、研究結果に基づく実際の適用はエジプト政府の開発政策及び水資源政策に合致しており、政策面の持続性は高い。

＜組織面の持続性＞

プロジェクトの実施により CU、ARC、NWRC による共同研究実施体制が確立された。しかし、プロジェクトによる支援なしに、研究継続のためにエジプト側でこの共同研究体制が継続するかは不透明であり、組織面の持続性は中程度である。

＜財政面の持続性＞

プロジェクト開始当初、運営費に係るエジプト側の負担がなされないことが問題となったが、その後交通費、現地調査やデータ収集に必要な経費の一部負担がなされたことから、将来、研究活動の継続に必要となる一定の経費は確保されると思われる。他方、プロジェクトで供与した機材の維持管理費については新たに予算を措置する必要があるため、財政面の持続性は中程度である。

＜技術面の持続性＞

プロジェクトの研究成果は政策提言、研究提言によりエジプト国内で広く共有される予定である。他方で、各研究機関内における、本プロジェクトにより習得した技術、分析技術、機材の管理方法等について、プロジェクトに参加していなかった研究者に対する共有は限定的であった。そのため技術面の持続性は中程度である。

３－３　効果発現に貢献した要因

(1) 計画内容に関すること

なし。

（2）実施プロセスに関すること

- 過去の技術協力プロジェクトが支援､改良した地域を研究のサイトとして選定することによる効率的な研究活動の実施。

３－４　問題点及び問題を惹起した要因

（1）計画内容に関すること

なし。

（2）実施プロセスに関すること

- 研究機材の盗難が発生したことによる観測活動の進捗への影響。
- エジプト側研究員の頻繁な交代が円滑な研究活動の進捗に影響を与えた。
- エジプト側の複数の研究機関（CU、ARC、NWRC）が連携して共同研究を実施したエジプトで初めてのケースであったため、プロジェクトの運営・管理に不可欠な研究機関間の調整に予想以上の労力と時間を費やした

３－５　結　論

本プロジェクトは終了時評価時点においておおむね円滑に実施されており、高い妥当性、有効性、インパクト、中程度の効率性、持続性がみられたと評価された。またプロジェクト目標は各成果の達成により、達成された。そのため、合同評価団は、当初予定どおり 2015 年 3 月にプロジェクトが終了されるべきと結論する。

３－６　提　言

（プロジェクト終了までの残りの期間において対応すべき事項）

（1）完了していない活動の実施

一部終了していない研究活動についてプロジェクト実施期間内に終了させる必要がある。具体的には、成果 4 における 2013、2014 年のデータを基にした燃料作物 5 種類の最適灌漑水量、栽植密度の分析作業をプロジェクト終了までに完了させることが必要である。

（2）政策、研究提言の策定と提出

研究成果を基に政策提言、研究提言を策定中である。プロジェクト終了までに、エジプト側関係機関との協議を踏まえて提言を完成させ、エジプト側関係機関に提出することが必要である。

（3）供与機材の適切な配置に必要な手続きの実施

プロジェクトが供与した研究機材について、使用用途を踏まえた適切な研究機関への配置に必要な手続きを完了させることが必要である。

（プロジェクト終了後において対応すべき事項）

（1）政策、研究提言の反映

- 水資源・灌漑省（Ministry of Water Resources and Irrigation。以下「MWRI」という。）は、

プロジェクトが策定する政策提言をエジプトの新たな開発計画、セクターの開発戦略に反映させるために必要な検討、手続きを実施することが必要である。
- CU、ARC、NWRC はプロジェクトが提案した研究提言を研究計画・戦略に反映させ研究を実施に移す検討、手続きを実施することが必要である。

(2) 研究の継続

CU、ARC、NWRC は更に精緻かつ統計的にも有効なデータを収集し解析を可能にするために、フィールドにおける実験を継続することが必要である。

(3) 機材管理体制の強化

CU、ARC、NWRC は機材の運営管理を担当する職員を任命するとともに維持管理に必要な十分な予算を確保することが必要である。

(4) 研究成果の発信

CU、ARC、NWRC は、論文、ジャーナル、学会発表等により可能な限り本プロジェクトの研究成果を外部に発表することが必要である。このような成果の外部への発表に関しては 3 機関が協調して実施することが必要である。

(5) エジプトと日本の研究機関間の連携の継続

エジプト側の研究機関／研究者が研究を継続するにあたり、日本側研究機関／研究者は可能な限り必要な支援が継続されることが期待される。

３－７　教　訓

- 本プロジェクトは、3 研究機関（CU、ARC、NWRC）をエジプト側実施機関として実施されたため、実施機関間の調整に多大な労力を要した。効率的なプロジェクト運営管理のために、日本人専門家（研究者）の長期派遣、エジプト側 3 研究機関からプロジェクト調整員を配置しプロジェクトの調整を図る仕組みを構築するなどの対応が有効であったと思われる。
- 本プロジェクトが扱う課題は広範な研究分野にわたっており、また研究成果を基に政策への提言を行うにあたり、大学と関係省庁（農業土地開拓省、MWRI）傘下の研究 2 機関が連携して共同研究を実施することは有効であった。エジプトにおいて複数の研究機関が同等な立場で連携して共同研究を実施する初めてのケースであり、共同研究を実施する体制としてのモデルとなった。
- 本プロジェクトはプロジェクト･デザイン･マトリックス（Project Design Matrix。以下「PDM」という。）を作成せず、それに替わり MP〔上位目標、プロジェクト目標、成果（アウトプット）及びそれらの指標を規定〕と Expected Output（4 研究分野ごとの研究活動）を活用してプロジェクトの進捗と達成度を管理していた。しかしながら、MP における各成果と Expected Output の研究分野は必ずしも一致していなかった。プロジェクト活動は Expected Out の各研究分野の活動に沿って実施されたため、結果として研究活動によって生み出された各研究分野の研究成果が簡潔に MP の成果及びその指標に整合せず、MP をログフレーム

とした評価を困難なものにした。そのため、PDM を作成しない場合においても、それに替わるログフレームはプロジェクト目標、成果、活動の間の論理的な組み立てがなされるとともに、実際の活動もそのログフレームに沿って実施されるように管理する必要があり、実際の活動と乖離する場合には速やかにログフレームとの間の調整がなされることが望ましい。

３－８　フォローアップ状況

特になし。

終了時評価調査結果要約表（英文）

<table>
<tr><td colspan="3">I. Outline of the Project</td></tr>
<tr><td colspan="2">Country： Arab Republic of Egypt</td><td>Project title : The Project for Sustainable Systems for Food and Bio-energy Production with Water-saving Irrigation in the Egyptian Nile Basin</td></tr>
<tr><td colspan="2">Issue/Sector：Agricultural and Rural Development</td><td>Cooperation scheme：Technical Cooperation (SATREPS)</td></tr>
<tr><td colspan="2">Division in charge： Rural Development Department,</td><td>Estimated Total Cost：400,301,000Yen</td></tr>
<tr><td rowspan="3">Period of Cooperation</td><td rowspan="3">(R/D): June, 2009 ~ June, 2014
(Amended R/D):
June, 2009 ～March, 2015
(Five years and ten month)</td><td>Implementation Organizations in the Partner Country
Cairo University (CU)
Water Management Research Center (WMRC)
Agriculture Research Center (ARC)</td></tr>
<tr><td>Supporting Organization in Japan
University of Tsukuba
Tottori University</td></tr>
<tr><td>Related Cooperation: Water Management Improvement Project II (WMIP II), Strengthening for Water Management Transfer (SWMT) (Technical Cooperation)</td></tr>
</table>

1. Background of the Project

Due to the rapid population growth, averaging the annual increase as high as two percent per year, the Government of Egypt has set its national development goals focusing on expansion of employment opportunities in agriculture sector and increase in food production. However, Egypt is facing shortage of water resources and farmland. For instance, the agricultural production in the Nile Delta as a major agricultural area seems to have been already reached at the maximum of the productivity, and there is little space to develop new farmland in the area as well. In addition, it is difficult to develop new water resources since the amount of water intake from Nile River which covers most of the water resources is limited to 55.5billion tons by the bilateral agreement with Sudan.

Under this circumstance, Egypt is trying to develop improved water management methods in order to expand irrigated neighboring desert area and to increase food production. This expansion of the farmland is expected to absorb increasing workforce into agricultural sector which includes 30% of the workforce, and incomes of small-scale poor farmers.

While the Socio-Economic Development Five Year Plan (2007/8-2011/12) and National Water Resources Plan (NWRP) emphasize the agricultural and irrigation development for expansion of the farmland as priority more concrete measures are necessary to realize these policies. Therefore comprehensive and concrete measures for effective water use need to be proposed.

Based on the conditions stated above, Government of Egypt has submitted a proposal for the joint research project, Science and Technology Research Partnership for Sustainable Development (SATREPS), to the Government of Japan. This project, “Sustainable Systems for Food and Bio-Energy Production with Water-Saving Irrigation in the Egyptian Nile Basin” started in April 2009, and expected to propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond to the above mentioned condition.

2. Project Overview

The Project has been implemented as a joint research between Egyptian research Institutions (Faculty of Agriculture, Cairo University, National Water Research Center, and Agriculture Research Center), and Japanese Universities (Tuskuba University and Mie University), in order to propose the methods which realize efficient and sustainable agricultural production with efficient water management to response to the above mentioned condition as well as grasping the present situation in the Nile Delta after 50 years from the construction of Aswan high Dam.

(1) Overall Goal

To contribute to increasing agricultural production and to expanding employment opportunities, as stated in the Socio-Economic Development Five-Year Plan, the National Water Resource Plan and Agricultural Production Plan for Egypt 2017.

(2) Project Purpose

To propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond the rapid population growth.

(3) Outputs

(Output1) Evapotranspiration and salt/water balance in the Nile Delta are clarified.
(Output2) An improved plan of irrigation management at the different canal levels in the Nile Delta is developed.
(Output3) Methods for controlling salinity and fertility of soil are developed.
(Output4) Appropriate crop production and irrigation management systems at the farm level are developed.

(4) Inputs

Japanese side：Total cost 400,301,000 Yen
Expert 18 Experts
Long Term Expert (Project Coordinator) 3 Experts
Training in Japan 21 CPs
Provision of Equipment 147,123,762 Yen
Operational Cost 66,200,055 Yen

Egyptian side
Counterparts (CPs) 73 C/Ps
Provision of office space and laboratory and development of experimental farms
Operational Cost Transportation fee and utilities (2,051,136 yen (a part of cost share form WMRI)

II. Evaluation Team

Members of Evaluation Team	<Japanese Side>		
	Mr. Takeaki SATO	Leader	Visiting Senior Advisor, JICA
	Mr. Taro AZUMA	Evaluation Planning	Advisor, Team 2, Agricultural and Rural Development G1, Rural Development Dep., JICA
	Mr. Akira OGASAWARA	Evaluation & Analysis	Consultant, VSOC Co., Ltd.
	(Observor>		
	Dr. Kotaro INOUE	Science and Technology (Evaluation)	Principal Fellow/ Programme Officer, Japan Science and Technology Agency (JST)
	Ms. Miho TAKAHASHI	Science and Technology (Evaluation)	Assistant Programme Officer, JST
	<Egyptian Side>		
	Prof. Abd El Alim Metwally	Leader	Professor of Agronomy, Faculty of Agriculture, Cairo University (CU)
	Prof. Mohamed Fahmy Hussein	Member	Professor, Soil Science Department, Faculty of Agriculture Cairo University (CU)
	Prof. Mohamed Lotfy Yousef Nasr	Member	Professor of Water Economics, Water Management Research Institute (WMRI)
	Dr. Mohamed El Kholy	Member	Associate Professor, Environment Deportment, Soil, Water and Environment Research Institute (SWERI)
Period of Evaluation	2015/ 1/10～1/31		Type of Evaluation：Terminal Evaluation

III. Results of Evaluation

3. Outline of the Result of Evaluation

3-1. Achievement of Outputs and Project Purpose

<Output 1> Achieved

The water and salt balance in the pilot drainage site and quantitative values of evapotranspiration (ET) of each irrigation method were clarified, and the strip irrigation, drip irrigation instead of extended irrigation interval method are proposed. In addition, other than the indicators, the Project found out that the ET value was decreased remarkably over the horizontal distance of 10 times the wind break tree height.

Indicator 1-1. Fluctuation of transpiration and evaporation by using the eddy correlation system from the field under the long-interval irrigation treatments is quantified and agreed with the previous studies, Indicator 1-2.The water use efficiency (yield per unit water) in conventional and proposed water saving irrigations is quantitatively compared, Indicator 1-3 The relation between windbreak porosity and reduction of evapotranspiration is quantified for Casualina and Eucalypts trees, Indicator 1-4 The water/salt balance model for canal/drain command area is developed and extended to the delta area, are achieved.

<Output 2> Achieved

The Project found out that there was a clear difference in farmers' behavior between areas where a limited water intake time by rotation irrigation was observed and areas near to canals where farmers could take irrigation water at all time. Along with the findings, two possible methods for the implementation of water saving were considered; 1) to reduce irrigation time with leaving amount of irrigation water as it is, and 2) to reduce amount of irrigation water with leaving irrigation time as it is. Furthermore, it was revealed that water saving would increase the rate and frequency of recycling drainage water in downstream areas, while it would not affect upstream areas and thus effects of water saving was concentrated on downstream areas. Based on this analysis, the Project proposed intensified water recycling in the upstream part of the main irrigation canal as well.

Indicator 2-1 Analysis of monitoring data on fluctuations of water levels, frequency of pumping and pumping volume at the pilot Marwa/Meska is presented, Indicator 2-2 Interaction of observed fluctuations above with the capacity of Marwa, the number of farmer and area of farmland is identified, Indicator 2-3 Fuel efficiency for traditional pumping and improved pumping methods at the pilot Marwa/Meska is quantified, Indicator 2-4 Impacts of water saving options at the branch canal level are assessed under different scenarios by using the results above, are achieved.

<Output 3> Achieved

The Project obtained the relevant document on the current situation of salt accumulation in soil and found out that (1) salt accumulation in downstream area is more intensified than in upstream area in the delta, (2) salt accumulation was also observed in some areas scattered in upstream of the delta. The Project has presented the understanding that all such salt accumulation is related to water intake management situation of farmers and drainage water reuse. So as to leach the salt, rice cultivation is clarified as an effective method in the delta. The Project also proposes that selecting cultivars with salt-tolerant properties is also one of the keys to overcome this issue.

Indicator 3-1 Monitoring data on distribution and intensity of salt accumulation at paddy and non-paddy fields in the mid-delta are analyzed and compared with previous studies, Indicator 3-2 Monitoring data on spatial distribution and temporal fluctuation of ground water level, flow and EC value of the tile drainage of the pilot fields are analyzed, Indicator 3-3 Methods of improving tile drainage to control salinity are investigated, Indicator 3-4 Parameters for water, salt, heavy metals and other contaminants movement in soils at the experimental field are identified, Indicator 3-5 Decrease of salinity level after using farmland as paddy field is quantified, Indicator 3-6 Water permeability and physical parameters of soils with the application of calcium sulfate (Gypsum) and organic matter in crop fields is quantified, Indicator 3-7 A simulation model of water, salt, heavy metals and other contaminants movement in soils at the experimental field is developed and extended to delta areas of similar soils, are achieved.

<Output 4> Mostly Achieved

Strip irrigation was proposed as an easily applicable and promising water saving method for the future. It shows a good aspect of higher yield as well as water saving. However, it has some non-applicable crops for strip irrigation, such as Egyptian clover. For non-applicable crops, further technical developments based on the principle of avoiding water logging and water saving are recommended.

Indicator 4-1 Salt tolerance of cultivated varieties of major crops is quantified by using both pot (and lysimeter) experiment(s), Indicator 4-2 Appropriate cropping pattern corresponding to the future water availability is proposed based on survey data on cropping pattern at the target area, Indicator 4-3 Crop yield and quality under different irrigation treatments are identified, Indicator 4-4 Feed value of straws (rice, wheat, maize) grown under different irrigation treatments is measured and an appropriate feeding design is developed, are achieved except measuring yield of different bio-fuel crops under different conditions, which will be finalized by the end of the Project.

<Project Purpose> Achieved (at the end of the Project)

Indicator 1 Difference of evapotranspiration and crop yield under conventional and different water saving irrigation treatments is quantified, Indicator 2 An optimal water saving irrigation treatment is identified at the Marwa/Meska level by clarifying water management approaches, including water management scheduling, under different irrigation treatments, Indicator 3 An optimal method for the reuse of drainage water is identified in the middle delta, and indicator 4 Optimal cropping patterns are identified according to available water resources, are achieved.

The Project has already developed a policy and research recommendation based on the achievement of the Project, and will submit to Egyptian side as well as having presentation at the occasion of the final symposiums which will be held in March 2015 both in Egypt and Japan to introduce the recommendations and to disseminate the achievement of the Project.

3.2. Summary of Review Results

(1) Relevance

The relevance of the Project is high since the Project is highly consistent with the Egyptian development plan and sector strategy, and Japanese aid policy. The Sixth Five-year Socio-economic Development Plan (2007-2012) is the primary development plan formulated by the government of Egypt. In the Plan, Long-term Agricultural Development Strategy (2007) aims at "increasing agricultural production by 3.9 % annually through achieving economic efficiency in allocation and use of resources to sustain development and protect the environment" as the first objective. The National Water Resources Plan (NWRP) (2006-2017) was also formulated in October 2006, with the coherent strategy consisting of the following three basic pillars; developing additional new water resources, making better use of existing water resources, and protecting health and environment.

Country Assistance Program for Egypt of the government of Japan formulated in June 2008, it states that Japan will provide strategic assistance to Egypt with " Poverty Reduction and Improvement of Living Standard" emphasizing on development of agriculture and rural communities.

(2) Effectiveness

Effectiveness of the Project is high. The outputs are expected to be achieved by the end of the Project, then the project purpose also is expected to be achieved accordingly. Achievement level of each output is satisfactory as described in "3.1 Output." Logical sequence of the relationship between output 1, 2, 3 and 4 and the project purpose is strong enough since (i) clarification of evapotranspiration and salt/water balance, (ii) development of an improved plan of irrigation management, (iii) development of methods for controlling salinity and fertility of soil and (iv) development of appropriate crop production and irrigation management systems are indispensable to making proposal of the methods to realize efficient and sustainable agricultural production with efficient water management.

(3) Efficiency

The efficiency of the Project is moderate. With regards to quality and quantity of input from the Japanese side such as dispatch of experts, provision of equipment, operational cost and trainings in Japan are relatively appropriate. Modality of Japanese expert dispatch, long-term researchers could not be dispatched. After the political change in June 2013, the Project attempted to promote smooth coordination of the Project by expanding the dispatch periods of the Project Manager. With regards to quality and quantity of input from the Egyptian side, Egyptian researchers who specialize in various research fields are appropriately assigned. Frequent changes in assignment of Egyptian researchers negatively affected to the efficiency of the Project activities.

[Promoting factors]

- The Project selected study sites of Abshan and Bahr El Nour to evaluate the effects of irrigation water quality on several soil properties. Bahr El Nour was a site developed by a Japanese technical cooperation project, which contributed to the efficiency of the Project.

[Inhibiting factors]

- Interruption and delay of some project activities caused by temporal unstable situation
- Frequent changes in assignment of researcher from Egyptian side.

(4) Impact

- The impact of the Project is relatively high. The overall goal of the Project is set with a considerable longer-term perspective than assumed. In addition to that, it is still uncertain that the overall goal will be achieved three to five years after the termination of the Project since it is considered to be achieved by broader factors/conditions including the contribution of the Project. From this perspective, it is not appropriate the overall goal is targeted to be evaluated on the ex post evaluation. Besides that, the following impacts were observed by the implementation of the Project.

- ➢ The Project is drafting policy and research recommendations to the Egyptian Government based on the research results. The recommendations are expected to be important inputs for the incoming water resource development plan.
- ➢ ET System for Eddy Correlation Method is already introduced to the curriculum of the Faculty of Agriculture of the Cairo University. Due to ET System for Eddy Correlation Method which is introduced by the Project, two master degree students from the Faculty of Agriculture at Cairo University started their theses, working with the Project Manager from the Egyptian side, Dr. Rushdi El-Kilani.
- ➢ The Project is in the process of publishing a book "Irrigated Agriculture in Egypt- past, present and future (tentative title, as of 1 January 2015)," based on the outcomes of the project research activities, which is expected to promote awareness of people working in the field of agriculture and other related sectors.
- ➢ The Project attempts to disseminate the research results in the form of journal article. A total of ten papers were already published. Six presentations in academic conferences, 49 oral presentations and 12 poster presentations were also made in academic opportunities during the project period.
- ➢ Scientific clarification from the Project was highly useful for SWMT implementation on water management according to the Chief Advisor.
- ➢ Improving Small Scale Farmers' Market-Oriented Agriculture Project (ISMAP), JICA technical cooperation project in Egypt, is keen to demonstrate the intercropping and strip irrigation techniques and to practices experiments by the Project to target farmers. It is expected that the experiment results will be disseminated and practiced by farmers in the future.
- ➢ The Project introduced the system for science-based decision-making in Egypt.

- There is no concrete negative impact at the time of the terminal evaluation.

(5) Sustainability

The overall sustainability of the Project is moderate.

(i) Political sustainability

Political sustainability is high since the acceptance of social application is highly consistent with the strategies of the Egyptian government as mentioned in "Relevance" above.

(ii) Organizational sustainability

Organizational sustainability is moderate. Structure of implementation organizations (CU, NWRC and ARC) was established. However, it is not certain that this collaboration between three research institutions continues without supports from the Project.

(iii) Financial sustainability

Financial sustainability is moderate. There were some concerns particularly about cost sharing from the Egyptian side at the beginning of the Project. The Egyptian side shared some transportation cost for field surveys and data collection. In this regard, it is expected for them to bear the cost for research activities in the future. However, it is also necessary to secure the budget for O&M of the equipment that the Project provided.

(iv) Technical sustainability

Technical sustainability is moderate. It is expected that the research results on water and salt balance, water management, soil fertility and food and oil crop production will be shared through policy and research recommendation. However, within the counterpart organizations, they did not sufficiently share with research skills, techniques of data analysis, and management of provided research equipment to the other researchers who have not been involved with the Project.

3.3. Factors that promoted or inhibited the achievement of the Project Purpose

(1) Factors concerning to Planning

- Nil.

(2) Factors concerning to the Implementation Process

- Use of a project site developed by a Japanese technical cooperation project for comparison survey on irrigation water quality

3.4. Factors that impeded realization of effects

(1) Factors concerning to Planning

- Nil.

(2) Factors concerning to the Implementation Process

- Interruption and delay of some project activities caused by temporal unstable situation
- Frequent changes in assignment of researchers from Egyptian side
- The Project is recognized as a pioneer project in cooperation among three research institutions, CU, NWRC, and ARC. As for the coordination of these institutions, it took more time and efforts among them and the Japanese experts than expected.

3.5. Conclusion

- The Project has been implemented relatively smoothly at the moment of the terminal evaluation with high relevance, effectiveness and impact, and moderate efficiency and sustainability. It is evaluated that the project purpose will be achieved at the end of the Project with satisfactory achievement level of outputs. Accordingly, the Evaluation Team concluded that it is appropriate to terminate the Project in March 2015 as scheduled.

3.6. Recommendations

(Recommendations for the Remaining Period of Project Implementation)

(1) Completion of uncompleted analysis of research activities

- (For the Project) In collaboration with counterpart organizations, the Project needs to complete some unfinished research analysis on bio-fuel crops for more accurate analysis based on the data during 2013-2014.

(2) Finalizing policy and research recommendations

- (For the Project) The Project is drafting policy and research recommendations and elaborating and revising it based on the discussions with Egyptian side. The Project needs to be sure of completing the recommendations and presenting them to the relevant ministries and research institutions.

(3) Ownership transfer of provided equipment

- (For the Project) The Project needs to complete necessary procedures so as to properly allocate equipment provided by the Project to each institution.

(Recommendations after Termination of the Project)

(1) Reflection of policy and research recommendations into relevant national plan and strategy

- (For MWRI) The Ministry is recommended to attempt to reflect the policy recommendation into new development strategies and incoming sector strategies.
- (For CU, NWRC, and ARC) They are recommended to attempt to reflect the research recommendation into future research plans/ strategies.

(2) Continuation of research activities

- (For CU, NWRC, and ARC) For more accurate statistical implications and more accurate analysis, they are recommended to consider conducting more experiments at the fields.

(3) Strengthening implementation structure for equipment management

- (For CU, NWRC, and ARC) They are recommended to appoint staff in charge of equipment management and to secure an enough budget for its operation and maintenance.

(4) Dissemination of research results

- (For CU, NWRC, and ARC) They are recommended to present research results of the Project as much as possible in the form of published papers, presentations in academic conferences, oral presentation and poster presentation. Furthermore, they are recommended to disseminate the research results to the field by collaboration between three research institutions.

(5) Maintaining academic relationship between Japanese and Egyptian sides

- (For Relevant universities and research institutions of Japanese side) Relevant universities and research institutions and/or researchers in Japan are recommended to continue their supports to the relevant Egyptian research institutions and/or researchers in order for them to continue their research activities.

3.7. Lessons Learned

-Since this Project has three research institutions in Egyptian side as counterparts, it required a lot of efforts for coordination between these institutions. For smooth management of the Project, long-term expert(s) (researcher(s)) should have been dispatched throughout the Project and coordination body among three counterpart organizations from the Egyptian side should have been organized.

- The Project formulated a basic structure for joint research in collaboration with CU, NWRC and ARC. Consequently, the Project is a good example of joint research-work between multi-disciplines in several institutions.

3.8. Follow-up Situation

-Nil.

(end)

第１章　終了時評価調査の概要

１－１　背　景

エジプト・アラブ共和国（以下「エジプト」という。）では、急激な人口増加（年率 2%）に対応するため、食糧生産の増大と農業分野での雇用の拡大が主な開発課題として挙げられている。しかし、主要な農業地域であるナイルデルタ地域での農業生産量は限界に達していると考えられることに加え、同地域内で新たに農地を開発する余地は少ない。一方、同国の水資源の大部分を賄うナイル川からの取水はスーダンとの二国間の協定により年間555億tに制限されていること、エジプトの年間降水量が 25 ㎜程度（カイロ）であることから新たな水資源の開発も困難である。このため同国は、ナイルデルタ周辺の砂漠地域に灌漑農地を拡大し、食糧生産の増大を図ろうとしている。また、農業セクターでは就業人口の 3 割を抱え、その多くが小規模農地で貧困層であることから、これら周辺地域への新たな農地の開発・拡大を通じて、就業人口の増加に対応するとともに、農民の収入の増加を図ろうとしている。

エジプトの「第 6 次国家社会経済開発計画」（2007 年 8 月～2011 年 12 月）においては、新たな農地の拡大を通じた農業・灌漑開発が優先分野に挙げられているが、同計画や 2017 年を目標年に掲げる NWRP の施策は具体性に乏しい。このため、アスワンハイダムの建設により洪水が排除されたあとの塩類集積による土壌への影響、塩類集積回避のために埋設された暗渠排水の効果、流域水収支や塩収支、食用作物の栽培に利用できていない排水の再利用の可能性等を把握したうえで、農業用水の有効利用を図るための包括的かつ具体的な水管理の方策を示す必要があり、大学等の研究機関がデータや知見に基づいて現状を分析し、改善策を提示することが求められている。

このような背景の下、ナイルデルタ地域における節水的な水管理の方策を示す目的でエジプト政府はわが国に対して SATREPS プロジェクトの実施要請を行った。これを受けて、日本側は 2009 年 6 月から 5 年 10 カ月間の予定で本プロジェクトを実施しており、これまで、「水・塩収支」「水管理」「土壌の肥沃性」「食糧・燃料作物生産」の 4 研究グループごとに、関連分野における共同研究が進められるとともに、エジプト側研究者への技術移転が行われてきた。

１－２　評価対象プロジェクトの概要

協力期間	2009 年 6 月～2015 年 3 月（5 年 10 カ月間） （当初 2014 年 6 月までであったものを 10 カ月間延長）
実施機関	日本側：筑波大学、鳥取大学 エジプト側：CU 農学部、NWRC、ARC
対象地域	エジプト
上位目標	社会経済開発 5 カ年計画、NWRP 及び国家農業生産計画に記載されている農業生産の増大と雇用機会の拡大に貢献する。
プロジェクト目標	急激な人口増加に対応するナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策を示す。

成果	1）ナイルデルタの各種条件下での水及び塩の収支に係る諸条件が明らかになる。 2）用水路レベルでの水配分及び水管理の合理化の方策が提示される。 3）圃場の塩害防止の方策が提示される。 4）適切な作物選択がなされ、圃場レベルの灌漑方法の改善手法が提示される。

プロジェクトの枠組みを示すために作成された文書がプロジェクト・マスタープランである。プロジェクト・マスタープランは、プロジェクト開始前の 2009 年 5 月に作成され、討議議事録（Record of Discussions。以下「R/D」という。）の添付書類として合意された。最新版のプロジェクト・マスタープランは、2012 年 3 月に実施された中間レビューの際に改訂されたものである。今回の終了時評価調査では、この 2012 年 3 月に改訂され、2013 年 3 月の R/D 改訂時に合意されているプロジェクト・マスタープラン（付属資料 1）に基づいて実施された。

１－３　目　的

終了時評価調査は、プロジェクト終了を 2015 年 3 月に控え、エジプト側と合同で以下の点を目的として実施された。1）技術協力の開始から終了（調査時点）までの実績確認（活動、投入）、実施プロセスの検証、2）プロジェクト目標と成果の達成状況、貢献要因・阻害要因の分析、3）それらを踏まえた評価 5 項目（妥当性、有効性、効率性、インパクト及び持続性）の観点に基づく総合的な評価、4）プロジェクト終了時までに行うべきこと、並びにプロジェクト終了後に先方政府が行うべきことについての提言、5）類似プロジェクトのための教訓の抽出。

１－４　評価団の構成

終了時評価は、日本側評価団とエジプト側評価団の合同評価団によって実施された。

（1）日本側評価団

日本側評価団は、以下の表に示す 3 名で構成された。そのほかに、国立研究開発法人科学技術振興機構[1]（Japan Science and Technology Agency。以下「JST」という。）から 2 名、評価対象プロジェクトの日本側研究代表 1 名が、オブザーバーとして参加した。

氏名	担当分野	所属等
佐藤　武明	団長／総括	独立行政法人国際協力機構（JICA）国際協力専門員
東　太郎	協力企画	JICA 農村開発部 農業・農村開発第一グループ 第二チーム企画役
小笠原　暁	評価分析	株式会社 VSOC 事業部 コンサルタント

[1] 2015 年 4 月に国立研究開発法人科学技術振興機構と名称変更。

日本側評価団同行者

井上　孝太郎	科学技術評価	JST 上席フェロー（SATREPS）/研究主幹
高橋　美穂	科学技術評価	JST 地球規模課題国際協力室 調査員
佐藤　政良	研究代表	筑波大学 名誉教授

（2）エジプト側評価団員

エジプト側評価団は、以下表に示す 4 名で構成された。

氏名	担当分野	所属等
Prof. Abd El Alim Metwally	総括	CU 農学部 教授
Prof. Mohamed Fahmy Hussein	団員	CU 農学部 土壌科学科 教授
Prof. Mohamed Lotfy Yousef Nasr	団員	NWRC Water Management 水管理研究所（WMRI）水経済教授
Dr. Mohamed El Kholy	団員	ARC、土壌・水・環境研究所（SWERI）准教授

１－５　調査日程

エジプトでの現地調査は 2015 年 1 月 10～31 日の間に実地された。調査日程は以下のとおり。

月/日	曜日	作業工程
1 月/11 日	日	カイロ着（評価分析団員） JICA エジプト事務所、プロジェクト業務調整専門家との打合せ
1 月/12 日	月	エジプト側評価団との打合せ
1 月/13 日	火	CU 農学部へのインタビュー（Project Advisor、C/P）
1 月/14 日	水	NWRC へのインタビュー 稲作研究研修センター（RRTC）へのインタビュー、サハ実験圃場視察
1 月/15 日	木	ARC、サハ実験圃場表敬及びインタビュー
1 月/16 日	金	報告書作成
1 月/17 日	土	報告書作成
1 月/18 日	日	国家水資源研究センターへの表敬及びインタビュー 国家水資源研究センター（Kanatel）へのインタビュー
1 月/19 日	月	CU 農学部へのインタビュー カイロ着（総括／協力企画） JICA エジプト事務所との打合せ及び調査団内打合せ

1 月/20 日	火	ARC（ギザ）へのインタビュー 土壌･水･環境研究所（Soil, Water and Environment Research Institute。以下「SWERI」という。）へのインタビュー 「水管理能力強化プロジェクト」チーフアドバイザーへのインタビュー
1 月/21 日	水	エジプト側評価団との打合せ プロジェクトマネジャー（CU 農学部長）との打合せ
1 月/22 日	木	プロジェクト成果発表会（1） ARC へのインタビュー、実験圃場、プロジェクト実験施設視察
1 月/23 日	金	報告書作成
1 月/24 日	土	実験圃場（ザンカロン）視察（総括、協力企画）
1 月/25 日	日	報告書作成
1 月/26 日	月	プロジェクト成果発表会（2） 調査団内打合せ
1 月/27 日	火	プロジェクト成果発表会（3） MWRI 計画局長との打合せ
1 月/28 日	水	水管理研究所（WMRI）へのインタビュー ARC との協議 FCR へのインタビュー プロジェクトダイレクターとの打合せ
1 月/29 日	木	合同評価委員会（合同評価レポートへの署名） 第 12 回合同調整委員会（JCC） M/M 署名 日本大使館、JICA エジプト事務所への報告
1 月/30 日	金	カイロ発

第２章　終了時評価調査の方法

２－１　終了時評価調査の枠組み

SATREPS 案件は、JST による研究支援及び JICA による技術協力の連携により推進されている技術協力プロジェクトであり、中間レビュー及び終了時評価においても JST 及び JICA が連携して実施している。JICA は、通常の技術協力プロジェクトと同様、「新 JICA 事業評価ガイドライン第 1 版」に沿って、ODA 事業としての評価を行っており、2013 年 3 月に承認された英文版 MP を基にプロジェクトの実績確認･評価を行った。（付属資料 1 を参照）

一方、JST は地球規模課題解決に資する、科学技術の向上、科学技術政策及び社会への貢献などの観点から日本国内及び相手国を含めた国際共同研究全体の評価を実施[2]した。

（1）技術協力プロジェクトと地球規模課題対応国際科学技術協力（SATREPS）の差異

中間レビュー実施時とは異なり、本終了時評価調査においては、中間レビュー時に設定された英文版 MP の評価指標を基にプロジェクトの実績確認･評価を行った。Expected Output は、各成果（アウトプット）の研究活動と位置づけられるが、評価に際してはあくまでも補助的な位置づけとした。

通常の技術協力プロジェクトと SATREPS の差異を下表に示したが、これらの差異にかんがみ、本終了時評価では各成果の研究成果の達成状況とプロジェクト目標の達成状況との論理関係に着目して評価を行った。

技術協力プロジェクトと SATREPS の違い

	活動	成果（アウトプット）	プロジェクト目標	活動/成果/プログラム目標の関係
通常の技術協力プロジェクト	「計画を策定する」「マニュアルを作成する」「研修を実施する」など、<u>具体的な行為</u>が「活動」として位置づけられる。	「研修プログラムが整備される」「技術を習得する」など、<u>活動の結果として発現する成果</u>が「成果」として位置づけられる。	「行政能力が強化される」「灌漑基盤が整備される」など、<u>複数の成果によってもたらされる効果</u>が「プロジェクト目標」として位置づけられる。	活動が成果をもたらし、複数の成果によってプロジェクト目標が達成されるという<u>直線的な因果関係</u>として位置づけられる。

2　「地球規模課題対応国際科学技術協力（SATREPS）」JST 終了時評価の実施要領（平成 24 年 8 月）

SATREPS	「排水路レベルでの水と塩の動きを解明する」「農民グループ間の水配分の実態を明らかにする」など、個々の研究目標（研究項目）が「Expected Output（活動）2」として位置づけられている。	「水管理の合理化の方策が提示される」「圃場の塩害防止の方策が提示される」など、個々の研究目標（研究項目）を複数束ねた多少上位に位置する研究目標が「成果」として位置づけられている。	「水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策を示す」と、各研究項目に取り組んだ結果を総合的に分析・考察する研究目標が「プロジェクト目標」として位置づけられている。	Expected Output という個々の研究成果はプロジェクト目標達成に直接貢献するが、両者の関係は直線的にはならず、個々の成果が重層的に体系立てられ、総合的に考察されることでプロジェクト目標が達成される。

出所：エジプト「ナイル流域における食糧・燃料の持続的生産プロジェクト」中間レビュー調査 報告書

２－２　評価設問と必要なデータ・評価指標

評価設問は、プロジェクト目標と直接関連する「研究成果を反映させた農業生産の効率化と持続性の確保を実現するための方策を示す」とする。詳細の評価の設問･必要なデータ・評価指標は評価グリッドに示した（付属資料 2 を参照）とおり。

２－３　終了時評価調査の手順

本終了時評価調査のデータ収集･分析方法を以下のとおり、終了時評価調査の手順として示す。資料のレビュー、関係者への質問票とインタビュー、現地調査により収集したデータを基に、実施プロセス、達成度、評価 5 項目による分析･評価を行った。

(1) データ/情報収集：研究活動、農業セクターに関するデータ/情報を資料レビュー、関係者へのインタビュー/質問票調査、実地踏査を通して収集する。

(2) プロジェクト実績の確認：データ／情報収集、現地調査をとおしてプロジェクト活動の進捗を確認する。これらの結果を基に成果とプロジェクト目標の達成度を MP の評価指標に基づいて評価する。

(3) 実施プロセスの確認：プロジェクトの実施プロセス（実施体制、関係者間のコミュニケーション、技術移転状況等）を確認し、プロジェクト活動が計画どおりに実施されているかを確認する。加えて、プロジェクトの実施プロセス等に影響を及ぼしている促進要因、阻害要因を特定する。

(4) 評価 5 項目（妥当性、有効性、効率性、インパクト、持続性）による案件の評価：プロジェクトの実績と実施プロセスを基に、評価 5 項目に基づく分析及び評価を行う。（それぞれの定義は 7 ページの表を参照）

評価５項目の定義　（中間レビュー時に採用した定義）

1）妥当性	プロジェクトのめざす効果（プロジェクト目標）が受益者のニーズに合致しているか、エジプト・日本の政策と整合性をもっているか、プロジェクトのデザインは効果発現の手段として適切か、という観点から検討する。
2）有効性	各研究項目が産出している研究成果は、プロジェクト目標達成に資する知見となっているか、または、達成に向け重要な示唆を与えているか、という観点から検討する。
3）効率性	投入は着実に研究成果の産出に結びついているか、投入のタイミング・質・量は妥当であったか、という観点から検討する。
4）インパクト	プロジェクトが実施されたことにより生じる波及効果について、当初予期しなかった効果も含め検討する。
5）持続性	プロジェクト終了後、研究実施過程で用いられた機材・方法論及び研究成果がエジプト側研究者によって維持・利用されていく見込みはあるかという点について、政策・制度・組織･財政・技術的な観点から検討する。

（5）提言・教訓の策定：プロジェクトの評価結果から提言･教訓を策定する。

２－４　評価調査の制約・限界

評価対象プロジェクトでは、PDM を作成する替わりに MP を作成しており、評価にあたっては以下の制約・限界が生じた。MP は成果（アウトプット）→プロジェクト目標→上位目標のログフレームが設定されているが、成果の達成に関連する各研究活動は Expected Output で設定されているとおり 4 研究グループ（水・塩収支、水管理、土壌の肥沃性、食糧・燃料作物生産）の研究活動として実施されている。Expected Output の各研究グループ下の研究活動が MP の各成果（アウトプット）に必ずしも結びついていないため、各研究グループの研究活動の成果が MP の各成果の達成に結びつかない場合があった。

- 各研究項目（活動）が成果（アウトプット）に直線的に結びついていない（研究項目が明確に一つの成果に付属していない）
- 上位目標に対する指標が設定されていないため、上位目標の達成見込みは、定性的な評価にとどまった。
- 上位目標達成にはプロジェクト目標の達成以外にも論理的に不確実な要因があり、本終了時評価調査では、上位目標の達成見込みは、定性的な評価に頼ることとなった。

第３章　プロジェクトの実績と実施のプロセス

３－１　投入実績

３－１－１　日本側

（1）専門家の派遣

筑波大学、鳥取大学、東京大学、三重大学から合計で 18 名[3]の専門家（短期派遣の研究員で派遣分野は、プロジェクトマネジャー、水・塩収支、水管理、土壌、作物生産及びバイオエネルギー）、及び 3 名の長期専門家（業務調整）がプロジェクト開始の 2009 年 6 月 9 日以来派遣されている。長期専門家、短期専門家の人月（Man Month。以下「MM」という。）はそれぞれ 64.57MM、95.50MM であった。本プロジェクトは、長期専門家として業務調整員を派遣して日々の業務管理・調整にあたり、特定の専門性を有した研究者が短期専門家として派遣され、CU、ARC、NWRC の研究者と共同研究を実施するとともに研究スキルの技術移転を行った。派遣専門家のリストは付属資料 2 の Annex3 のとおり。

（2）機材の供与

プロジェクト活動に必要な機材が供与機材として供与され、その総額は 1 億 2,663 万 8,011 円及び 151 万 7,463 エジプトポンド（Egyptian Pound。以下「EGP」という。）であった。供与機材の詳細は付属資料 2 の Annex3 のとおり。日本円での合計は、1 億 4,712 万 3,762 円[4]となる。

（3）在外事業強化費の負担

付属資料 2 の Annex4 のとおり、日本側の在外事業強化費の負担額は、482 万 7,730.73 EGP であり、在外事業強化費から支出された。日本円では 6,620 万 55 円[5]となる。

（4）本邦研修

合計で 21 名の研修員が選定され、日本の筑波大学が主催する本邦研修に参加した。その内容としては、キックオフミーティングへの参加、水･塩収支、土壌、家畜、バイオ燃料、作物等の実験･研究であった。エジプト側の参加者の詳細は付属資料 2 の Annex4 の「4. Training in Japan」のとおり。

３－１－２　エジプト側の投入

（1）カウンターパート（C/P）の配置

付属資料 2 の Annex4 のとおり、合計で 73 名の C/P を配置した。現在は、15 名の研究者が C/P としてプロジェクト活動に従事している。

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[3] 専門家に加えて、筑波大学から 32 名の学生が JST の予算で派遣され、データ収集、情報収集等の現地での業務を行うとともに、自身の研究に取り組んだ。

[4] 適用為替レートは、プロジェクトチームが業務費換算の際に適用している為替レートを使用し計算した。2014 年度分は 14 円/EGP とした。

[5] 適用為替レートは、13.5 円/EGP とした。この値は、プロジェクトチームが業務費換算の際に適用している為替レートを単純平均して適用した。

（2）施設と機材の提供

エジプト側から供与された施設と機材は、CU、ARC 等における事務設備、事務スペース等である。詳細は、付属資料 2 の Annex4 のとおり。

（3）業務費の負担

C/P 機関は、一部の業務費を負担している。具体的には、CU はプロジェクトの運転手の基本給を負担しており、水管理研究所（Water Management Research Institute。以下「WMRI」という。）はザンカロン実験圃場の実験にかかる経費を予定どおりの予算に基づいて負担し、ARC は 2013 年の夏期からサハ実験圃場の研究経費を負担している。2010～2014 年の間の WMRI のザンカロン実験圃場の実験にかかる経費の負担額の合計は 15 万 1,936 EGP であった。それ以外の負担額の金額は不明である。

エジプト側の業務費の負担金額の詳細は、付属資料 2 の Annex4 及び「4. Cost Sharing from WMRI」のとおり。

３－２　成果（アウトプット）の達成度

３－２－１　成果 1

成果 1：ナイルデルタの各種条件下での水及び塩の収支に係る諸条件が明らかになる。

指標ごとの達成状況は以下のとおり。終了時評価時点で成果 1 の指標は以下のとおり達成されており成果 1 は達成されたと評価された。

指標	これまでに得られた主な知見・成果
（メスカレベル） （指標 1-1）長期間断灌漑が行われている試験圃場において、蒸散量及び蒸発量の変化が定量化される	長期間断については、ET 量を測定した結果、この方法が必ずしも大きな節水効果をもたないことが判明した。またほかに有力な節水方法を見いだしたことから、本指標自体が意味を失った。他方で、長期間断灌漑に替わる細溝灌漑、ドリップ灌漑等が提唱され、それらの方法について、ET が量的に明らかにされた。
（メスカレベル） （指標 1-2）節水栽培と慣行栽培における水利用効率（単位灌水量当たりの作物収量）が定量的に比較される	グループ 4（食糧・燃料作物生産）の活動として実施された。節水効果をメイズの単位水量当たりの収量増加効果として測定し、慣行栽培と比較して細溝灌漑で 33％の増加、ドリップ灌漑で 181％の収量の増加が示された。

（メスカレベル） （指標 1-3）Casualina 及び Eucalyptus の防風林における間隙率と ET 量減少との関係が定量化される。	デルタ内の防風林の空隙率を 14 カ所で評価したところ、41～53%（平均 47%）と比較的均一であった。そのため異なる間隙率の防風林について蒸発散量を検討することの意味は小さいと判断され、実施しなかった。Al Krakat（間隙率 44%）にて ET 量を測定した結果、樹高の 10 倍の平面距離に対して、ET が 22%減少されることが示された。
（水路・デルタレベル） （指標 1-4）パイロット用水・排水路において水塩動態モデルが構築され、デルタ全域に適用される	パイロット用排水路地区における水、塩動態としては、以下の段階を経て変化することが示された。①灌漑用水の地表排水と地下排水への分離、②地下排水における ET による溶存物質（TDS）の濃縮、③地表排水による希釈、④排水路からの反復利用による再灌漑と再流出、⑤それによる再濃縮の構造。灌漑用水の EC（平均 0.4 dS/m）が ET による濃縮で暗渠排水は 3 倍の 1.2 dS/m に、その後表面排水（漏水を含む）による希釈で 1.0 dS/m になり、支線排水路の下流で、反復利用地区からの排水（3.5 dS/m）によって 1.3 dS/m になる。幹線排水路はこの地点で 1.2～1.3 dS/m である。1 回目の濃縮排水と希釈、排水の反復利用地区の濃縮排水による EC 上昇を示すモデルとなった。 ただし、デルタ全体へのモデル適用は、活動計画の変更により行われなかった。

３－２－２　成果 2

成果 2 : 用水路レベルでの水配分及び水管理の合理化の方策が提示される。

間断通水による取水時期の制限がある地区と、常時取水可能な水路近傍では、農家の行動（水田地帯と畑作地帯の差などを含め）が異なることが示された。その結果に基づき、節水の実施方法として、通水時間は現状のままとして水量を減らす方法と、水量を現状のままとして通水時間を減らす方法が示され、前者は下流部メスカに主に影響し、後者は相対的通水能力の小さいマルワ・メスカに主に影響することが示された。また、支線用水路における反復利用の実施については、節水が下流部における排水再利用の頻度を上昇させるのに対して、上流部ではまったく影響がなく、影響が下流部に集中することが明らかにされた。この分析結果に基づき、本プロジェクトは幹線水路の上流部においても排水の反復利用を導入することを提案した。

指標ごとの達成状況は以下のとおり。終了時評価時点で成果 2 の指標は以下のとおり達成されており成果 2 は達成されたと評価された。

指標	これまでに得られた主な知見・成果
（メスカレベル） （指標 2-1）パイロットメスカ・マルワにおいて、水位変化及びポンプによる取水頻度・取水量のモニタリングデータが解析される	パイロット地区における、モニタリング結果を解析し、間断通水による取水時期の制限がある地区と、水路近傍、下流部など常時取水が可能な地区での農家行動（水田地帯と畑作地帯の差などを含め）が異なることが示された。
（メスカレベル） （指標 2-2）マルワの水位変化と、マルワの規模・農家数・農地面積の相互関係に係る論理が構築される	ポンプ能力を灌漑面積で除した「相対的取水能力」という概念が提唱され、それとメスカの水位変化（通水時間と、上下流等で異なる取水可能時間）の二つが関係して農家の取水能力が決定されるという論理構造を提示した。これは、用水路の上下流関係とともに、用水管理を規定する以下の二つのファクターであることを示している。①節水の方法として、通水日数を現行のままで通水量を減少させる場合は、主に影響を受けるのは下流部である、②通水日数を減少させる場合には、相対的取水能力の小さい地区が主に影響を受ける
（メスカレベル） （指標 2-3）パイロットメスカ・マルワにおいて、個別ポンプ及び共同ポンプについて、供給水当たりの燃費が比較される	個別ポンプと共同ポンプの燃費差については、理論的考察と聞き取りを進めた結果、大きな差はないものと判断されたので、具体的計測は行わなかった。
（メスカ・水路・デルタレベル） （指標 2-4）上の解明を前提に、水配分削減の方法による影響発現の仕方の違いが示される	節水の実施方法として考えられる二つの方法、①通水時間は現状のままとして水量を減らす方法と、②水量を現状のままとして通水時間を減らす方法について、前者は下流部メスカに主に影響し、後者は相対的通水能力の小さいマルワ・メスカに主に影響することを示した。また、支線用水路における反復利用の実施については、水配分の削減による節水が、下流部における排水の反復利用の頻度を上昇させるのに対して、上流部ではまったく影響がなく、影響が下流部に集中することを明らかにした。

３－２－３　成果 3

成果 3：圃場の塩害防止の方策が提示される。

ナイルデルタにおける塩類集積の現状についてのデータから、①全体としてデルタ上流から下流に向かって塩類集積が進行していること、②上流部であっても、スポット的に集積土壌が存在することを見いだすとともに、その結果が取水管理上の有利不利、排水の反復利用に関係していることが示された。本プロジェクトはそのような塩集積は、塩を含む用水の使用が原因

であることを示した。また、稲作は有効な除塩効果があることを検証するとともに、耐塩性の強い作物の選定が有効であることを提示した。

指標ごとの達成状況は以下のとおり。終了時評価時点で成果3の指標は以下のとおり達成されており成果3は達成されたと評価された。

指標	これまでに得られた主な知見・成果
（メスカ・水路レベル） （指標 3-1）デルタ中央部の水田及び畑地における塩類集積の空間的分布と集積塩類の特徴が示される	デルタにおける塩類集積の現状について資料を入手し、①全体としてデルタ上流から下流に向かって塩類集積が進行していること、②上流部であっても、スポット的に集積土壌が存在すること、を見いだした。それが、取水管理上の有利不利、排水の反復利用に関係していることを示した。土壌の塩類集積（土壌EC）が、使用する用水の EC 値と線型関係にあることからそれが示され、また下流部の塩類集積が「海水の浸入」を説明理由にすることなく、灌漑水利用の水質で説明できることを示した。
（メスカ・水路レベル） （指標 3-2）試験圃場において、暗渠排水の水位変化・流量変化・EC 値が示される	サハ実験圃場では吸水渠間の地下水位が測定され、地下水位は灌漑後に深さ 0.7m 程度まで上昇し、その後 2 週間程度で地下 1.3m 程度まで低下するという動きを確認した。また、吸水渠からの排水量は灌漑もしくは降雨ののち､3 日程度で急減することが明らかとなった。水平方向の地下水面の勾配は小さく、根群域の土壌塩分蓄積量の水平分布は比較的均一で、吸水渠の中間といった離れた位置でも除塩効果が発揮されていることが確認された。 パイロット圃場において、暗渠排水の流量は、夏期は 2 ㎜/d、冬期は 1 ㎜/d を基底流量とし、灌漑が行われた直後に一時的に流量が増加すること、EC については流量と直接的関係をもたず、全体として安定的（1.2 dS/m 程度）であるという構造を示した。
（メスカ・水路レベル） （指標 3-3）上記数値に基づく暗渠排水の改善方法が提案される	暗渠排水施設の機能について、実態調査に併せて、受益農家、技術スタッフに対してアンケート調査を実施し、施設の効果が比較的高く評価されていることを確認した。一方で、敷設後 14～30 年を経過しており、維持・修復・更新等の老朽化対策が今後の課題として残り、施設の監視と維持管理の充実の必要性を認識した。暗渠排水施設の管理に関して最も深刻な問題は、幹線排水路の水位が極端に高い（受益農地標高－幹線排水路水位＜2.5m）ことと作付けパターン・ローテーションの設定に一貫性がないことであり、このことにより暗渠排水施設本来の機能が発揮されず、かつ栽培作物の生育が阻害されていることが示された。

（メスカ・水路レベル） （指標 3-4）デルタ土壌の水・塩分・重金属等の移動特性を表すパラメーターが特定される	デルタ土壌の水及び溶質移動特性を測定した。これにより作物のストレス応答特性が分かれば数値予測が可能となった。終了時評価時点において作物のストレス応答特性はデータ解析中である。
（メスカ・水路レベル） （指標 3-5）試験圃場において、畑地が水田に転換された際の、水田耕作前後における塩分集積の比較値が示される	15 地点の現地調査からは、水田耕作の土壌塩類低下の優位なデータは得られなかったが、サハ実験圃場における水田をメイズ畑作圃場と比較した結果、相対的に塩類の上昇を抑制する効果が認められた。ただし、冬作後と夏作後で一定の傾向をもち、夏作後の土壌塩類が高くなるという季節変化をもつことが示された。
（メスカ・水路レベル） （指標 3-6）排水を再利用した灌漑を行っている試験圃場において、カルシウム施用（Gypsum）及び籾殻鋤き込みによる土壌改良度（透水性、土壌物理性）が定量化される	カルシウム（Ca）、籾殻の施用による土壌物理性の改良について、室内カラム実験と圃場実験を行った結果から、土壌の水分含量、土壌 pH 及び土壌 EC、水溶性 Na 量などについて、統計学的に有意な施用効果は認められなかったが、1ha 当たり 20 t の籾殻施用を行った場合、大間隙の形成と緩衝能の増大によって土壌 EC を低下させる効果があることが確認された。また、砂含量については、灌漑水の EC が 1.5 dS/m 以上でも砂含量が 50%程度であれば EC 上昇が抑えられることを現地調査から確認した。
（デルタレベル） （指標 3-7）上記パラメーターに基づくシミュレーションモデルが試験圃場で構築され、同じ土壌条件下の地域で適用される	デルタ土壌の水及び溶質移動特性のばらつきの大きさは把握されていないものの、ザンカロンとサハの両実験圃場における違いが大きくないことから、他の地域にもおおむね適用可能と考えている。重金属については吸着特性の測定が行えなかったことから数値予測は困難である。数値モデル WASH_2D については、畝形状に未対応であり、畝間灌漑は一次元で近似するか、畝間灌漑以外のケースについてのみ数値予測を行うことを検討している。

３－２－４　成果４

成果４：適切な作物選択がなされ、圃場レベルの灌漑方法の改善手法が提示される。

導入の容易さと節水効果の観点から、将来的に有力な灌漑方法として細溝灌漑が提言された。細溝灌漑は節水効果に加え収量増の面からも有利であることが示された。他方で細溝灌漑に適用可能作物と対象外作物が存在するので、後者については、提言された節水、根群域排水不良の回避という二つの原則に基づく今後の技術開発が期待される。また、作付けパターンについては、稲作不適地、あるいは、稲作が現在禁止されている地域における農家の作付け意思決定を分析する場合には、数年に1回の稲作導入を含め、将来の水管理に関するさまざまなオプションが議論できる可能性があることが判明した。

成果4の上記の記述及び以下に示された指標の達成状況により、終了時評価時点で成果4はほ

ぼ達成されたが、燃料作物の異なる灌漑水量、栽植密度における生産量の比較による各作物の最適灌漑水量、栽植密度の分析については、2013、2014年のデータを基に本プロジェクト終了までに解析作業を完了する必要がある。

指標	これまでに得られた主な知見・成果
（実験室レベル） （指標 4-1）ポット苗栽培によって主要作物の耐塩性が定量化される	小麦、稲、トウモロコシの対塩性試験を実施し、各作物の各品種の各生育ステージにおける耐塩性に差異があることが判明した。
（メスカ･水路レベル） （指標 4-2）用水管理調査地区において年間の作付け体系（作目選択、播種時期・収穫時期）が示され、将来の水供給予測に対応する作付け体系が提案される	用水管理地区における年間作付けの計画表が作成された。しかし、将来の水管理については、デルタ全体への供給水量は減少させるものの、上流部における反復利用の強化によって、末端での水利用に大きな影響を及ぼさない方法を提示したので、将来の作目変化は当面考慮する必要性がなくなった。 ただし、本調査の対象エリアは稲作地帯であったため、基本的に夏作に水稲、冬作に小麦あるいはビートを選択するという農家の作付け意思決定が過半を占めていた。 よって、稲作不適地、あるいは、稲作が現在禁止されている地域における農家の作付け意思決定を分析する場合には、提唱されるように、数年に 1 回の稲作導入を含め、将来の水管理に関するさまざまなオプションが議論できる可能性がある。
（メスカ･水路レベル） （指標 4-3）試験圃場において、灌漑方式ごとの作物収量及び品質が比較される	将来の灌漑方法として細溝灌漑を中心とする方法が有力な灌漑方法として提言された。この方法には、適用可能作物と対象外作物が存在するので、後者については、提言された節水、根群域排水不良の回避という二つの原則に基づく今後の技術開発を待つことになる。 作物の品質については、テンサイについて実施され、ドリップ灌漑の糖含有率が高いことが明らかになった。他の作物については特に品質において問題になることは認められていない。
（メスカ･水路レベル） （指標 4-4）試験圃場において、灌漑方式ごとの稲藁・麦藁・トウモロコシ茎の飼料価が示され、より飼料価の高い飼料の生産方法が提案される	エジプトで栽培した作物（メイズ）の副産物（茎葉）の家畜による消化率が低いことがサハ実験圃場の栽培試験で再確認された。この消化率の低下は、高温と水分不足により起きることが環境調節下での試験によって明らかになった。また、点滴灌漑により栽培された作物（メイズ）の副産物が他の方式と比較した場合、繊維の消化率が更に低いが、この原因はエジプトの高温環境と点滴灌漑の乾燥環境によるものであることが示唆された。新たに提唱された新タイプの混作については、副産物及びマメ科牧草の成分分析及び消化試験が一部実施され、混作により得られた茎葉及び牧草を混合して作成された飼料の栄養価及び消化率が高まることが示されたことからエジプトの環境下で生ずる副産物の消化率の低下を改善できる可能性が示唆された。

（メスカ·水路レベル） （指標 4-5）灌水量・栽植密度の違いによる油料作物収量及び生育の違いが示され、適切な栽培方法が特定される	燃料作物について、5 種類の燃料作物〔ジャトロファ、ホホバ、キャスタービーン（ヒマ）、キャノーラ（ナタネ）、ヒマワリ〕の異なる灌漑水量、栽植密度における生産量の比較を行った。2012 年までのデータで各作物の最適灌漑水量、栽植密度が分析されたが、2013、2014 年のデータを基に解析作業を行っており、プロジェクト終了までに結果がでる予定である。 それ以前の結果によると、1 年生植物（ナタネ、ヒマワリ）の水生産性が高いことが判明している。

３－３　プロジェクト目標の達成度

プロジェクト目標：急激な人口増加に対応するナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策を示す。

成果の指標の達成状況から、プロジェクト終了までにプロジェクト目標は達成されている。また、プロジェクトは既に研究成果に基づくエジプト側に対する政策提言･研究提言案の策定をめざしており（付属資料3を参照）、プロジェクト終了までにエジプト政府関係機関からのコメントを踏まえ必要な修正を加えたうえで提言を策定し、エジプト政府に提出する予定である。2015年3月にエジプトと日本で開催予定の本プロジェクトのシンポジウムにおいて政策・研究提言を含めプロジェクトの成果を発表する予定である。

指標	達成状況
（指標 1）圃場レベルにおいて、現行方式を含め、異なる節水方法（灌漑方式・間作）による ET 量・作物収量の差異が比較される	灌漑方法として、慣行法（畝間灌漑など）、細溝灌漑、点滴灌漑、長期間断灌漑、マルチングを、対象作物として、①（夏作）コメ、メイズ、綿、②（冬作）小麦、テンサイ、ベルシーム（エジプシャンクローバー）、ソラマメを対象とし、これらの組み合わせについて、試験を行いながら節水に有力な方法を選定した。 ET の値は、基準 ET に対する係数 kc として表示され、慣行法で、コメ 1.30、小麦 1.07、テンサイ 0.75、メイズ 0.84 など、作物別の値が得られた。またメイズについては、灌漑法による比較で、細溝灌漑 0.57、長期間断灌漑 0.90、点滴灌漑 0.45 が得られた。 収量については、慣行法のメイズに対し、細溝灌漑で 27%、点滴灌漑で 55%の増収となり、また、テンサイの点滴灌漑では、糖収量として 33%の増収になった。以上の差異が明確にされるとともに、主要な作物に対する有力な灌漑法が抽出された。

（指標 2）マルワ・メスカレベルにおいて、異なる灌漑方法（水供給頻度）による農民の水管理行動と水の動態が解明され、節水的かつ適切な水管理方法が示される	①伝統的灌漑システムと灌漑改善（IIP）による改良システム、②水田地帯と畑作地帯、③水路の上流部と下流部という三つの区分けで分析が行われ、①農民の灌漑における協同行動のレベルが改良システムで上昇すること、②灌漑水量は畑作地帯では、利用可能水量と関係しないが、水田地帯では、取水可能水量が多いと多量に取水され、上下流の不平等が拡大することが明らかになった。そのうえ、下流域の農民は、①下流部は夜間灌漑、②汚染された排水の使用、③不足水を補うための地下水取水への支出などの不利益を被っていること、が明らかになった。これらのことから、水田地帯ではローテーション灌漑が適切で、非水田地帯には連続灌漑が適していることが結論された。
（指標 3）パイロット排水路/ナイルデルタレベルにおいて、用水反復利用の方法が示される	ナイルデルタの用排水分離の現状を確認し、排水の反復利用の方法として、幹線用水路の上流部からの排水の混合を提言した。各支線用水路において、現状は取水上不利な下流部において排水の反復利用がなされており、下流部の地域にその影響が集中し、上下流の農民間の不平等が拡大しており、水管理の安定性が損なう可能性があるため、反復利用による影響をより広範な地域で配分することを目的としている。
（指標 4）各レベルにおける節水方法・用水反復利用方法が比較検討され、最適な節水・作付けオプションとその節水効果が示される	圃場レベルでは、現実的に採用することができる灌漑方法として細溝灌漑が提唱され、収量に影響なく灌漑水量を 25%以上節減できることを示した。また、水路レベルでは、灌漑用水路の原水の EC が 0.4 dS/m 程度であるのに対して、暗渠排水と表面排水が流入する支線農業排水路では 1.0～1.2 dS/m 程度になることから、灌漑用水として地域に導入された水の 30～40%程度が排水されていることが判明した。その結果、排水の反復利用は現状で排水量の 20%以上が可能であることを示した。他方で、上下流の平等性等の視点から、幹線用水路の上流部から反復利用を組み入れることが適切との方法を示した。

提言の具体的内容は以下のとおり。

＜政策提言＞

1）幹線用水路のレベルにおいて、上流部から反復利用の導入

2）マルワ以下の水管理の改善への政府による積極的な関与

3）砂漠地域開発による水の地域的転用によるデルタ地域の損失を補てんするために、砂漠地域開発利益の一部のデルタにおける灌漑排水の改善への配分

＜研究提言＞

1）細溝灌漑における土壌の湿域の制御と管理、湛水（Waterlogging）防止方法の研究

2）点滴灌漑の経済調査

3）地域、土壌等の違いによる長期間断灌漑効果

4) 防風林による ET 抑制効果
5) 農閑期における土壌表面からの ET の抑制方法
6) 灌漑効率と土地生産性を高める間作（インタークロッピング）方法
7) 土壌の塩分管理のための水稲栽培の頻度を含む最適条件の調査
8) 排水の反復利用に係る土壌に対する最適配分（EC）の研究とその結果に基づく反復利用ガイドラインの策定

３－４　上位目標達成の見込み

上位目標：社会経済開発 5 カ年計画、NWRP 及び国家農業生産計画に記載されている農業生産の増大と雇用機会の拡大に貢献する。

エジプト側の関係機関、研究機関は上位目標に示されている課題の重要性を十分認識しており、プロジェクトが策定した政策・研究提言を含む対応策に対して前向きな姿勢を示している。しかしながら上位目標の達成度合いを現時点で評価することは時期尚早であるとともに、目標の達成に政策、研究提言が政策に反映され実行される以外に、農業生産の拡大と雇用機会の創出に必要な具体的な施策が実行される必要がある。

３－５　実施プロセスにおける特記事項

３－５－１　活動の進捗

プロジェクト実施初期段階において、コストシェア（エジプト側研究員の活動に係る経費負担等）に関する理解の相違が日本側とエジプト側の間に存在していたため、活動が円滑に進まず、計画よりも遅れがみられた。これに対して両者間で協議を重ねエジプト側の理解を得ることにより、遅れを最小限にとどめることができた。

プロジェクト活動は、2011、2013 年のエジプトにおける政治的混乱と 2011 年 3 月に日本で発生した東日本大震災の影響（日本側研究機関の被災）により中断を余儀なくされた。このような状況に対処するため、プロジェクトの実施期間を 2013 年 3 月に 2015 年 3 月まで 10 カ月延長されることが決定。また、2013 年 7 月以降の政治的混乱により 13 名の専門家の派遣が中止になった際には、その後日本側のプロジェクトマネジャーの集中的な派遣により活動への影響を最小限に抑えるように対応した。

プロジェクト実施初期における実験施設設置、特にサハ実験圃場において適切な点滴灌漑設備の設置の遅れが発生し、1 年（2010 年夏期～2011 年夏期）の間、同実験圃場では、有効な点滴灌漑の実験データを得ることができなかった。その後、点滴灌漑の施設を改修して、2011 年冬期には、小麦（従来灌漑及び長期間断灌漑）、2012 年夏期には、稲作（従来灌漑）とメイズ（細溝灌漑）、2012 年冬期には、テンサイ（従来灌漑及び細溝灌漑）、2013 年夏期には、稲作（長期間断灌漑）及びメイズ（点滴灌漑）の実験を行って節水灌漑比較等のための実験データを収集･分析を実施し、当初予定していた観測を完了することができた。

３－５－２　プロジェクトの実施体制

(1) プロジェクトチーム

プロジェクトは、1 名の長期専門家（業務調整）、各研究分野の短期専門家（短期研究員）、

5 名のプロジェクトアシスタントで構成された。アシスタントは、CU のプロジェクト事務所とともに実験圃場である、サハ圃場、ザンカロン圃場に配置された。

エジプト側は、3 研究機関から植物病理、社会学、水管理、水環境、農村開発、社会経済学等を専門とする研究者を配置した。彼らは担当の研究テーマごとに日本人専門家と協力して研究に従事した。

(2) 合同運営委員会（JSC）及びプロジェクト・マネジメント・ユニット（PMU）

本プロジェクトは、エジプト側研究機関が 3 機関（CU、ARC、NWRC）あるとともに、各機関から水管理、排水管理、作物栽培等の分野を扱う同機関傘下の複数の研究所から専門家が配置されたため、常に複数の研究機関間の連携、調整を図りながら、プロジェクトを運営、管理する必要があった。そのため合同運営委員会（Joint Steering Committee。以下「JSC」という。）、各研究グループ代表者から構成するプロジェクト・マネジメント・ユニット（Project Management Unit。以下「PMU」という。）といった会合を定期的に開催することにより、プロジェクト全体及び研究グループごとの進捗管理と関係者のコミュニケーションの強化を図った。これに加え、元 CU 農学部長の Dr. Samir A. Aboulroos をプロジェクトアドバイザーとして、またリソースパーソン（Executive）として Dr. Hisham Mustafa（WMRI 所長）、Dr. Mohamed Soliman（FCRI 所長）、Dr. Khaled Ali Abou Shady（Sakha Research Station の所長）を任命し、業務調整員が中心となって適宜、プロジェクトの進捗を報告し、問題点を共有する体制を取った。彼らは、プロジェクトの運営に積極的に関与し、問題が生じた際の対処を含め、プロジェクトの円滑な進捗に貢献した。

(3) 研究グループ

当初本プロジェクトは、水・塩収支（G1）、水管理（G2）、土壌の肥沃性（G3）、食糧・燃料作物生産（G4）及びバイオエネルギー（G5）の五つのグループで実施された。バイオエネルギー（G5）に関しては、2011 年 12 月に実施された第 4 回 JSC において、研究活動をグループ 2 とグループ 4 に統合することが了承された。その結果、本プロジェクトは四つの研究グループで実施されることとなった。各研究グループには日本側とエジプト側の双方からグループリーダーが指名され、各グループの研究の取りまとめを行うとともに、各研究グループには最低 1 名の日本人研究者と 1 名のエジプト人研究者が配置されて共同研究活動を行った。

３－５－３　コミュニケーション

(1) プロジェクト内部のコミュニケーション

プロジェクト内部における情報共有及び協議のために合計で 12 回の JSC と 20 回の PMU 会合が定期的に実施された。グループリーダーレベルの進捗確認のための会合である PMU 会合は当初 R/D に則り、毎月実施される予定であったが、実際には必要性に応じて実施され有効に機能した。加えて、2014 年 9 月 3、4 日の 2 日間にわたり、関係者からの意見聴取及びプロジェクト活動進捗発表を目的としてラウンドテーブル会合が開催され、関係機関から 95 名の関係者、研究者、専門家の出席があった。この会合はプロジェクトによる政策提言、研究提言の作成のきっかけとなった。

中間レビューで提言された英文の年次技術報告書については、2012 年 11 月及び 2014 年 7 月の 2 回作成され、本プロジェクトの内部で共有されている。これらの報告書は、研究活動の進捗共有及びプロジェクトの方向性を共有するのに有益であった。それらに加えて、最終報告書が、今後両者の間で作成、共有される予定である。

プロジェクト開始当初は、研修者間のデータ共有の仕方、研究に対する姿勢について日本側、エジプト側双方に理解の齟齬があったが、プロジェクト関係者間において、プロジェクトの主旨に基づく理解の共有をとる等の対応をとり円滑な共同研究の継続を図った。

その他日本側とエジプト側の間で大きなコミュニケーションにおける問題は発生しなかった。プロジェクトのアシスタントもコミュニケーションとプロジェクトの進捗に貢献したことが認められた。具体的には、専門家とエジプト側研究者への連絡の役割を担い、データ収集の補助、会議等の準備及び運営にも貢献した。

(2) 外部への発信

2012 年 7 月 16、17 日に本プロジェクトはカイロにて国際シンポジウム「Water management and agricultural production in Egypt. ~Present and Future~」を開催し、MWRI、農業省、エジプト日本科学技術大学（Egypt-Japan University of Science and Technology。以下「E-JUST」という。）、ICARDA、開発研究所（Institut de Recherche pour le Développement。以下「IRD」という。）（フランス）、カイロドイツ大学からの発表と討議が行われた。この場で、本プロジェクトは、共同研究の進捗に基づき、研究の問題意識であるナイル川の限られた水資源の有効活用について問題提起し、1) 砂漠開発による利益のデルタ整備への一部還元、2) デルタ内農家の平等化の考えに基づく「広域化した用水反復利用の強化」の考え方を提示し、今後の研究の方向性について出席者との議論を行った。

2013 年 3 月 18 日に本プロジェクトは茨城県つくば市で国際シンポジウム「エジプトの水と農業 －SATREPS のアプローチ－」を開催し、東京大学、朝日新聞社からの招待講演を含め 13 題の発表とパネルディスカッションが行われた。参加者は、英語でのシンポジウムであったにもかかわらず、大学、研究所、行政、民間企業、及び一般市民も含め 70 名の参加があった。

2015 年 3 月にはエジプト及び日本において、本プロジェクトの研究成果を発表することを目的にシンポジウムを開催する計画を進めている。

３－５－４　技術移転

日本側、エジプト側双方にとって共同実験の実施、現地調査を通した効果的な能力開発が図られた。エジプト側研究者にとって本邦研修が特に有益であったということを調査の結果として確認した。彼らは、日本における研修では、ET タワー、水流･溶質の移動の数値モデル、用水路における水量のモニタリングの技術を習得し、共同研究活動を通じた実践的な姿勢及び方法論を学んだ。

共同研究を通した具体的な技術移転は、まず第一に 2010 年 3 月に日本側、エジプト側双方による基本研究計画策定から開始された。各研究分野の詳細計画については、日本人専門家がエジプトに渡航した際にエジプト側と協議のうえ決定した。日本側研究者の現地滞在中は、エジプト側研究者が同行し、現地活動を通じた技術移転を行うとともに、次回渡航時までの作業

計画を決定・共有した。これらの経験を通して、エジプト側研究者は、研究計画から実施に至る研究活動のプロセスを日本人研究者とともに経験することができた。

また、日本側研究者の不在時には、エジプト側研究者の作業状況、活動報告をメール等の手段を使って日本側研究者にすることを徹底した。日本側研究者はその報告内容を確認し、必要に応じてメール、スカイプ、もしくは、プロジェクト事務所を通じて活動内容の追加・修正を提案した。

３－５－５　他のプロジェクトとの連携

本プロジェクトは、効率的な水管理の推進、ナイルデルタ地域における効率的な水管理に関連する実施中の他の JICA の技術協力プロジェクトとも連携した。特に SWMT 及びその前身案件である WHIP2 については、これらプロジェクト専門家が、本プロジェクトの JSC のメンバーとなるとともに、随時関係者間で意見交換を行い、双方のプロジェクト活動の共有がなされている。これらのプロジェクトは二次水路及び支線水路において、水利組合による効率的な水管理の実現をめざしているが、本プロジェクトの研究もナイルデルタ全体から圃場における水管理の現状分析、水管理の必要性、将来の水管理のあるべき姿を提示することを目的としており、技術協力プロジェクトの目的、活動の妥当性を、科学的根拠を基にエジプト側に提示できたことが評価されている。

第4章　評　価　結　果

４－１　評価５項目によるプロジェクトの評価

４－１－１　妥当性

本プロジェクトが研究の結果として提示する「ナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策」は、エジプトの開発計画、セクター開発戦略、またわが国の援助方針に合致しており妥当性は高い。

(1) エジプトの開発計画/戦略との整合性

第6次国家社会経済開発計画はエジプトの主たる開発計画であり、そのなかの長期農業開発戦略（2007年）において「開発の持続と環境保全のための配分と資源の活用の経済効率性の実現を通した毎年 3.9%の農業生産の増加」が第一の戦略的目標として掲げられている。また、2006年10月に策定されたNWRP（2006～2017年）は追加的な新たな水資源の開発、既存の水資源のより有効な活用、健康と環境の保護の三つの柱からなっており、本プロジェクトのめざす、効率的な水管理を通した持続的な農業生産は、同計画の記述[6]からもエジプトにとって優先度の高い課題ととらえられている。

また、エジプト政府は、国家農業生産計画（Sustainable Agricultural Development Strategy towards 2030）を策定しており、第一の戦略目的として農業資源の持続的な利用を掲げている。

(2) 日本の開発援助政策との整合性

わが国の対エジプト援助重点分野「貧困削減と生活水準の向上」のなかの開発課題「農業・農村開発」の下に位置づけられる「ナイルデルタ等の水利用・農業生産の効率化、小農の所得向上支援」プログラムにおいて、ナイルデルタ地域では、特に水利用効率化を重点的に進め、効率的な水配分、水路の水質・環境改善、排水再利用を総合的に推進するとされており、本プロジェクトは同方針に合致している。

(3) 日本の技術の優位性

わが国では、江戸時代からの水管理の歴史、経験を有しており、筑波大学が実施した本邦研修で研修内容としても、その長い歴史のなかで培われた知見が活用された。また、日本側研究者がデータの取り方、研究に対する態度（研究者が直接現場に赴き調査を実施する）などをエジプト側が理解できるようにしながら、共同研究、技術移転を図った結果、日本の研究実施プロセス、研究実施への態度に対して高い評価を得た。

また、日本で一般的に活用されている測定機材等を本プロジェクトでは導入した。具体的には、超音波ドップラー流速計（Acoustic Doppler Current Profiler。以下「ADCP」という。）、時間領域反射測定（Time Domain Reflectmetry。以下「TDR」という。）装置、ETタワー（発散量を連続的に測定･記録できる装置で、連続的なET量の変化の測定が可能）と

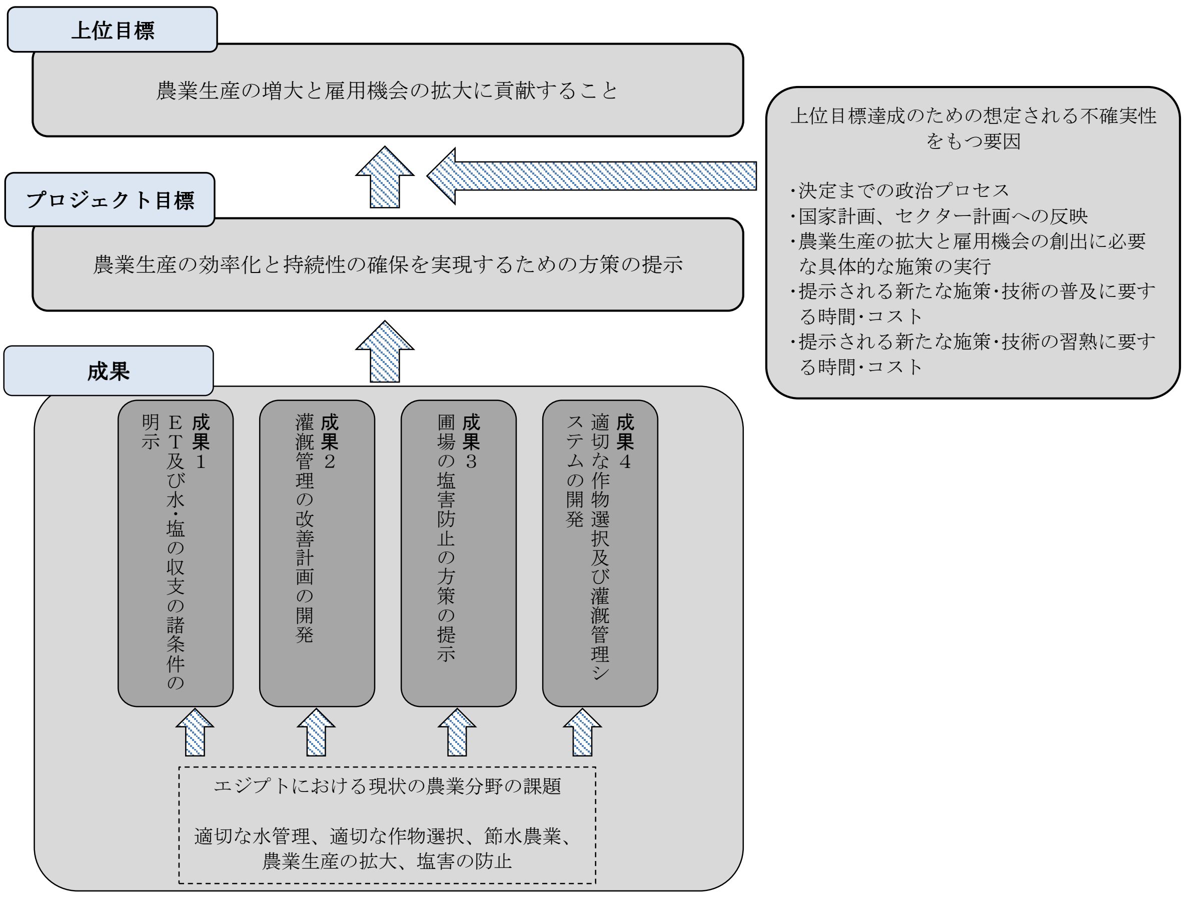
[6] 本計画の冒頭部分に記載のあるとおり、”Integrated Water Resources Management approach”により策定されたものである。農業分野に関しては、”The objective of water resources management is to support the socio-economic activities of the country, taking into account the sustainability of the natural system.”及び "Improvement of water use efficiency both in- and outside the Nile system will largely depend on the efficient use of water in agriculture. ”と記載されている。

いった、エジプトでは初めて導入された機材･新しい機材の導入及び操作を経験し、それらの機材を活用して研究に必要な測定、データ取得を実施することができるようになった。また、稲作に関する知識や経験においては、日本に優位性があり、エジプト側の期待も高かった。

４－１－２　有効性

本プロジェクトの有効性は高いと評価できる。

「３－３　プロジェクト目標の達成度」のとおり、プロジェクト終了までにプロジェクト目標は達成される見込みである。各成果の達成度は「３－２　成果（アウトプット）の達成度」のとおり満足いくレベルに達されており、また各成果（1）ET 及び水･塩の収支の諸条件の明示、(2) 灌漑管理の計画の改善、(3) 圃場の塩害防止の方策の提示、(4) 適切な作物選択及び灌漑管理システムの開発は、プロジェクト目標である「農業生産の効率化と持続性の確保を実現するための方策を示す」ために必要な要件であることから、成果 1～4 とプロジェクト目標の間の論理関係が成り立っている。成果、プロジェクト目標、上位目標の間の論理関係は下図のとおり。



成果、プロジェクト目標、上位目標の間の論理関係（調査団作成）

４－１－３　効率性

本プロジェクトの効率性は中程度と評価できる。

日本側の投入（専門家派遣、供与機材、在外事業強化費、本邦研修）は、各研究分野に対して必要な質、量（数）、及びタイミングで投入されておりおおむね適切であったと判断された。長期専門家（業務調整員）は、専門分野ごとに短期の専門家が研究活動を実施するなかで、プロジェクト全般の調整･管理、エジプト側研究機関間の調整等、円滑なプロジェクトの運営管理に貢献した。研究内容に係る密なコミュニケーションをエジプト側と図るために、中間レビュー時に提言された日本側研究者の長期派遣については実現できなかったが、2013 年以降日本側の研究代表（プロジェクトマネジャー）の派遣期間を延長することで対応し、エジプト側との円滑な調整を図った。

供与機材については、大部分が効果的に活用されているが、本プロジェクト終了に際して、研究機関間での移行手続き中のため、調査時は一部活用されていないものがあった。具体的には、供与機材はエジプト側実施機関の代表である CU に供与されたが、実際の研究活動においては、研究分野により、他の 2 研究機関にも配置されて活用されていた。プロジェクト終了後のこれら研究機関間の機材の配置に必要な手続きが完了しておらず、必要な手続きがプロジェクト終了までに完了する必要がある。なお、遠隔地に備え付けられた研究機器･機材の幾つかが、一時的に不安定な治安状況の影響（盗難等）で適切に機能せず、水量及び EC 値の測定に支障を来たす事象が発生した。

エジプト側の投入について、各研究分野の研究員はおおむね適切に配置されたが、研究員の頻繁な交代がプロジェクトの円滑な進捗に負の影響を与えた。73 名の研究員が配置されたが、現在は 15 名の研究員がプロジェクトに従事している。

灌漑用水の水質の土壌環境に与える影響を観測するためにアブシャン及びバハル・エル・ヌール地区を研究サイトとして選定した。バハル・エル・ヌールは過去に JICA の技術協力プロジェクトが支援、改良した地域であり、同地域を選定したことにより、既存のデータや知見を活用することが可能となり、プロジェクトの効率性に貢献した。

本プロジェクトは複数の研究機関（CU、ARC、NWRC）が連携して共同研究を実施したエジプトで初めてのケースであった。そのためプロジェクトの運営・管理には研究機関間の調整が不可欠であり、それに予想以上の労力と時間を費やした。

貢献要因･阻害要因は以下のとおり。

［貢献要因］

・過去の技術協力プロジェクトが支援、改良した地域を研究のサイトとして選定することによる効率的な研究活動の実施

［阻害要因］

・研究機材の盗難が発生したことによる観測活動の進捗への影響

・エジプト側研究員の頻繁な交代

４－１－４　インパクト

本プロジェクトのインパクトはおおむね高いと評価される。

本案件で設定されている上位目標である「社会経済開発 5 カ年計画、NWRP 及び国家農業生産計画に記載されている農業生産の増大と雇用機会の拡大に貢献する」は多分に長期的な目標

であるとともに、本プロジェクトによる貢献以外の要因も含めて達成される広範な性格のものであるため不確定要素[7]が多い。そのため、上位目標の達成は、本プロジェクトの目標が達成され、持続すること以外の要素にも影響を受けるものと考えられる。そのため事後評価も含め、上位目標は本プロジェクトにより達成される目標として評価の対象とすることは必ずしも適当ではない。

他方で、本プロジェクト実施により以下の正のインパクトが認められた。提言策定については、当初より計画された成果ではないことから、インパクトにも含めた。

- 研究成果を踏まえたエジプト政府に対する政策、研究提言がプロジェクト終了までに策定される予定であり、今後の水資源計画や開発計画等に反映され研究成果が具現化されることが期待される。
- プロジェクトで導入した ET システムによる Eddy Correlation（渦相関）について、エジプト側の研究代表である Dr. Rushidi El-Kilani の下、2 名の CU 農学部の大学院生が修士論文に着手している。また CU 農学部のカリキュラムに ET システムによる Eddy Correlation が追加された。
- 研究成果を基に書籍「Irrigated Agriculture in Egypt－Past, present and future（2015 年 1 月時点での仮の表題）」を出版予定であり、本プロジェクトによる研究成果が農業分野及び他の関連分野に従事する人々にも広く一般に発信されることとなる。書籍は、歴史的開発、研究成果を基にした農業の現状、資源開発の問題点といった項目から構成される予定である。
- プロジェクト実施期間中にジャーナル 10 回、学会発表 6 回、口述発表 49 回、ポスタープレゼンテーション 12 回が実施され、研究成果を外部に発信した。
- 科学的な根拠に基づく水管理に係る当該分野の知見が他の実施中の技術協力プロジェクト SWMT に提供され、プロジェクトの推進に貢献した。
- 本プロジェクトで有効性が確認された細溝灌漑及び間作技術について、実施中の技術協力プロジェクト「小規模農家の市場志向型農業改善プロジェクト」が関心を示しており、同プロジェクトによる試験圃場での試行が今後検討される予定である。
- 本プロジェクトの実施により、エジプトの研究機関に科学的根拠に基づく意思決定システムが導入されつつある。

なお、負のインパクトは観察されていない。

４－１－５　持続性

本プロジェクトの持続性は中程度と評価できる。政策面、組織面、財政面、技術面に分けて記述する。

（1）政策面

上述の「妥当性」のとおり、本プロジェクトが研究対象とする水・塩収支、水管理、塩

[7] 決定までの政治プロセス、国家計画、セクター計画への反映、農業生産の拡大と雇用機会の創出に必要な具体的な施策の実行、提示される新たな施策･技術の普及に要する時間･コスト、提示される新たな施策･技術の習熟に要する時間･コスト等が挙げられる。また、農業生産の増大、雇用機会の拡大は農業分野の水利用の高度化、農業生産の効率化以外の要因（農業技術、雇用政策、他産業の政策や発展状況等）（22ページの図参照）が挙げられる。

害防止、適切な食物選択及び灌漑方法の改善手法に関する研究結果に基づく実際の適用はエジプト政府の政策に合致しており、政策面の持続性は高い。

（2）組織面

CU、ARC、NWRC による共同研究実施体制は確立されたが、プロジェクト実施中も共同研究体制の構築と維持には労力を要し、プロジェクト後もこの共同研究体制が維持されるかは不透明であるため、組織面の持続性は中程度である。

（3）財政面

本プロジェクト開始当初、運営費に係るエジプト側の負担がなされないことが問題となったが、その後交通費、現地調査やデータ収集に必要な経費を一部負担した（WMRI は 2010～2014 年の間、ザンカロンの実験圃場における運営費を合計 15 万 1,936EGP 負担した）ことから、将来、研究活動を継続するために必要となる一定の経費は確保されると思われる。他方で、本プロジェクトで供与した機材の維持管理費については新たに予算を措置する必要があるため、財政面の持続性は中程度である。

（4）技術面

本プロジェクトの研究成果は政策提言、研究提言によりエジプト国内で広く共有される予定である。他方で研究機関内における、本プロジェクトにより習得した技術、分析技術、機材の管理方法等について、プロジェクトに参加していなかった研究者に対する研究者への共有は限定的であった。また、エジプト側は機材の運用及び維持管理に必要な人員及び予算措置を講じる必要がある。そのため技術面の持続性は中程度である。

なお、中間レビューで指摘のあった ET システムの仕組み、維持管理についての知識・技術をもったエジプト側研究者の養成については、本邦における研修及び 2014 年 11 月にエジプトで実施した研修により対応した。

４－２　結　論

本プロジェクトは終了時評価時点においておおむね円滑に実施されており、高い妥当性、有効性、インパクト、中程度の効率性、持続性がみられたと評価された。またプロジェクト目標は各成果の満足できる達成度により、プロジェクト終了時点において達成されるものと評価される。そのため、本評価団は本プロジェクトを予定どおり 2015 年 3 月で終了することが適当であると結論づけられた。

第５章　提言と教訓

５－１　提　言

５－１－１　プロジェクト終了までにプロジェクトが対応すべき事項

（1）完了していない活動の実施

指標についてはおおむね達成しているが、一部終了していない研究活動についてプロジェクト実施期間内に終了させる必要がある。具体的には、成果 4 における 2013、2014 年のデータを基にした燃料作物 5 種類の最適灌漑水量、栽植密度の分析作業をプロジェクト終了までに完了させることが必要である。

（2）政策、研究提言の策定と提出

研究成果を基に政策提言、研究提言を策定中である。プロジェクト終了までに、エジプト側関係機関との協議を踏まえて提言を完成させ、エジプト側関係機関に提出することが必要である。

（3）供与機材の適切な配置に必要な手続きの実施

プロジェクトが供与した研究機材について、使用用途を踏まえた適切な研究機関への配置に必要な手続き（現状すべての機材がエジプト側研究代表機関である CU に登録されているため、他機関で使用される機材について所有権の移転及び登録手続きを行うもの）を完了させることが必要である。

５－１－２　プロジェクト終了後にエジプト側が対応することが期待される事項

（1）政策、研究提言の政策への反映

・MWRI はプロジェクトが策定する政策提言をエジプトの新たな開発計画、セクターの開発戦略に反映させるために必要な検討、手続きを実施することが必要である。

・CU、ARC、NWRC はプロジェクトが提案した研究提言を研究計画・戦略に反映させ研究を実施に移す検討、手続きを実施することが必要である。

（2）研究の継続

CU、ARC、NWRC は更に精緻かつ統計的にも有効なデータを収集し解析を可能にするために、フィールドにおける実験を継続することが必要である。

（3）機材管理体制の強化

CU、ARC、NWRC は機材の運営管理を担当する職員を任命するとともに十分な予算を確保することが必要である。また、研究機関内においても機材を必要とする研究サイトにおいて機材が活用できる措置を取ることが必要である。

（4）研究成果の発信

CU、ARC、NWRC は、論文、ジャーナル、学会発表等により可能な限り本プロジェクトの研究成果を外部に発表することが必要である。このような成果の外部への発表に関し

ては3機関が協調して実施することが必要である。

５－１－３　プロジェクト終了後に日本側が対応することが期待される事項

(1) エジプトと日本の研究機関間の連携の継続

エジプト側の研究機関／研究者が研究を継続するにあたり、日本側研究機関／研究者が可能な限り必要な支援を継続することが期待される。

５－２　教　訓

1) 本プロジェクトは、3 研究機関（CU、ARC、NWRC）をエジプト側実施機関として実施されたため、実施機関間の調整に多大な労力を要した。効率的なプロジェクト運営管理のために、日本人専門家（研究者）の長期派遣、エジプト側 3 研究機関からプロジェクト調整員を配置しプロジェクトの調整を図る仕組みを構築するなどの対応が有効であったと思われる。

2) 本プロジェクトが扱う課題は広範な研究分野にわたっており、また研究成果を基に政策への提言を行うにあたり、大学と関係省庁（農業土地開拓省、MWRI）傘下の研究2機関が連携して共同研究を実施することは有効であった。エジプトにおいて複数の研究機関が同等な立場で連携して共同研究を実施したのは本プロジェクトが初めてであり、共同研究を実施する体制としての良いモデルとなった。

3) 評価指標の記述とプロジェクトの進捗との整合性

本プロジェクトは、JICA の技術協力プロジェクト管理のための基本的なツールである PDM の替わりに MP（上位目標、プロジェクト目標、成果及びそれらの指標を規定）及び Expected Output（4研究分野ごとの研究活動を規定）を活用してプロジェクトの進捗を管理していた。しかしながら、MP の成果及びその評価指標と、その成果を生み出す Expected Output に規定される 4 研究分野の各研究活動との間に必ずしも整合性がとれていない部分が見受けられ、各研究分野の活動を各成果に結びつけ、簡潔にプロジェクトの成果を評価できない例がみられた。そのため、実際の研究 4 分野の研究活動と、それに対応する MP の成果及び評価指標を整理すべきであったと考えられる。

PDM を作成しない場合においても、それに替わるログフレームはプロジェクト目標、成果、活動の間の論理的な組み立てがなされるとともに、実際の活動もそのログフレームに沿って実施されるように管理する必要があり、実際の活動と乖離する場合には速やかにログフレームとの間の調整がなされることが望ましい。

第6章　団　長　所　感

エジプトはナイル川という豊富な水資源を有しており、近隣諸国が絶対的水不足の状況にあることと比較すると恵まれているが、この水資源も人口の増加によりいずれは水不足に陥ることは容易に予想できる。本プロジェクトは、日本・エジプト両国の研究者により、この問題にどう対応していくかの方策を示すことにある。

本プロジェクトは、SATREPS の第 1 期案件の一つとして開始され、途中、エジプトの政変や東日本大震災などの困難にも直面し活動の遅延も生じたが、双方の努力・工夫により挽回し、プロジェクト終了までには所期の目標を達成する見込みである。以下に何点か所感を述べる。

(1) 実施体制

まず、実施体制の特徴に触れると、本プロジェクトは水、土壌、作物など幅広い研究成果をベースに、総合的な方策が示されることになっているため、エジプト側の C/P も CU、NWRC、ARC の 3 機関にわたることとなった。これまで、日本も含めた援助国側とエジプト側の複数の機関が一体となってプロジェクトを実施した例はほぼ皆無である。それほど縦割りの強いエジプト社会において、このような体制での研究活動の実施は、単一 C/P に比して難易度が高いものと考えられ、実際に先方 3 機関と日本側及び 3 機関同士の横の連携・調整のための苦労も相当あったようである。そのような状況下、粘り強い対応でプロジェクトを成功に導いた専門家をはじめとする関係者に敬意を表するとともに、このような形態での協力が可能であることを示したことは、今後の協力を考えるうえでも大変意義のあることである。なお、提言された事項を実施するためにも、活動がプロジェクト終了後に急に低下してしまうことがないようにしなければならず、今後も情報交換や共同研究などを通じてこの体制を維持し、更に発展させることができるようにエジプト側の引き続きの努力を期待する。日本側研究機関もプロジェクトによって築き上げたエジプト側研究機関との関係を維持し、今後も必要に応じて支援を検討することが望ましい。

また、日本側の専門家の体制としては、長期専門家は業務調整員 1 名のみであり、他の専門家はシャトル型で日本・エジプト間を行き来する形態をとっている。今回の評価調査で感じたことは、やはり、業務調整員一人では、他の日本人研究者が不在の際の対応が難しい場面もあったように思われた。中間評価以降は専門家もできるだけ長期間エジプトに滞在して共同研究を行う体制とするように努力したが、教訓にも述べたように、プロジェクト開始前に研究者の長期専門家としての派遣も考えれば、より円滑なプロジェクト運営ができたのではないかと考える。

(2) 社会実装に向けて

SATREPS の意義の一つは、研究成果の社会実装とされている。本プロジェクトの成果については更なる追加実験が必要なものもあり、すべてがすぐに社会実装に結びつくわけではない。しかし、例えば細溝灌漑は従来から一部の農民は使用していた方法であるが、本プロジェクトによって定量的にその有効性が示され、今後は農家への普及も科学的な根拠に基づき進めていくことができるようになった意義は大きい。

政策提言及び研究提言は、当初のプロジェクトの成果としては考えられていなかったが、

エジプト側の発案により作成されることとなり、プロジェクトのインパクトとして大きいものとなった。この提言の先方政策への反映は政策レベルでの社会実装といえるものであり、プロジェクト終了までに、現在のドラフトを最終化して先方政府へ提出したあとは、エジプト側で、この提言を実際の政策・研究に反映させていく具体的な検討がなされることが必要である。水資源・灌漑政策の責任官庁である MWRI の計画局長によれば、本提言は大変重要であり、次期 NWRP へ反映させることにしたいとの発言があり、日本側にもその作成プロセスにかかわってほしい意向も示されたことから、今後は同省とより密なコンタクトを取りつつ、本プロジェクトの成果のエジプト側政策への打ち込みをしていくことが望まれる。

（3） 上位目標の設定

SATREPS ではプロジェクトの中身・性格を考慮し、上位目標は必ずしも設定する必要はないとしている。本プロジェクトは上位目標が設定されているが、さまざまな要素も関係して長期的に達成されるような目標となっていることや、指標が設定されていないことなど、通常とはやや異なるものであったため、インパクト評価の整理に議論を要した。 SATREPS においては、上位目標については無理に設定することはせずに、柔軟にプロジェクトフレームを検討することも必要と考える。

付　属　資　料

1．マスタープラン和訳及びExpected Output

マスタープラン

<table>
<tr><td colspan="2"><u>上位目標</u>
社会経済開発5カ年計画、国家水資源計画及び国家農業生産計画に記載されている農業生産の増大と雇用機会の拡大に貢献する</td></tr>
<tr><td><u>プロジェクト目標</u>
急激な人口増加に対応するナイルデルタ地域での農業分野の水利用の高度化を図りながら、農業生産の効率化と持続性の確保を実現するための方策を示す</td><td><u>プロジェクト目標の指標</u>
1． 圃場レベルにおいて、現行方式を含め、異なる節水方法（灌漑方式・間作）による蒸発散量・作物収量の差異が比較される
2． マルワ・メスカレベルにおいて、異なる灌漑方法（水供給頻度）による農民の水管理行動と水の動態が解明され、節水的かつ適切な水管理方法が示される
3． パイロット排水路/ナイルデルタレベルにおいて、用水反復利用の方法が示される
4． 各レベルにおける節水方法・用水反復利用方法が比較検討され、最適な節水・作付けオプションとその節水効果が示される</td></tr>
<tr><td><u>アウトプット</u>
1. ナイルデルタの各種条件下での水及び塩の収支に係る諸条件が明らかになる</td><td><u>アウトプット1にかかわる指標</u>
（メスカレベル）
1． 長期間断灌漑が行われている試験圃場において、蒸散量及び蒸発量の変化が定量化される
2． 節水栽培と慣行栽培における水利用効率（単位灌水量当たりの作物収量）が定量的に比較される
3． Casualina 及び Eucalyptus の防風林における間隙率と蒸発散量減少との関係が定量化される
（水路・デルタレベル）
4． パイロット用水・排水路において水塩動態モデルが構築され、デルタ全域に適用される</td></tr>
<tr><td>2. 用水路レベルでの水配分及び水管理の合理化の方策が提示される</td><td><u>アウトプット2にかかわる指標</u>
（メスカレベル）
1． パイロットメスカ・マルワにおいて、水位変化及びポンプによる取水頻度・取水量のモニタリングデータが解析される
2． マルワの水位変化と、マルワの規模・農家数・農地面積の相互関係に係る論理が構築される
3． パイロットメスカ・マルワにおいて、個別ポンプ及び共同ポンプについて、供給水当たりの燃費が比較される
（メスカ・水路・デルタレベル）
4． 上の解明を前提に、水配分削減の方法による影響発現の仕方の違いが示される</td></tr>
</table>

3. 圃場の塩害防止の方策が提示される	<u>アウトプット3にかかわる指標</u> （メスカ・水路レベル） 1. デルタ中央部の水田及び畑地における塩類集積の空間的分布と集積塩類の特徴が示される 2. 試験圃場において、暗渠排水の水位変化・流量変化・EC 値が示され 3. 上記数値に基づく暗渠排水の改善方法が提案される 4. デルタ土壌の水・塩分・重金属等の移動特性を表すパラメーターが特定される 5. 試験圃場において、畑地が水田に転換された際の、水田耕作前後における塩分集積の比較値が示される 6. 排水を再利用した灌漑を行っている試験圃場において、カルシウム施用（Gypsum）及び籾殻鋤き込みによる土壌改良度（透水性、土壌物理性）が定量化される （デルタレベル） 7. 上記パラメーターに基づくシミュレーションモデルが試験圃場で構築され、同じ土壌条件下の地域で適用される
4. 適切な作物選択がなされ、圃場レベルの灌漑方法の改善手法が提示される	<u>アウトプット4にかかわる指標</u> （実験室レベル） 1. ポット苗栽培によって主要作物の耐塩性が定量化される （メスカ・水路レベル） 2. 用水管理調査地区において年間の作付け体系（作目選択、播種時期・収穫時期）が示され、将来の水供給予測に対応する作付け体系が提案される 3. 試験圃場において、灌漑方式ごとの作物収量及び品質が比較される 4. 試験圃場において、灌漑方式ごとの稲藁・麦藁・トウモロコシ茎の飼料価が示され、より飼料価の高い飼料の生産方法が提案される 5. 灌水量・栽植密度の違いによる油料作物収量及び生育の違いが示され、適切な栽培方法が特定される

Expected Outputs with PI/CP (2nd December, 2014)

PRJECT DIRECTOR: Dr. Hany El-Shemy   PROJECT MANAGERS: Dr. Masayoshi Satoh (Japan) and Dr. Rushdi El Kilani (CU)
ADVISOR: Dr. Samir A. Aboulroos (CU)
OTHER EXECUTIVES: Dr. Hisham Mustafa (Director, WMRI), Dr. Mohamed Soliman (Directoer, FCRI), Dr. Khaled Ali Abou Shady (Director, Sakha Research Station)

Expected Outputs	PI, Egyptian	CP, Egyptian	PI, Japanese	CP, Japanese
Group 1: Water and Salt Balance	**GL: Dr. Rushdi El-Kilani (CU)**		**GL: Dr. H. Fujimaki (TU)**	
1. Evapo-transpiration (ET) in conventional and water-saving cultivations for major crops is quantified.	Dr. Rushdi El-Kilani (CU)	Dr. Mahmoud Abdalla (ARC), Dr. Ahmed Abdel Fattah (WMRI)	Dr. Michiaki Sugita (UT)	
2. Transpiration of wind break trees and ET from agricultural land surrounded by the trees are quantified.	Dr. Rushdi El-Kilani (CU)	Dr. Mahmoud Abdalla (ARC), Dr. Ahmed Abdel Fattah (WMRI), Dr. Safaa Ghorab (ARC)	Dr. Michiaki Sugita (UT)	
3. Specific features of water distribution and water/salt balance in the irrigated land at different improvement stages of water management are clarified, thus a water/salt balance model for the middle delta is	Eng. Yousef Mahfouz Hassanin (DRI) Eng. Ahmed Habash (DRI)	Dr. Mohamed Ismail (SWERI)	Dr. Tomoyuki Taniguchi (UT)	Dr. Masayoshi Satoh (UT), Dr. Xin Yuan (UT)
4. The relationship among water, soil and crops will be clarified	Dr. Rushdi El-Kilani (CU)	Dr. Sayed Ahmed Safina (CU), Dr. Mahmoud Abdalla (ARC)	Dr. Shuichiro Yoshida (Tokyo Univ.)	Dr. Katsuyoshi Shimizu (UT)
Group 2: Water Management	**GL: Dr. Talaat El Gamal (WMRI)**		**GL: Dr. M. Satoh (UT)**	
1. State of water distribution among farmers/farmers' groups and its impact on land use and farming are clarified	Dr. Talaat El Gamal (WMRI)	Dr. Mohamed Meleha (WMRI)	Dr. Masayoshi Satoh (UT)	Dr. Atsushi Ishii (UT), Dr. Tomoyuki Taniguchi (UT), Dr. Xin Yuan (UT)
2. Factors influencing on water distribution such as hydraulic facilities, organization and farmers' behavior are analyzed	Dr. Gamal Fawzy (WMRI)	Dr. Mohamed H. A. Nawar (CU)	Dr. Atsushi Ishii (UT)	Dr. Shusuke Matsushita (UT)
3. Impacts and problems of decreased allocation of water on water distribution and crop selection under the present facilities and organizations are identified.	Dr. Waleed Abou El Hassan (WMRI)	Dr. Mohamed Meleha (WMRI)	Dr. Tomoyuki Taniguchi (UT)	
4. Energy source and efficiency in lifting water are analyzed.	Dr. Abdrabbo Abdel-Azim A. Shehata Aboukheira (WMRI)		Dr. Ryozo Noguchi (UT)	Dr. Tomoyuki Taniguchi (UT)
5. Possible countermeasures to prevent the identified problems and to secure efficiency and sustainability of irrigation are proposed	Dr. Talaat El Gamal (WMRI)	Dr. Mohamed H. A. Nawar (CU)	Dr. Masayoshi Satoh (UT)	Dr. Atsushi Ishii (UT), Dr. Tomoyuki Taniguchi (UT), Dr. Xin Yuan (UT)
Group 3: Soil Fertility	**GL: Dr. Bassiouni A. Zayed (ARC)**		**GL: Dr. T. Higashi (UT)**	
1. Soil quality (including soil classification and dynamics of salt), quality of irrigation water and ground water level are clarified.	Dr. Sayed Saad Naeem (ARC)	Dr. Howida Bayome El-habat (ARC)	Dr. Teruo Higashi (UT)	Dr. Aki Kubota (UT)
2. Problems of the present design criteria and management of tile drain are identified, and an appropriate plan for groundwater control to avoid salt accumulation in the soil is proposed	Dr. Waleed Abou El Hassan (WMRI)		Dr. Yoshinobu Kitamura (TU)	Dr. Haruyuki Fujimaki (TU)
3. Future salt and contaminant transport are predicted considering the change in water quality and groundwater level.	Dr. Rushdi El-Kilani (CU)		Dr. Haruyuki Fujimaki (TU)	
4. Leaching effect of paddy cultivation is clarified.	Dr. Bassiouni Abdel Razik Zayed (ARC)	Dr. Ismail Saad Hassan El-Refaee (ARC)	Dr. Haruyuki Fujimaki (TU)	Dr. Aki Kubota (UT)
5. Appropriate methods for irrigation and soil quality control in the experimental farms for food and bio-fuel crops are developed	Dr. Bassiouni Abdel Razik Zayed (ARC)	Dr. Ibrahim Hashim (ARC)	Dr. Teruo Higashi (UT)	Dr. Aki Kubeta (UT)
Group 4: Food and Oil Crop Production	**GL: Dr. Korany Abdel-Gawad (CU)**		**GL: Dr. S. Maruyama (UT)**	
1. Present cropping pattern is analyzed and the appropriate cropping pattern corresponding to the future water availability is proposed	Dr. Mohamed H. A. Nawar (CU)	Dr. Azza El Bendari (CU)	Dr. Shusuke Matsushita (UT)	Dr. Katsuyoshi Shimizu (UT)
2. Present irrigation application is quantitatively analyzed and water-saving irrigation methods are examined.	Dr. Sayed Ahmed Safina (CU)	Dr. Saad Shebl (ARC), Dr. Sherif Maher (ARC), Dr. Yousri Atta Abraham (WMRI)	Dr. Sachio Maruyama (UT)	Dr. Haruyuki Fujimaki (TU), Dr. Katsuyoshi Shimizu (UT), Dr. Aki Kubota (UT)
3. State of salt accumulation distribution is clarified and appropriate selection of salt tolerant crops including new lines is tested and proposed.	Dr. Abdallah Abd El Naby (ARC)	Dr. Sherif Maher (ARC)	Dr. Katsuyoshi Shimizu (UT)	
4. Present state of animal usage is clarified and efficient systems for forage production and livestock feeding are designed	Dr. Alaa El-Din Hassan Mohamed (ARC)	Dr. Ahmed Mohamed Abdel Magied Hussein (ARC)	Dr. Naoto Ishikawa (UT)	
5. Methods for fuel crop production using drainage water are developed.	Dr. Safaa Ghorab (ARC)		Dr. Haruyuki Fujimaki (TU)	Dr. Katsuyoshi Shimizu (UT)

* Subject to change by duty, performance and neccesity approved in JSC

CU=Cairo University, UT=University of Tsukuba, TU=Tottori University

Expected Outputs with PI/CP (18th Feb. 2013)

PRJECT DIRECTOR: Dr. Ahmed Nagib, PROJECT MANAGERS: Dr. Masayoshi Satoh

ADVISOR: Dr. Samir A. Aboulroos (CU)
OTHER EXECUTIVES: Dr. Nahla Z. Abou El-Fatouh (WMRI), Dr. Abdel Aziz A.Abdel Aziz (Directoer, FCRI), Dr. Salah Helal (Agr. Research Stations, ARC) , Dr. Khaled Ali Abou Shady (Director, Sakha Agr Res Station)

Expected Outputs	PI, Egyptian	CP, Egyptian	PI, Japanese	CP, Japanese
Group 1: Water and Salt Balance	**GL: Dr. Rushdi El-Kilani (CU)**		**GL: Dr. H. Fujimaki (TU)**	
1. Evapo-transpiration (ET) in conventional and water-saving cultivations for major crops is quantified.	Dr. Rushdi El-Kilani (CU)	Dr. Mahmoud Adullah (ARC), Dr. Ahmed Mohammed (WMRI)	Dr. Sugita (UT)	
2. Transpiration of wind break trees and ET from agricultural land surrounded by the trees are quantified.	Dr.Rushdi El-Kilani (CU)	Dr. Mahmoud Adullah (ARC), Dr. Ahmed Mohammed (WMRI)	Dr. Sugita (UT)	
3. Specific features of water distribution and water/salt balance in the irrigated land at different improvement stages of water management are clarified, thus a water/salt balance model for the middle delta is developped.	Eng. Yousef Mahfouz Hassanin (DRI)	Dr. Mohamed Ismail (SWERI)	Dr. Taniguchi (UT)	Dr. Satoh (UT), Dr. Yuan (UT)
4. The relationship among water, soil and crops will be clarified.	Dr. Rushdi	Dr. Sayed Safina, Dr. Mahmoud Adullah (ARC),	Dr. Yoshida	Dr. Shimizu
Group 4: Food and Oil Crop Production	**GL: Dr.Korany Abdel-Gawad (CU)**		**GL: Dr. S. Maruyama (UT)**	
1. Present cropping pattern is analyzed and the appropriate cropping pattern corresponding to the future water availability is proposed	Dr.Rafea El-Zanaty (CU)	Dr.Samir Hegazy (CU)	Dr.Matsushita (UT)	Dr. Shimizu
2. Present irrigation application is quantitatively analyzed and water-saving irrigation methods are examined.	Dr.Sayed Safina (CU)	Dr. Saad, Shebl, Dr. Sherif Maher, Dr. Yousri Attia Abraham (WMRI)	Dr.Maruyama(UT)	Dr. Fujimaki (TU), Dr. Shimizu (UT), Dr. Kubota (TU)
3. State of salt accumulation distribution is clarifiec and appropriate selection of salt tolerant crops including new lines is tested and proposed.	Dr. Abdallah Abd El Naby (ARC)	Dr. Sherif Maher (ARC)	Dr.Shimizu (UT)	
4. Present state of animal usage is clarified and efficient systems for forage production and livestock feeding are designed.	Dr. Alaa El-Din Hassan Mohamed (ARC)	Dr. Ahmed Mohamed Abdel Magied Hussein (ARC)	Dr.Ishikawa (UT)	
5. Methods for fuel crop production using drainage water are developed.	Dr. Safaa Ghorrab (ARC)		Dr.Fujimaki (UT)	Dr.Shimizu (UT)

The Joint Terminal Evaluation Report

on

Japanese Technical Cooperation (SATREPS)

for

the Project for Sustainable Systems for Food and Bio-energy Production with Water-saving Irrigation in the Egyptian Nile Basin in the Arab Republic of Egypt

Cairo
January 29, 2015

Mr. Takeaki Sato
Leader
Visiting Senior Advisor,
Japan International Cooperation Agency (JICA)

Prof. Abd El Alim Metwally
Leader
Professor of Agronomy, Faculty of Agriculture,
Cairo University (CU)

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Abbreviations

ARC	Agricultural Research Center
C/P	Counterpart
CU	Cairo University
EGP	Egyptian Pound
ISMAP	Improving Small-Scale Farmers' Market-Oriented Agriculture Project
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
JSC	Joint Coordination Committee
JST	Japan Science and Technology Agency
MP	Master Plan
MWRI	Ministry of Water Resources and Irrigation
NWRC	National Water Research Center
NWRP	National Water Resources Plan
O&M	Operation and Maintenance
PMU	Project Management Unit
R/D	Record of Discussions
RRTC	Rice Research and Training Center
SATREPS	Science and Technology Research Partnership for Sustainable Development
SWERI	Soil, Water and Environment Research Institute
SWMT	Project for Strengthening Water Management Transfer
WMIP2	Water Management Improvement Project 2
WMRI	Water Management Research Institute

Chapter 1. Introduction

1.1. Background

Due to the rapid population growth, averaging the annual increase as high as two percent per year, the Government of Egypt has set its national development goals focusing on expansion of employment opportunities in agriculture sector and increase in food production. However, Egypt is facing shortage of water resources and farmland. For instance, the agricultural production in the Nile Delta as a major agricultural area seems to have been already reached at the maximum of the productivity, and there is little space to develop new farmland in the area as well. In addition, it is difficult to develop new water resources since the amount of water intake from Nile River which covers most of the water resources is limited to 55.5billion tons by the bilateral agreement with Sudan.

Under this circumstance, Egypt is trying to develop improved water management methods in order to expand irrigated neighboring desert area and to increase food production. This expansion of the farmland is expected to absorb increasing workforce into agricultural sector which includes 30% of the workforce, and incomes of small-scale poor farmers.

While the Socio-Economic Development Five Year Plan (2007/8-2011/12) and National Water Resources Plan (NWRP) emphasize the agricultural and irrigation development for expansion of the farmland as priority more concrete measures are necessary to realize these policies. Therefore comprehensive and concrete measures for effective water use need to be proposed.

Based on the conditions stated above, the Faculty of Agriculture, Cairo University (CU), in collaboration with the Water Management Research Institute, has submitted a proposal for the joint research project, Science and Technology Research Partnership for Sustainable Development (SATREPS), to the Government of Japan. At the same time, University of Tsukuba submitted proposal for Joint research with CU to Japan Science and Technology Agency (JST). This project, "Sustainable Systems for Food and Bio-Energy Production with Water-Saving Irrigation in the Egyptian Nile Basin" started in April 2009, and expected to propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond to the above mentioned condition.

Approaching to the completion of the project in March 2015, JICA decided to conduct a terminal evaluation with the objectives of verifying and analyzing the achievement of project purpose and outputs, the implementation process, evaluating the Project in terms of five evaluation criteria and compiling a joint review report based on the survey results.

1.2. Project Overview

(1) Overall Goal

To contribute to increasing agricultural production and to expanding employment opportunities, as stated in the Socio-Economic Development Five-Year Plan, the National Water Resource Plan and Agricultural Production Plan for Egypt 2017.

(2) Project Purpose

To propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond the rapid population growth.

(3) Output

1. Evapotranspiration and salt/water balance in the Nile Delta are clarified.
2. An improved plan of irrigation management at the different canal levels in the Nile Delta is developed.
3. Methods for controlling salinity and fertility of soil are developed.
4. Appropriate crop production and irrigation management systems at the farm level are developed.

(4) Project Period

June 9, 2009～March 31, 2015 (five years and ten month)

1.3. Objectives of the Terminal Evaluation

(1) To verify the progress of project activities, achievement of outputs and implementation process along with the latest Master Plan (MP),

(2) To evaluate the Project in terms of relevance, effectiveness, efficiency, impact and sustainability,

(3) Based on the review results, to discuss challenges to the achievement of project purpose, consider the implementation strategy for the remaining period of the Project, and draw lessons on continuation of current project activities, and

(4) To compile the information collected in the form of a joint evaluation report of the Project.

1.4. Schedule of the Terminal Evaluation

The Terminal Evaluation was conducted from January 11 to January 30, 2015. The schedule is attached as Annex 1.

1.5. Members of the Terminal Evaluation Team

Members of the terminal evaluation Team, nine members in total consists of Japanese side and Egyptian side. Members of each side are shown in the tables below.

[Japanese side]

Name	Role	Title
Mr. Takeaki SATO	Leader	Visiting Senior Advisor, JICA
Mr. Taro AZUMA	Evaluation Planning	Advisor, Team 2, Agricultural and Rural Development G1, Rural Development Dep., JICA
Dr. Kotaro INOUE	Science and Technology (Evaluation)	Principal Fellow/ Programme Officer, Japan Science and Technology Agency (JST)
Ms. Miho TAKAHASHI	Science and Technology (Evaluation)	Assistant Programme Officer, JST
Mr. Akira OGASAWARA	Evaluation and Analysis	Consultant, VSOC Co., Ltd.

[Egyptian side]

Name	Role	Title
Prof. Abd El Alim Metwally	Leader	Professor of Agronomy, Faculty of Agriculture, Cairo University (CU)
Prof. Mohamed Fahmy Hussein	Member	Professor, Soil Science Department, Faculty of Agriculture Cairo University (CU)
Prof. Mohamed Lotfy Yousef Nasr	Member	Professor of Water Economics, Water Management Research Institute (WMRI)
Dr. Mohamed El Kholy	Member	Associate Professor, Environment Deportment, Soil, Water and Environment Research Institute (SWERI)

Chapter 2. Method of Evaluation

2.1. Framework of the Terminal Evaluation

The Terminal Evaluation team followed "JICA Guidelines for Project Evaluation (2010)" as a basis for conducting the terminal evaluation. The performance of the Project was assessed based on Master Plan adopted on March 11, 2012 (see Annex 2).

2.2. Steps of the Terminal Evaluation

(1) Data/information collection: Relevant data/information to measure the progress of the Project was collected through literature review, interview/questionnaire and on-site observation.

(2) Verification of the project achievement: The progress of project activity was examined through the study. The achievement of the outputs and project purpose were measured by objectively verifiable indicators of the Master Plan.

(3) Verification of implementation process: Implementation process of the Project was reviewed to see if the activities were implemented according to the schedule. In addition, promoting and/or constraining factors that affected the implementation process were identified.

(4) Evaluation based on the five evaluation criteria: Based on the analysis of the Project performance and implementation process above, the Project was evaluated with the five evaluation criteria (see Table 2-1).

Table 2-1: Definition of the Five Evaluation Criteria

1) Relevance	Relevance refers to the validity of the Project Purpose and the Overall Goal in connection with the development policy of a recipient country as well as the needs of beneficiaries.
2) Effectiveness	Effectiveness refers to the extent to which the expected benefit was brought about as a result of the Project.
3) Efficiency	Efficiency refers to the productivity of the implementation process, examining if the input of the Project was efficiently converted into the output.
4) Impact	Impact refers to direct and indirect, positive and negative impacts caused by implementing the Project, including the extent to which the Overall Goal has been attained.
5) Sustainability	Sustainability refers to the extent to which Egypt can further develop the Project, and the benefits generated by the Project can be sustained under the recipient country's policies, technology, systems and financial state.

(5) Proposing recommendations and lessons learned: Recommendations and lessons learned to the Project based on the evaluation results were identified.

Chapter 3. Project Achievement

3.1. Inputs

3.1.1. Japanese Side

(1) Dispatch of Experts

A total of 21 experts[1], which include three long-term experts in project coordination (coordinator) and 18 experts from University of Tsukuba, Tottori University and Mie University (the areas of expertise in Project Manager, water and salt balance, water management, soil fertility and food production and bio energy) have been dispatched for the Project since the commencement of the Project on June 9, 2009. The Project deployed long-term experts in project coordination on a daily basis for project management and coordination and deploys researchers with specific expertise as short-term experts for technical transfer on research skills and techniques and co-research by the Universities from the Japanese side, CU, NWRC and ARC. The list of the experts and its dispatch schedule is shown in "1. Dispatch of Japanese Researchers/Experts" in Annex 3.

(2) Provision of Equipment

Equipment was provided for the Project activities by the project budget, which amounted to 126,638,011 JPY and 1,517,463 EGP. The items of equipment are shown in "2. List of Equipment," in Annex 3.

(3) Operational Cost

The total amount of expenditure borne by Japanese side was 4,827,730.73 EGP, which is equivalent to 59,863,861.05 JPY[2] as summarized in "3. Operational Cost Sharing," in Annex 3.

(4) Overseas trainings in Japan

A total of 21 Egyptian researchers from CU, NWRC and ARC were selected to participate in overseas trainings held by Tsukuba University in Japan. They were delegated t o Japan for attending Kick off meeting, experiment and research on water and salt balance, soil fertility, livestock, bio-fuel and crops, etc. The Egyptian researchers who participated in the training are listed in "4. Training in Japan," in Annex 3.

3.1.2. Egyptian Side

(1) Appointment of Counterpart Personnel

A total of 73 Egyptian researchers in total were assigned for the Project activities as shown in "1. Assignment of Egyptian C/P," Annex 4. Currently, 15 Egyptian researchers in total are assigned for the Project activities.

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[1] In addition to experts, Tsukuba University sent 32 Japanese students on JST budget. They were involved with their own research by using data, information and field experience in the Project.

[2] The exchange rate applied is 12.4 JPY/ EGP, which is used for calculation of operational cost by the project team.

(2) Provision of Facility and Equipment

Facility and equipment provided by the Egyptian side was some clerical facilities and clerical space at CU and ARC for the project office.

The details of the facility and equipment and are shown in "2. Provision of Facility and Equipment," in Annex 4.

(3) Operational Cost Sharing

Counterpart institutions (CU, NWRC and ARC) shared some project activity cost autonomously. The institutions shared project research activity cost for analysis work at laboratories. In concrete, Cairo University paid basic salary for project drivers. WMRI shared research activities expenditures for the Zankalon experimental field as scheduled along with approved budget schedule. ARC shared research activity expenditures for the Sakha experimental field since winter season of 2013. WMRI shared a total of 151,936 EGP for operational costs for experiments in 2010 to 2014 at the Zankalon experimental field. Other than that, the exact amount of all activity cost shared by the Egyptian side is not identified.

The details of cost share by the Egyptian side are shown in "3. Operational Cost Sharing" and "4. Cost Sharing from WMRI," Annex 4.

3.2. Outputs

3.2.1. Output 1

Output 1	Evapotranspiration and salt/water balance in the Nile Delta are clarified.

The water and salt balance in the pilot drainage site showed the water management processes of (i) separation of irrigation water into surface drainage and subsurface drainage, (ii) concentrating total dissolved solids (TDS) by ET, (iii) diluting by surface drain, (iv) re-irrigation and reflow by water recycling from drain and (v) re-concentrating. As for the control of evapotranspiration, instead of extended irrigation interval method, the Project proposed other water saving methods including strip irrigation, drip irrigation, etc. and ET values of those methods were quantitatively clarified as well.

Other than the indictors shown in Annex 5, the Project found out that the ET value was decreased remarkably over the horizontal distance of 10 times the wind break tree height.

According to the brief description on output 1 as stated above and the fulfillment of indicators as shown in Annex 5, it is evaluated that Output 1 has been achieved at the time of the Terminal Evaluation.

3.2.2. Output 2

Output 2	An improved plan of irrigation management at the different canal levels in the Nile Delta is developed.

The Project found out that there was a clear difference in farmers' behavior (including the difference between paddy and no-paddy areas) between areas where a limited water intake time by rotation irrigation was observed and areas near to canals where farmers could take irrigation water at all time.

Along with the findings above, two possible methods for the implementation of water saving were considered: to reduce irrigation time with leaving amount of irrigation water as it is and to reduce amount of irrigation water with leaving irrigation time as it is. Furthermore, it was revealed that water saving would increase the rate and frequency of recycling drainage water in downstream areas, while it would not affect upstream areas and thus effects of water saving was concentrated on downstream areas. Based on this analysis, the Project suggested intensified water recycling in the upstream part of the main irrigation canal as well.

According to the brief description on output 2 stated above and the fulfillment of indicators as shown in Annex 5, it is evaluated that Output 2 has been achieved at the time of the Terminal Evaluation.

3.2.3. Output 3

Output 3	Methods for controlling salinity and fertility of soil are developed.

The Project obtained the relevant document on the current situation of salt accumulation in soil and found out that (i) salt accumulation in downstream area is more intensified than in upstream area in the delta, (ii) salt accumulation was also observed in some areas scattered in upstream of the delta. The Project has presented the understanding that all such salt accumulation is due to the use of saline irrigation water developed as described in "3.2.1. Output 1." So as to leach the salt, rice cultivation is clarified as an effective method in the delta. The Project also proposes that selecting cultivars with salt-tolerant properties is also one of the keys to overcome this issue.

According to the brief description on Output 3 stated above and the fulfillment of indicators as shown in Annex 5, it is evaluated that Output 3 has been achieved.

3.2.4. Output 4

Output 4	Appropriate crop production and irrigation management systems at the farm level are developed.

Strip irrigation was proposed as an easily applicable and promising water saving method for the future. It shows a good aspect of higher yield as well as water saving. There may be a variety of discussions on cropping options, including introduction of rice crops once in a few years as proposed, in analyzing the future decision-making of farmers on cropping in the areas where rice crops is not suitable or the areas where rice cultivation is prohibited. They are attributed to the better aeration to the root zone of plants. However, it has some non-applicable crops for strip irrigation, such as Egyptian clover. For non-applicable crops, future technical developments based on the principle of avoiding water logging and water saving are recommended.

According to the brief description on Output 4 stated above and the fulfillment of indicators as shown in Annex 5, it is evaluated that Output 4 has been almost achieved except measuring yield of different bio-fuel crops under different conditions, which will be finalized by the end of the Project.

3.3 Project Purpose

Project purpose	To propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond the rapid population growth.

The project purpose will be achieved at the end of the Project according to the fulfillment of indicators and development of policy and research recommendations.

The Project has already developed policy recommendations and research recommendations (drafts) based on the research results of the Project[3]. In the documents, the Project proposes strip irrigation, drip irrigation, extended irrigation interval and planting rice as the methods for efficient and sustainable agricultural production. The Project is finalizing the recommendations which will be submitted to the Egyptian Government at the end of the Project. Final symposiums will be held in March 2015 both in Japan and Egypt to introduce the recommendations and to disseminate the achievement of the Project.

[3] The recommendations are attached in "Annex 6: Policy and Research Recommendations."

3.4 Overall Goal

Overall Goal	To contribute to increasing agricultural production and to expanding employment opportunities, as stated in the Socio-Economic Development Five-Year Plan, the National Water Resource Plan and Agricultural Production Plan for Egypt 2017.

The relevant ministries and research institutes are well aware of its necessity of increase in agricultural production with efficient water management and they have positive attitudes to take some measures provided by to tackling this issue.

However, it is too early to evaluate the perspective of achievement of overall goal at this moment. Overall goal of the Project may be achieved if policy recommendations and research recommendations are adopted by the Egyptian Government and some concrete actions are taken for increasing agricultural production and expanding employment opportunities.

The overall goal is a long-term goal which is affected by uncertain factors. It should not be the direct target at the time of ex-post evaluation. However, the Egyptian side should make possible efforts in achieving the overall goal.

Chapter 4. Implementation Process

4.1. Progress of Activities

Since there was difference in recognition of cost sharing at the beginning of the Project between Egyptian and Japanese sides, the progress of project activities was behind the schedule. Due to enhancing communications, the Project succeeded in catching up the delay.

Project activities were interrupted because of political changes in Egypt in 2011 and 2013 and the Great East Japan Earthquake in March 2011 occurred in Japan. In response to the situation, the Project period was extended for 10 months up to March 2015 so as to make up for the interrupted activities and delayed schedule. In addition, dispatch of 13 Japanese experts in total was cancelled during July to September 2013. The delay was covered by intensive dispatch of Project Manager from the Japanese side.

4.2. Implementation Structure

The Project has been managed properly even though a variety of researchers from different research institutions were involved in project research activities. Smooth management among the both sides was enhanced by sharing information such as Joint Coordination Committee (JSC) and Project Management Unit (PMU) meetings.

The project team consists of one long-term Japanese expert (project coordinator), short-term experts in specific disciplines, and five project assistances who were assigned to the project office at Cairo University and Sakha and Zankalon stations.

Egyptian side assigned researchers who specialize in soil, plant pathology, sociology, water management, soil and water environment, rural development and socio-economics. They were involved with research theme(s) in charge in cooperation with Japanese researchers.

Initially, the Project implemented its research activities, forming five research groups; Group 1: Water and Salt Balance; Group 2: Water Management; Group 3: Soil Fertility; Group 4: Food and Oil Crop Production; and Group 5: Bio-Energy.

With regard to Group 5, it was approved in the 4th JSC meeting held in December 2011 that some research activities on bio-energy were merged with Group 2 and Group 4. Accordingly, the Project implemented its research activities with four research groups. For each research theme, at least one researcher from the Japanese side and at least one researcher from the Egyptian side were assigned under the supervision of group leaders from the both sides.

4.3. Communication

Eleven JSC and twenty PMU meetings were held periodically for sharing information. Although PMU meetings were assumed to be held on a monthly basis, the Project held them according to the necessity.

Annual Technical Reports in English were made twice, namely, in November 2012 and July 2014. Those reports were useful to share the progress of research activities and direction of the Project. Furthermore, the Final Report will be made and shared among the Japanese experts and the Egyptian researchers.

There was no serious miscommunication between the Japanese and Egyptian researchers. Project assistants also contributed to communication and progress of the Project.

4.4. Capacity Development

Capacity development was effectively achieved for both sides through joint field work and experiment. Furthermore, the Evaluation Team found that training in Japan was especially beneficial to Egyptian researchers. They successfully obtained new skills such as ET eddy correlation method; numerical modeling of water flow and solute transport; monitoring of water discharge in canals; and practical attitude and methodology of research through inter-activity.

4.5. Collaboration with Other Projects

The Project maintained a coordinated relation with other JICA technical cooperation projects that were intended to promote efficient water management and water saving in the Nile Delta. Japanese experts from Project for Strengthening Water Management Transfer (SWMT) and Water Management Improvement Project 2 (WMIP2) were invited to JSC meetings to share the progress of project activities. The Chief Advisor of SWMT stated that scientific clarification was highly useful for project implementation on water management. Currently, researchers and experts from each project share information and exchange opinions, making use of opportunities.

Chapter 5. Evaluation of the Project

5.1. Evaluation of the Project

5.1.1. Relevance

The relevance of the Project is high since the Project is highly consistent with the Egyptian and Japanese development policy, relevant sector strategies in Egypt and its necessity.

(1) Egyptian development plans/strategy

The Sixth Five-year Plan 2007-2012 is the primary development plan formulated for Egypt. In the Plan, Long-term Agricultural Development Strategy (2007) is described and aims at "increasing agricultural production by 3.9% annually, through achieving economic efficiency in allocation and use of resources to sustain development and protect the environment" as the first objective. The National Water Resources Plan (NWRP) 2017 was developed in October 2006 with the coherent strategy consisting of the following three basic pillars: developing additional new water resources, making better use of existing water resources and protecting health and environment.

Furthermore, the Egyptian Government has formulated Sustainable Agricultural Development Strategy towards 2030, which focuses on sustainable use of agricultural resources as one of the first objectives of the Strategy.

(2) Consistency with the Japanese aid policy

Japan's formulated Country Assistance Program for Egypt in June 2008. In the Program, Japan will provide strategic assistance to Egypt with "Poverty Reduction and Improvement of Living Standard emphasizing on development of agriculture and rural communities.

(3) Necessity of the Project

The Project aims at providing integrated research results of several research measures for efficient and sustainable agricultural production with efficient water management. The Project is consistent with the necessity of the country since the issue of sustainable agricultural production with efficient water management is regarded as an integrated issue for the country as described in the NWRP 2017.

5.1.2. Effectiveness

Effectiveness of the Project is high.

As described in "3.3. Project Purpose," the achievement of the project purpose is expected. Achievement level of each output is satisfactory as described in "3.2. Output." Logical sequence of the causal relationships between output 1, 2, 3 and 4 and the project purpose is strong enough since (i) clarification of evapotranspiration and salt/water balance, (ii) development of an improved plan of irrigation management, (iii) development of methods for controlling salinity and fertility of soil and (iv) development of appropriate crop production and irrigation management systems are indispensable to making proposal of the methods to realize efficient and sustainable agricultural production with efficient water management.

5.1.3. Efficiency

The efficiency of the Project is moderate.

With regards to quality and quantity of input from the Japanese side such as dispatch of experts, provision of equipment, operational cost and trainings in Japan are relatively appropriate. Delegation of short-term and long-term experts in various professional fields complemented project activities/fields under the coordination and management of project activities by project coordinators. Modality of Japanese expert dispatch, long-term researchers could not be dispatched. After the political change in June 2013, the Project attempted to promote smooth coordination of the Project by expanding the dispatch periods of the Project Manager.

With regards to quality and quantity of input from the Egyptian side, Egyptian researchers who specialize in various research fields are appropriately assigned. Frequent changes in assignment of Egyptian researchers negatively affected to the efficiency of the Project activities. A total of fifteen researchers are currently working for the Project out of 73 Egyptian researchers in total have assigned.

In addition, the Project selected study sites of Abshan and Bahr El Nour to evaluate the effects of irrigation water quality on several soil properties. Bahr El Nour was a site developed by a Japanese technical cooperation project, which contributed to the efficiency of the Project.

Some research devices and equipment (water level sensor & EC sensor, etc.) installed in remote areas were not functioned properly, caused by temporal unstable situation, which interrupted measurement of water flow and EC values.

The Project can be recognized as the pioneer project by the cooperation among CU, WMRI, ARC and JICA. As for the coordination of counterpart organization, it took time and efforts among counterpart organizations and the Japanese experts than expected.

[Promoting factors]

- ✓ Use of a project site developed by a Japanese technical cooperation project for comparison survey on irrigation water quality

[Inhibiting factors]

- ✓ Interruption and delay of some project activities caused by temporal unstable situation
- ✓ Frequent changes in assignment of researchers from Egyptian side

5.1.4. Impact

The impact of the Project is relatively high.

At this moment, it is not appropriate to assess the achievement of the Overall Goal of the Project as described in "3.4 Overall Goal."

- ➢ The Project is drafting policy and research recommendations to the Egyptian Government based on the research results. The recommendations are expected to be important inputs for the incoming water resource development plan.
- ➢ Curriculum on ET System for Eddy Correlation Method is already developed at Cairo University. Thanks to ET System for Eddy Correlation Method which is introduced by the Project, two master degree students from the Faculty of Agriculture at Cairo University

started their theses, working with the Project Manager from the Egyptian side, Dr. Rushdi El-Kilani.

- The Project is in the process of publishing a book "*Irrigated Agriculture in Egypt- past, present and future* (tentative, as of 1 July 2014)," on the outcomes of the project research activities, which is expected to promote awareness of people working in the field of agriculture and other related sectors. The book will consist of historical development, present situation based on the research results and challenges in exploiting resources.
- Furthermore, the Project attempts to disseminate the research results in the form of journal article. A total of ten papers were already published. Six presentations in academic conferences, 49 oral presentations and 12 poster presentations were also made in academic opportunities during the project period.
- The Evaluation Team found out that scientific clarification from the Project was highly useful for SWMT implementation on water management according to the Chief Advisor.
- Improving Small-Scale Farmers' Market-Oriented Agriculture Project (ISMAP), another JICA technical cooperation project in Egypt, is keen to demonstrate the intercropping and strip irrigation techniques and practices experimented by the Project to target farmers. It is expected that the experiment results will be disseminated and practiced by famers in the future.
- The Project introduced the system for science-based decision-making in Egypt.

There is no concrete negative impact at the time of the terminal evaluation.

5.1.5. Sustainability

The overall sustainability of the Project is moderate.

(1) Political sustainability

Political sustainability is high since the acceptance of social application based on the research results on water and salt balance, water management, soil fertility and food and oil crop production is highly consistent with the government strategies as described in "5.1.1. Relevance."

(2) Organizational sustainability

Organizational sustainability is moderate. Structure of implementation organizations (CU, NWRC and ARC) was established. However, it is necessary for them to improve the current relationship among the organizations.

(3) Financial sustainability

Financial sustainability is moderate. There were some concerns particularly about cost sharing from the Egyptian side at the beginning of the Project. The Egyptian side shared some transportation cost for field surveys and data collection. WMRI shared a total of 151,936 EGP for operational costs for experiments in 2010 to 2014 at the Zankalon experimental field. In this regard, it is expected for them to bear the cost for research activities in the future. However, budget for O&M of project equipment should be secured.

(4) Technical sustainability

Technical sustainability is moderate. It is expected that the research results on water and salt balance, water management, soil fertility and food and oil crop production will be shared through policy recommendation. However, within the counterpart organizations, they did not sufficiently share with research skills, techniques of data analysis, and management of provided research equipment to the other researchers who have not been involved with the Project,

It is necessary for C/P organizations to take concrete measures for maintenance and operation of the provided equipment. The Project already started to training on preventive use of equipment. For instance, counterpart organizations already obtained skills in operation and maintenance of ET System for Eddy Correlation Method, attending Training Session on Maintenance and Operation of the WAT ET Station held on November 2014.

5.2 Conclusion

The Project has been implemented smoothly at the moment of the terminal evaluation with high relevance, effectiveness and impact, and moderate efficiency and sustainability. It is evaluated that the project purpose will be achieved at the end of the Project with satisfactory achievement level of outputs. Accordingly, the Evaluation Team concluded that it is appropriate to terminate the Project in March 2015 as scheduled.

Chapter 6. Recommendations

6.1 Recommendations for the Remaining Period of Project Implementation

(1) Completion of uncompleted analysis of research activities

- (For the Project) In collaboration with counterpart organizations, the Project needs to complete some unfinished research analysis on bio-fuel crops for more accurate analysis.

(2) Finalizing policy and research recommendations

- (For the Project) The Project is drafting policy and research recommendations and elaborating and revising it with comments and suggestion from the Project Advisor, project resources persons (executives) and C/Ps. The Project needs to be sure of completing the recommendations and presenting them to the relevant ministries and research institutions, utilizing opportunities of final symposiums in Japan and Egypt and other occasions as scheduled. They need to be submitted to the relevant ministries and research institutions.

(3) Ownership transfer of provided equipment

- (For the Project) The Project needs to complete necessary procedures so as to properly allocate equipment provided by the Project to each institution.

6.2 Recommendations after Termination of the Project

(1) Reflection of policy and research recommendations into relevant national plan and strategy

- (For MWRI) The Ministry is recommended to attempt to reflect the policy recommendation into new development strategies and incoming sector strategies. It may lead to realization of the overall goal of the Project in the future.
- (For CU, NWRC, and ARC) They are recommended to attempt to reflect the research recommendation into future research plans/ strategies and incoming sector strategies. It may lead to realization of the overall goal of the Project in the future.

(2) Continuation of research activities

- (For CU, NWRC, and ARC) For more accurate statistical implications and more accurate analysis, they are recommended to consider conducting more experiments at the fields.

(3) Strengthening implementation structure for equipment management

- (For CU, NWRC, and ARC) They are recommended to appoint staff in charge of equipment management and to secure an enough amount of budget for its operation and maintenance. The best use of equipment provided by the Project should be ensured and maintained within each institute.

(4) Dissemination of research results

- (For CU, NWRC, and ARC) They are recommended to present research results of the Project as much as possible in the form of published papers, presentations in academic conferences, oral presentation and poster presentation. Furthermore, they are recommended to disseminate the research results to the field by collaborating with other relevant research institutions and implementation section.

(5) Maintaining academic relationship between Japanese and Egyptian sides

- (For Relevant universities and research institutions in Japan) Relevant universities and research institutions and/or researchers in Japan are recommended to continue to support the relevant Egyptian research institutions and/or researchers as far as they can, taking advantage of the opportunities acquired by the Project.

Chapter 7. Lessons Learned

(1). For Implementation structure by multi-institutions, there were some difficulties in project coordination. For smooth coordination of the Project, long-term expert(s) (researcher(s)) should have been dispatched throughout the Project and coordination body among three counterpart organizations from the Egyptian side should have been organized.

(2). The Project formulated a basic structure for joint research in collaboration with CU, NWRC and ARC. Consequently, the Project is a good example of joint research-work between multi-disciplines in several institutions.

(end)

Annexes

Annex 1: Schedule of the Terminal Evaluation

No.	Date	Day	Work Schedule
1	2015/1/11	Sun	AM: Arrival PM: Meeting in JICA Egypt/ Meeting with Project Manager and Project Coordinator and JICA office
2	2015/1/12	Mon	AM: Kick-Off Meeting with Egyptian evaluation team members / Explanation of the JICA evaluation method
3	2015/1/13	Tue	AM: Interview with Project Advisor (CU) PM: Interview with C/Ps from CU
4	2015/1/14	Wed	AM: Interview with C/Ps form WMRI PM: Interview with C/Ps from RRTC and Field visit (Sakha experiment field)
5	2015/1/15	Thu	AM: Courtesy call to ARC Sakha Station PM: Interview with C/Ps from RRTC and ARC
6	2015/1/16	Fri	Report writing
7	2015/1/17	Sat	Report writing
8	2015/1/18	Sun	AM: Courtesy call to NWRC and interview with C/Ps from NWRC PM: Interview with C/Ps from NWRC in Kanatel
9	2015/1/19	Mon	AM: Interview with C/Ps from CU PM: Meeting in JICA Egypt Office/ Internal Meeting with mission members
10	2015/1/20	Tue	AM: Interview with C/Ps from ARC in Giza and C/Ps from SWERI PM: Interview with Chief Advisor of SWMT Project
11	2015/1/21	Wed	AM and PM: Meeting with Egyptian members PM: Courtesy call to Project Manager (CU) and internal meeting
12	2015/1/22	Thu	AM: Presentation on the Project Achievement -1 PM: Interview with C/P from ARC and visit ET tower at CU and WAT laboratory
13	2015/1/23	Fri	Report writing
14	2015/1/24	Sat	Field visit (Zankalon experiment field) and Report writing
15	2015/1/25	Sun	Report writing
16	2015/1/26	Mon	AM: Presentation on the Project Achievement -2 PM: Internal meeting and report writing
17	2015/1/27	Tue	AM: Presentation on the Project Achievement -3, interview with General Director of MWRI Planning Department, and interview with NWRC/ MWRI on the Policy and Research Recommendations PM: Discussion on the Evaluation Report and finalizing the Report
18	2015/1/28	Wed	AM: Meeting with Director of WMRI PM: Round Table Discussion at ARC Meeting with Director of FCRI Report of the Evaluation Report to Project Director
19	2015/1/29	Thu	AM: Signing the Evaluation Report AM-PM: 12th JSC Meeting - Report on the results of evaluation / M/M signing PM: Report to Embassy of Japan / JICA Egypt Office
20	2015/1/30	Fri	Departure

Annex 2: Mater Plan of the Project and Expected Outputs

1. Mater Plan of the Project

<u>Overall Goal</u> To contribute to increasing agricultural production and to expanding employment opportunities, as stated in the Socio-Economic Development Five-Year Plan, the National Water Resource Plan and Agricultural Production Plan for Egypt 2017.	
<u>Project Purpose</u> To propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond the rapid population growth.	<u>Indicators for project purpose</u> ◆ Difference of evapotranspiration and crop yield under conventional and different water saving irrigation treatments is quantified. ◆ An optimal water saving irrigation treatment is identified at the Marwa/Meska level by clarifying water management approaches, including water management scheduling, under different irrigation treatments. ◆ An optimal method for the reuse of drainage water is identified in the middle delta. ◆ Optimal cropping patterns are identified according to available water resources.
<u>Outputs</u> 1. Evapotranspiration and salt/water balance in the Nile Delta are clarified.	<u>Indicators for Output 1</u> (Meska level) ◆ Fluctuation of transpiration and evaporation by using the eddy correlation system from the field under the long-interval irrigation treatments is quantified and agreed with the previous studies. ◆ The water use efficiency (yield per unit water) in conventional and proposed water saving irrigations is quantitatively compared. ◆ The relation between windbreak porosity and reduction of evapotranspiration is quantified for Casualina and Eucalypts trees. (Canal / Delta level) ◆ The water/salt balance model for canal/drain command area is developed and extended to the delta area.
2. An improved plan of irrigation management at the different canal levels in the Nile Delta is developed.	<u>Indicators for Output 2</u> (Meska level) ◆ Analysis of monitoring data on fluctuations of water levels, frequency of pumping and pumping volume at the pilot Marwa/Meska is presented. ◆ Interaction of observed fluctuations above with the capacity of Marwa, the number of farmer and area of farmland is identified. ◆ Fuel efficiency for traditional pumping and improved pumping methods at the pilot Marwa/Meska is quantified. (Meska/Canal/Delta levels) ◆ Impacts of water saving options at the branch canal level are assessed under different scenarios by using the results above.

3. Methods for controlling salinity and fertility of soil are developed.	Indicators for Output 3 (Meska/Canal levels) ◆ Monitoring data on distribution and intensity of salt accumulation at paddy and non-paddy fields in the mid-delta are analyzed and compared with previous studies. ◆ Monitoring data on spatial distribution and temporal fluctuation of ground water level, flow and EC value of the tile drainage of the pilot fields are analyzed. ◆ Methods of improving tile drainage to control salinity are investigated. ◆ Parameters for water, salt, heavy metals and other contaminants movement in soils at the experimental field are identified. ◆ Decrease of salinity level after using farmland as paddy field is quantified. ◆ Water permeability and physical parameters of soils with the application of calcium sulfate (Gypsum) and organic matter in crop fields is quantified. (Delta level) ◆ A simulation model of water, salt, heavy metals and other contaminants movement in soils at the experimental field is developed and extended to delta areas of similar soils.
4. Appropriate crop production and irrigation management systems at the farm level are developed.	Indicators for Output 4 (Laboratory level) ◆ Salt tolerance of cultivated varieties of major crops is quantified by using both pot (and lysimeter) experiment(s). (Meska/Canal levels) ◆ Appropriate cropping pattern corresponding to the future water availability is proposed based on survey data on cropping pattern at the target area. ◆ Crop yield and quality under different irrigation treatments are identified. ◆ Feed value of straws (rice, wheat, maize) grown under different irrigation treatments is measured and an appropriate feeding design is developed. ◆ Yield of bio-fuel crops under different irrigation treatments and planting densities is measured and an appropriate production method is suggested.

2. Expected Outputs

Expected Outputs with PI/CP (2nd December, 2014)

PRJECT DIRECTOR: Dr. Hany El-Shemy **PROJECT MANAGERS:** Dr. Masayoshi Satoh (Japan) and Dr. Rushdi El Kilani (CU)
ADVISOR: Dr. Samir A. Aboulroos (CU)
OTHER EXECUTIVES: Dr. Hisham Mustafa (Director, WMRI), Dr. Mohamed Soliman (Directeer, FCRI), Dr. Khaled Ali Abou Shady (Director, Sakha Research Station)

Expected Outputs	PI, Egyptian	CP, Egyptian	PI, Japanese	CP, Japanese
Group 1: Water and Salt Balance	GL: Dr. Rushdi El-Kilani (CU)		GL: Dr. H. Fujimaki (TU)	
1. Evapo-transpiration (ET) in conventional and water-saving cultivations for major crops is quantified.	Dr. Rushdi El-Kilani (CU)	Dr. Mahmoud Abdalla (ARC), Dr. Ahmed Abdel Fattah (WMRI)	Dr. Michiaki Sugita (UT)	
2. Transpiration of wind break trees and ET from agricultural land surrounded by the trees are quantified.	Dr. Rushdi El-Kilani (CU)	Dr. Mahmoud Abdalla (ARC), Dr. Ahmed Abdel Fattah (WMRI), Dr. Safaa Ghorab (ARC)	Dr. Michiaki Sugita (UT)	
3. Specific features of water distribution and water/salt balance in the irrigated land at different improvement stages of water management are clarified. thus a water/salt balance model for the middle delta is developped.	Eng. Yousef Mahfouz Hassanin (DRI) Eng. Ahmed Habash (DRI)	Dr. Mohamed Ismail (SWERI)	Dr. Tomoyuki Taniguchi (UT)	Dr. Masayoshi Satoh (UT), Dr. Xin Yuan (UT)
4. The relationship among water, soil and crops will be clarified.	Dr. Rushdi El-Kilani (CU)	Dr. Sayed Ahmed Safina (CU), Dr. Mahmoud Abdalla (ARC)	Dr. Shuichiro Yoshida (Tokyo Univ.)	Dr. Katsuyoshi Shimizu (UT)
Group 2: Water Management	GL: Dr. Talaat El Gamal (WMRI)		GL: Dr. M. Satoh (UT)	
1. State of water distribution among farmers/farmers' groups and its impact on land use and farming are clarified.	Dr. Talaat El Gamal (WMRI)	Dr. Mohamed Meleha (WMRI)	Dr. Masayoshi Satoh (UT)	Dr. Atsushi Ishii (UT), Dr. Tomoyuki Taniguchi (UT), Dr. Xin Yuan (UT)
2. Factors influencing on water distribution such as hydraulic facilities, organization and farmers' behavior are analyzed.	Dr. Gamal Fawzy (WMRI)	Dr. Mohamed H. A. Nawar (CU)	Dr. Atsushi Ishii (UT)	Dr. Shusuke Matsushita (UT)
3. Impacts and problems of decreased allocation of water on water distribution and crop selection under the present facilities and organizations are identified.	Dr. Waleed Abou El Hassan (WMRI)	Dr. Mohamed Meleha (WMRI)	Dr. Tomoyuki Taniguchi (UT)	
4. Energy source and efficiency in lifting water are analyzed.	Dr. Abdrabbo Abdel-Azim A. Shehata Aboukheira (WMRI)		Dr. Ryozo Noguchi (UT)	Dr. Tomoyuki Taniguchi (UT)
5. Possible countermeasures to prevent the identified problems and to secure efficiency and sustainability of irrigation are proposed.	Dr. Talaat El Gamal (WMRI)	Dr. Mohamed H. A. Nawar (CU)	Dr. Masayoshi Satoh (UT)	Dr. Atsushi Ishii (UT), Dr. Tomoyuki Taniguchi (UT), Dr. Xin Yuan (UT)
Group 3: Soil Fertility	GL: Dr. Bassiouni A. Zayed (ARC)		GL: Dr. T. Higashi (UT)	
1. Soil quality (including soil classification and dynamics of salt), quality of irrigation water and ground water level are clarified.	Dr. Sayed Saad Naeem (ARC)	Dr. Howida Bayome El-habat (ARC)	Dr. Teruo Higashi (UT)	Dr. Aki Kubota (UT)
2. Problems of the present design criteria and management of tile drain are identified, and an appropriate plan for groundwater control to avoid salt accumulation in the soil is proposed.	Dr. Waleed Abou El Hassan (WMRI)		Dr. Yoshinobu Kitamura (TU)	Dr. Haruyuki Fujimaki (TU)
3. Future salt and contaminant transport are predicted considering the change in water quality and groundwater level.	Dr. Rushdi El-Kilani (CU)		Dr. Haruyuki Fujimaki (TU)	
4. Leaching effect of paddy cultivation is clarified.	Dr. Bassiouni Abdel Razk Zayed (ARC)	Dr. Ismail Saad Hassan El-Refaee (ARC)	Dr. Haruyuki Fujimaki (TU)	Dr. Aki Kubota (UT)
5. Appropriate methods for irrigation and soil quality control in the experimental farms for food and bio-fuel crops are developed.	Dr. Bassiouni Abdel Razk Zayed (ARC)	Dr. Ibrahim Hashim (ARC)	Dr. Teruo Higashi (UT)	Dr. Aki Kubota (UT)
Group 4: Food and Oil Crop Production	GL: Dr. Korany Abdel-Gawad (CU)		GL: Dr. S. Maruyama (UT)	
1. Present cropping pattern is analyzed and the appropriate cropping pattern corresponding to the future water availability is proposed.	Dr. Mohamed H. A. Nawar (CU)	Dr. Azza El Bondari (CU)	Dr. Shusuke Matsushita (UT)	Dr. Katsuyoshi Shimizu (UT)
2. Present irrigation application is quantitatively analyzed and water-saving irrigation methods are examined.	Dr. Sayed Ahmed Safina (CU)	Dr. Saad Shebl (ARC), Dr. Sherif Maher (ARC), Dr. Yousri Atta Abraham (WMRI)	Dr. Sachio Maruyama (UT)	Dr. Haruyuki Fujimaki (TU), Dr. Katsuyoshi Shimizu (UT), Dr. Aki Kubota (UT)
3. State of salt accumulation distribution is clarified and appropriate selection of salt tolerant crops including new lines is tested and proposed.	Dr. Abdallah Abd El Naby (ARC)	Dr. Sherif Maher (ARC)	Dr. Katsuyoshi Shimizu (UT)	
4. Present state of animal usage is clarified and efficient systems for forage production and livestock feeding are designed.	Dr. Alaa El-Din Hassan Mohamed (ARC)	Dr. Ahmed Mohamed Abdel Magied Hussein (ARC)	Dr. Naoto Ishikawa (UT)	
5. Methods for fuel crop production using drainage water are developed.	Dr. Safaa Ghorab (ARC)		Dr. Haruyuki Fujimaki (TU)	Dr. Katsuyoshi Shimizu (UT)

* Subject to change by duty, performance and necessity approved in JSC

CU=Cairo University, UT=University of Tsukuba, TU=Tottori University

Annex 3: List of the Input from the Japanese Side

1. Dispatch of Japanese Researchers/Experts

1-1. Summary of Dispatch of Short-term Japanese Researchers/Experts

No.	Name	Specialty	Affiliation	Days	M/M
1	Dr. Masayoshi Sato	Project Manager	University of Tsukuba	601 days	20.03
2	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	Tottori University and Tsukuba University	565 days	18.83
3	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	University of Tsukuba	326 days	10.87
4	Dr. Aki Kubota	Water and Salt Balance, Soil Fertility	University of Tsukuba	226 days	7.53
5	Dr. Xin Yuan	Water and Salt Balance, Water Management	University of Tsukuba	224 days	7.47
6	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	University of Tsukuba	215 days	7.17
7	Dr. Aki Hoshino	Water and Salt Balance, Soil Fertility	University of Tsukuba	126 days	4.20
8	Dr. Naoto Ishikawa	Food Production, Bio Energy	University of Tsukuba	126 days	4.20
9	Dr. Shusuke Matsushita	Water Management, Food Production	University of Tsukuba	125 days	4.17
10	Dr. Michiaki Sugita	Water and Salt Balance, Water Management	University of Tsukuba	99 days	3.30
11	Dr. Sachio Maruyama	Food Production	University of Tsukuba	75 days	2.50
12	Dr. Shuichiro Yoshida	Water and Salt Balance	Tokyo University	32 days	1.07
13	Dr. Yoshinobu Kitamura	Water and Salt Balance, Soil Fertility	Tottori University	26 days	0.87
14	Dr. Atsushi Ishii	Water and Salt Balance	Mie University	24 days	0.80
15	Dr. Mitsuhiro Inoue	Water and Salt Balance	Tottori University	22 days	0.73
16	Dr. Teruo Higashi	Soil Fertility	University of Tsukuba	18 days	0.60
17	Dr. Tomohiro Takigawa	Food Production	University of Tsukuba	18 days	0.60
18	Dr. Ryozo Noguchi	Bio Energy	University of Tsukuba	17 days	0.57
	Total			2865 days	95.50

1-2 Short-term Japanese Researchers/Experts

No.	Name	Specialty	Period from	Period to	Days	Affiliation
1	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2009/6/9	2009/9/4	88 days	University of Tsukuba
2	Dr. Masayoshi Sato	Project Manager	2009/7/18	2009/7/23	6 days	University of Tsukuba
3	Dr. Michiaki Sugita	Water and Salt Balance	2009/8/6	2009/8/17	12 days	University of Tsukuba
4	Dr. Katsuyoshi Shimizu	Food Production	2009/8/8	2009/8/17	10 days	University of Tsukuba

5	Dr. Masayoshi Sato	Project Manager	2009/8/22	2009/9/2	12 days	University of Tsukuba
6	Dr. Tomoyuki Taniguchi	Water and Salt Balance	2009/8/22	2009/12/28	129 days	University of Tsukuba
7	Dr. Atsushi Ishii	Water and Salt Balance	2009/8/25	2009/9/1	8 days	Mie University
8	Dr. Haruyuki Fujimaki	Water and Salt Balance	2009/10/16	2009/10/28	13 days	University of Tsukuba
9	Dr. Masayoshi Sato	Project Manager	2009/10/24	2009/10/31	8 days	University of Tsukuba
10	Dr. Tomohiro Takigawa	Food Production	2009/10/24	2009/10/31	8 days	University of Tsukuba
11	Dr. Mitsuhiro Inoue	Water and Salt Balance	2009/11/15	2009/11/25	11 days	Tottori University
12	Dr. Teruo Higashi	Soil Fertility	2009/11/20	2009/11/26	7 days	University of Tsukuba
13	Dr. Haruyuki Fujimaki	Water and Salt Balance	2009/11/16	2009/12/1	16 days	University of Tsukuba
14	Dr. Masayoshi Sato	Project Manager	2009/12/19	2009/12/27	9 days	University of Tsukuba
15	Dr. Katsuyoshi Shimizu	Food Production	2010/1/14	2010/2/6	24 days	University of Tsukuba
16	Dr. Haruyuki Fujimaki	Water and Salt Balance	2010/2/24	2010/3/11	16 days	University of Tsukuba
17	Dr. Masayoshi Sato	Project Manager	2010/2/26	2010/3/13	16 days	University of Tsukuba
18	Dr. Atsushi Ishii	Water and Salt Balance	2010/2/26	2010/3/13	16 days	Mie University
19	Dr. Xin Yuan	Water and Salt Balance	2010/2/26	2010/3/13	16 days	University of Tsukuba
20	Dr. Tomoyuki Taniguchi	Water and Salt Balance	2010/2/26	2010/3/17	20 days	University of Tsukuba
21	Dr. Mitsuhiro Inoue	Water and Salt Balance	2010/3/2	2010/3/12	11 days	Tottori University
22	Dr. Tomohiro Takigawa	Food Production	2010/3/4	2010/3/13	10 days	University of Tsukuba
23	Dr. Sachio Maruyama	Food Production	2010/3/4	2010/3/13	10 days	University of Tsukuba
24	Dr. Ryozo Noguchi	Bio Energy	2010/3/4	2010/3/13	10 days	University of Tsukuba
25	Dr. Katsuyoshi Shimizu	Food Production	2010/3/4	2010/3/11	8 days	University of Tsukuba
26	Dr. Naoto Ishikawa	Food Production	2010/3/4	2010/3/12	9 days	University of Tsukuba
27	Dr. Shusuke Matsushita	Water Management	2010/3/5	2010/3/10	6 days	University of Tsukuba
28	Dr. Teruo Higashi	Soil Fertility	2010/3/6	2010/3/11	6 days	University of Tsukuba
29	Dr. Masayoshi Sato	Project Manager	2010/3/26	2010/3/31	6 days	University of Tsukuba

30	Dr. Tomoyuki Taniguchi	Water and Salt Balance	2010/3/26	2010/3/31	6 days	University of Tsukuba
31	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2010/4/20	2010/6/8	50 days	Tottori University
32	Dr. Masayoshi Sato	Project Manager	2010/5/11	2010/5/21	11 days	University of Tsukuba
33	Dr. Aki Hoshino	Water and Salt Balance, Soil Fertility	2010/5/17	2010/7/19	64 days	University of Tsukuba
34	Dr. Michiaki Sugita	Water and Salt Balance, Water Management	2010/6/19	2010/6/28	10 days	University of Tsukuba
35	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2010/7/1	2010/7/29	29 days	Tottori University
36	Dr. Sachio Maruyama	Food Production	2010/7/8	2010/7/20	13 days	University of Tsukuba
37	Dr. Naoto Ishikawa	Food Production, Bio Energy	2010/7/8	2010/7/20	13 days	University of Tsukuba
38	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2010/7/8	2010/7/20	13 days	University of Tsukuba
39	Dr. Xin Yuan	Water and Salt Balance, Water Management	2010/7/9	2010/7/23	15 days	University of Tsukuba
40	Dr. Masayoshi Sato	Project Manager	2010/7/9	2010/7/30	22 days	University of Tsukuba
41	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2010/7/9	2010/8/5	28 days	University of Tsukuba
42	Dr. Shusuke Matsushita	Water Management, Food Production	2010/7/16	2010/7/21	6 days	University of Tsukuba
43	Dr. Michiaki Sugita	Water and Salt Balance, Water Management	2010/7/31	2010/8/14	15 days	University of Tsukuba
44	Dr. Aki Hoshino	Water and Salt Balance, Soil Fertility	2010/8/21	2010/9/29	40 days	University of Tsukuba
45	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2010/9/14	2010/10/15	32 days	Tottori University
46	Dr. Yoshinobu Kitamura	Water and Salt Balance, Soil Fertility	2010/9/19	2010/10/1	13 days	Tottori University
47	Dr. Shusuke Matsushita	Water Management, Food Production	2010/9/24	2010/9/28	5 days	University of Tsukuba
48	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2010/9/29	2010/12/3	66 days	University of Tsukuba
49	Dr. Naoto Ishikawa	Food Production, Bio Energy	2010/10/22	2010/11/2	12 days	University of Tsukuba
50	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2010/10/23	2010/10/30	8 days	University of Tsukuba
51	Dr. Masayoshi Sato	Project Manager	2010/11/2	2010/11/16	15 days	University of Tsukuba
52	Dr. Aki Hoshino	Water and Salt Balance, Soil Fertility	2010/12/3	2010/12/24	22 days	University of Tsukuba
53	Dr. Naoto Ishikawa	Food Production, Bio Energy	2010/12/12	2010/12/18	7 days	University of Tsukuba

54	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2011/1/8	2011/2/1	25 days	University of Tsukuba
55	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/1/25	2011/2/2	9 days	Tottori University
56	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/3/19	2011/3/25	7 days	Tottori University
57	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/4/20	2011/5/2	13 days	Tottori University
58	Dr. Naoto Ishikawa	Food Production, Bio Energy	2011/4/21	2011/5/1	11 days	University of Tsukuba
59	Dr. Masayoshi Sato	Project Manager	2011/4/26	2011/5/4	9 days	University of Tsukuba
60	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/5/17	2011/6/9	24 days	Tottori University
61	Dr. Sachio Maruyama	Food Production	2011/5/23	2011/5/31	9 days	University of Tsukuba
62	Dr. Naoto Ishikawa	Food Production, Bio Energy	2011/5/29	2011/6/4	7 days	University of Tsukuba
63	Dr. Masayoshi Sato	Project Manager	2011/5/30	2011/6/4	6 days	University of Tsukuba
64	Dr. Masayoshi Sato	Project Manager	2011/7/1	2011/7/22	22 days	University of Tsukuba
65	Dr. Naoto Ishikawa	Food Production, Bio Energy	2011/7/9	2011/7/21	13 days	University of Tsukuba
66	Dr. Xin Yuan	Water and Salt Balance, Water Management	2011/7/11	2011/7/22	12 days	University of Tsukuba
67	Dr. Michiaki Sugita	Water and Salt Balance, Water Management	2011/7/11	2011/7/22	12 days	University of Tsukuba
68	Dr. Sachio Maruyama	Food Production	2011/7/12	2011/7/23	12 days	University of Tsukuba
69	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2011/7/22	2011/8/7	17 days	University of Tsukuba
70	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/7/27	2011/8/5	10 days	Tottori University
71	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/8/17	2011/8/29	13 days	Tottori University
72	Dr. Sachio Maruyama	Food Production	2011/10/1	2011/10/7	7 days	University of Tsukuba
73	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/10/2	2011/10/12	11 days	Tottori University
74	Dr. Masayoshi Sato	Project Manager	2011/11/14	2011/11/22	9 days	University of Tsukuba
75	Dr. Naoto Ishikawa	Food Production, Bio Energy	2011/11/17	2011/11/22	6 days	University of Tsukuba
76	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2011/12/10	2011/12/20	11 days	University of Tsukuba

77	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2011/12/16	2011/12/29	14 days	Tottori University
78	Dr. Shusuke Matsushita	Water Management	2011/12/18	2011/12/23	6 days	University of Tsukuba
79	Dr. Xin Yuan	Water and Salt Balance, Water Management	2011/12/19	2011/12/29	11 days	University of Tsukuba
80	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/1/16	2012/1/27	12 days	Tottori University
81	Dr. Masayoshi Sato	Project Manager	2012/1/21	2012/1/29	9 days	University of Tsukuba
82	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2012/2/10	2012/2/17	8 days	University of Tsukuba
83	Dr. Masayoshi Sato	Project Manager	2012/2/24	2012/3/14	20 days	University of Tsukuba
84	Dr. Xin Yuan	Water and Salt Balance, Water Management	2012/2/27	2012/3/14	17 days	University of Tsukuba
85	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/2/27	2012/3/17	20 days	Tottori University
86	Dr. Sachio Maruyama	Food Production	2012/3/8	2012/3/15	8 days	University of Tsukuba
87	Dr. Aki Kubota	Soil Fertility, Food Production	2012/3/8	2012/3/15	8 days	University of Tsukuba
88	Dr. Michiaki Sugita	Water and Salt Balance	2012/3/17	2012/3/26	10 days	University of Tsukuba
89	Dr. Shusuke Matsushita	Water Management	2012/4/12	2012/7/3	83 days	University of Tsukuba
90	Dr. Aki Kubota	Soil Fertility, Food Production	2012/4/14	2012/4/25	12 days	University of Tsukuba
91	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/4/16	2012/4/27	12 days	Tottori University
92	Dr. Masayoshi Sato	Project Manager	2012/4/20	2012/5/3	14 days	University of Tsukuba
93	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2012/4/23	2012/5/3	11 days	University of Tsukuba
94	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/5/14	2012/5/19	6 days	Tottori University
95	Dr. Masayoshi Sato	Project Manager	2012/5/29	2012/6/14	17 days	University of Tsukuba
96	Dr. Naoto Ishikawa	Food Production, Bio Energy	2012/5/31	2012/6/9	10 days	University of Tsukuba
97	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2012/5/31	2012/6/14	15 days	University of Tsukuba
98	Dr. Aki Kubota	Soil Fertility, Food Production	2012/5/31	2012/6/14	15 days	University of Tsukuba
99	Dr. Xin Yuan	Water and Salt Balance, Water Management	2012/6/2	2012/6/14	13 days	University of Tsukuba
100	Dr. Masayoshi Sato	Project Manager	2012/6/28	2012/7/23	26 days	University of Tsukuba
101	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/7/2	2012/7/21	20 days	Tottori University

102	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2012/7/10	2012/7/18	9 days	University of Tsukuba
103	Dr. Aki Kubota	Soil Fertility, Food Production	2012/7/10	2012/7/19	10 days	University of Tsukuba
104	Dr. Xin Yuan	Water and Salt Balance, Water Management	2012/7/10	2012/7/23	14 days	University of Tsukuba
105	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2012/7/12	2012/7/26	15 days	University of Tsukuba
106	Dr. Michiaki Sugita	Water and Salt Balance	2012/7/14	2012/7/19	6 days	University of Tsukuba
107	Dr. Sachio Maruyama	Food Production	2012/7/14	2012/7/21	8 days	University of Tsukuba
108	Dr. Teruo Higashi	Soil Fertility	2012/7/15	2012/7/19	5 days	University of Tsukuba
109	Dr. Aki Kubota	Soil Fertility, Food Production	2012/7/30	2012/8/21	23 days	University of Tsukuba
110	Dr. Masayoshi Sato	Project Manager	2012/7/31	2012/8/9	10 days	University of Tsukuba
111	Dr. Michiaki Sugita	Water and Salt Balance	2012/8/22	2012/8/27	6 days	University of Tsukuba
112	Dr. Masayoshi Sato	Project Manager	2012/8/28	2012/10/4	38 days	University of Tsukuba
113	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/8/30	2012/9/14	16 days	Tottori University
114	Dr. Aki Kubota	Soil Fertility, Food Production	2012/9/15	2012/9/22	8 days	University of Tsukuba
115	Dr. Xin Yuan	Water and Salt Balance, Water Management	2012/9/22	2012/10/4	13 days	University of Tsukuba
116	Dr. Naoto Ishikawa	Food Production, Bio Energy	2012/9/26	2012/10/3	8 days	University of Tsukuba
117	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/10/3	2012/10/12	10 days	Tottori University
118	Dr. Aki Kubota	Soil Fertility, Food Production	2012/11/2	2012/11/10	9 days	University of Tsukuba
119	Dr. Masayoshi Sato	Project Manager	2012/11/12	2012/11/25	14 days	University of Tsukuba
120	Dr. Masayoshi Sato	Project Manager	2012/12/13	2012/12/22	10 days	University of Tsukuba
121	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2012/12/17	2012/12/29	13 days	Tottori University
122	Dr. Masayoshi Sato	Project Manager	2013/1/18	2013/1/25	8 days	University of Tsukuba
123	Dr. Aki Kubota	Soil Fertility, Food Production	2013/1/20	2013/1/31	12 days	University of Tsukuba
124	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2013/1/21	2013/1/27	7 days	Tottori University
125	Dr. Masayoshi Sato	Project Manager	2013/2/1	2013/2/28	28 days	University of Tsukuba
126	Dr. Shuichiro Yoshida	Water and Salt Balance	2013/2/1	2013/2/8	8 days	Tokyo University
127	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food	2013/2/27	2013/3/8	10 days	Tottori University

		Production, Bio Energy				
128	Dr. Shusuke Matsushita	Water Management	2013/3/2	2013/3/11	10 days	University of Tsukuba
129	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2013/3/14	2013/3/25	12 days	University of Tsukuba
130	Dr. Aki Kubota	Soil Fertility, Food Production	2013/4/9	2013/4/20	12 days	University of Tsukuba
131	Dr. Masayoshi Sato	Project Manager	2013/4/9	2013/4/27	19 days	University of Tsukuba
132	Dr. Ryozo Noguchi	Bio Energy	2013/4/12	2013/4/18	7 days	University of Tsukuba
133	Dr. Xin Yuan	Water and Salt Balance, Water Management	2013/4/16	2013/4/27	12 days	University of Tsukuba
134	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2013/4/17	2013/4/26	10 days	Tottori University
135	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2013/4/18	2013/4/27	10 days	University of Tsukuba
136	Dr. Aki Kubota	Soil Fertility, Food Production	2013/5/14	2013/5/23	10 days	University of Tsukuba
137	Dr. Masayoshi Sato	Project Manager	2013/5/15	2013/6/11	28 days	University of Tsukuba
138	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2013/5/17	2013/5/26	10 days	Tottori University
139	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2013/6/6	2013/6/9	4 days	Tottori University
140	Dr. Xin Yuan	Water and Salt Balance, Water Management	2013/6/18	2013/7/1	14 days	University of Tsukuba
141	Dr. Masayoshi Sato	Project Manager	2013/6/27	2013/7/11	15 days	University of Tsukuba
142	Dr. Masayoshi Sato	Project Manager	2013/10/6	2013/10/17	12 days	University of Tsukuba
143	Dr. Aki Kubota	Soil Fertility, Food Production	2013/10/18	2013/10/30	13 days	University of Tsukuba
144	Dr. Masayoshi Sato	Project Manager	2013/11/22	2013/12/19	28 days	University of Tsukuba
145	Dr. Xin Yuan	Water and Salt Balance, Water Management	2013/11/29	2013/12/19	21 days	University of Tsukuba
146	Dr. Aki Kubota	Soil Fertility, Food Production	2013/12/3	2013/12/13	11 days	University of Tsukuba
147	Dr. Naoto Ishikawa	Food Production, Bio Energy	2013/12/10	2013/12/21	12 days	University of Tsukuba
148	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2013/12/13	2013/12/24	12 days	University of Tsukuba
149	Dr. Yoshinobu Kitamura	Water and Salt Balance, Soil Fertility	2013/12/14	2013/12/26	13 days	Tottori University
150	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2013/12/16	2013/12/26	11 days	Tottori University
151	Dr. Shuichiro Yoshida	Water and Salt Balance	2014/1/5	2014/1/12	8 days	Tokyo University
152	Dr. Masayoshi Sato	Project Manager	2014/1/9	2014/1/29	21 days	University of Tsukuba

153	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/2/6	2014/2/12	7 days	Tottori University
154	Dr. Aki Kubota	Soil Fertility, Food Production	2014/2/13	2014/2/24	12 days	University of Tsukuba
155	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2014/2/27	2014/3/10	12 days	University of Tsukuba
156	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2014/3/6	2014/3/17	12 days	University of Tsukuba
157	Dr. Xin Yuan	Water and Salt Balance, Water Management	2014/3/6	2014/3/19	14 days	University of Tsukuba
158	Dr. Masayoshi Sato	Project Manager	2014/3/6	2014/3/25	20 days	University of Tsukuba
159	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/3/19	2014/3/29	11 days	Tottori University
160	Dr. Masayoshi Sato	Project Manager	2014/4/12	2014/5/1	20 days	University of Tsukuba
161	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/4/21	2014/4/29	9 days	Tottori University
162	Dr. Michiaki Sugita	Water and Salt Balance	2014/5/9	2014/5/15	7 days	University of Tsukuba
163	Dr. Masayoshi Sato	Project Manager	2014/5/9	2014/5/23	15 days	University of Tsukuba
164	Dr. Aki Kubota	Soil Fertility, Food Production	2014/5/9	2014/5/23	15 days	University of Tsukuba
165	Dr. Xin Yuan	Water and Salt Balance, Water Management	2014/5/9	2014/5/23	15 days	University of Tsukuba
166	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/5/15	2014/5/19	5 days	Tottori University
167	Dr. Shuichiro Yoshida	Water and Salt Balance	2014/5/26	2014/6/3	9 days	University of Tsukuba
168	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2014/6/9	2014/6/20	12 days	University of Tsukuba
169	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/6/12	2014/6/19	8 days	Tottori University
170	Dr. Masayoshi Sato	Project Manager	2014/6/14	2014/7/9	26 days	University of Tsukuba
171	Dr. Xin Yuan	Water and Salt Balance, Water Management	2014/6/20	2014/7/3	14 days	University of Tsukuba
172	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/7/12	2014/7/19	8 days	Tottori University
173	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2014/7/13	2014/7/28	16 days	University of Tsukuba
174	Dr. Aki Kubota	Soil Fertility, Food Production	2014/8/1	2014/8/22	22 days	University of Tsukuba
175	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2014/8/3	2014/8/11	9 days	University of Tsukuba
176	Dr. Xin Yuan	Water and Salt Balance, Water Management	2014/8/21	2014/9/12	23 days	University of Tsukuba
177	Dr. Naoto Ishikawa	Food Production, Bio Energy	2014/8/26	2014/9/12	18 days	University of Tsukuba

178	Dr. Masayoshi Sato	Project Manager	2014/8/29	2014/9/12	15 days	University of Tsukuba
179	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/8/30	2014/9/5	7 days	Tottori University
180	Dr. Sachio Maruyama	Food Production	2014/8/30	2014/9/6	8 days	University of Tsukuba
181	Dr. Michiaki Sugita	Water and Salt Balance	2014/9/1	2014/9/11	11 days	University of Tsukuba
182	Dr. Aki Kubota	Soil Fertility, Food Production	2014/9/1	2014/9/11	11 days	University of Tsukuba
183	Dr. Tomoyuki Taniguchi	Water and Salt Balance, Water Management	2014/9/2	2014/9/12	11 days	University of Tsukuba
184	Dr. Shusuke Matsushita	Water Management	2014/9/3	2014/9/11	9 days	University of Tsukuba
185	Dr. Katsuyoshi Shimizu	Food Production, Bio Energy	2014/9/23	2014/10/4	12 days	University of Tsukuba
186	Dr. Masayoshi Sato	Project Manager	2014/9/28	2014/10/11	14 days	University of Tsukuba
187	Dr. Aki Kubota	Soil Fertility, Food Production	2014/10/6	2014/10/17	12 days	University of Tsukuba
188	Dr. Haruyuki Fujimaki	Water and Salt Balance, Soil Fertility, Food Production, Bio Energy	2014/10/17	2014/10/20	4 days	Tottori University
189	Dr. Michiaki Sugita	Water and Salt Balance	2014/11/5	2014/11/14	10 days	University of Tsukuba
190	Dr. Shuichiro Yoshida	Water and Salt Balance	2014/11/11	2014/11/17	7 days	Tokyo University
191	Dr. Masayoshi Sato	Project Manager	2014/11/14	2014/12/6	23 days	University of Tsukuba
192	Dr. Aki Kubota	Soil Fertility, Food Production	2014/11/18	2014/11/28	11 days	University of Tsukuba
					2865 days	

1-2 Long-term Japanese Experts

No.	Name	Specialty	Period from	Period to	Days	Affiliation
1	Mr. Tetsuo Kamitani	Project Coordinator	2009/9/15	2011/12/19	826 days	-
2	Mr. Shinichi Osaka	Project Coordinator	2011/11/28	2012/4/24	149 days	-
3	Mr. Tetsuo Kamitani	Project Coordinator (Short-term)	2012/6/29	2012/8/4	37 days	-
4	Ms. AyakoOsada	Project Coordinator	2012/9/18	2015/3/31	925 days	-
					1937 days	

2. List of Equipment

Place of Procurement	Name of Equipment	Unit/ set	Price (yen)	Price (LE)	Location	Arrival Date to Egypt	Current Condition (A, B or C)	Utilization (A, B or C)
JFY 2009								
Japan	Flux Measurement System (ET System for Eddy Correlation Method), packing charge	3	29,348,518		CU, SWERI, WMRI	2010/6/18	B	B
Japan	Acoustic Doppler Current Profiler with Boat, Batter Charger, Cable	1	4,974,900		WMRI	2010/3/16	A	A
Japan	TDR MEASUREMENT INSTRUMENT	4	2,683,800		CU, SWERI, WMRI	2010/3/16	A	B
Japan	50Ω MULTIPLEXERS WITH BRACKET	24	2,608,200		CU, SWERI, WMRI		A	B
Japan	15CM/3ROD PROBE FOR TDR 100	105	1,890,000		CU, SWERI, WMRI		A	B
Japan	DATALOGGER 4M	4	1,039,500		CU, SWERI, WMRI		A	B
Japan	Solar Module, Charge Controller	1	35,280		WMRI	2010/3/16	A	A
Japan	25-CH SOLID STATE MULTIPLEKERS	4	763,560		CU, SWERI, WMRI	2010/3/16	A	B
Japan	SOIL MOISTURE/TEMPERATURE/EC SENSOR	65	2,837,625		CU	2010/7/28	8 Broken A, C	B
Japan	EM 50 5ch LOGGER for Soil Moisture/ Temperature/ EC Sensor	13	1,103,340		CU	2010/3/16	3 Broken A, C	A
Japan	LAI PLANT CANOPY ANALYZER	1	1,764,000		CU	2010/3/16	A	A
Japan	Electric Balance	5	189,000		CU, WMRI, HRI	2010/3/16	2 not working A, C	A
Japan	ELECTRONIC LEVEL Pattern stuff SG-3M Metal tripod	1	319,725		WMRI	2010/3/16	A	A
Japan	Weather Hawk	1	309,960		CU	2010/3/16	A	A
Japan	HUMIDITY SENSOR	3	81,648		CU	2010/3/16	A	A
Japan	Small size constant temperature incubator shaker	1	458,850		APRI	2010/7/28	A	A
Japan	Fiber Analysis w/IMPULSE SEALER	1	1,129,800		APRI	2010/7/28	A	A
Japan	Profile Probe / Access tube long Data logger Delta-T Devices DL6	1 1	517,335		WMRI	2010/7/28	Broken and repaired A Lost C	A

Japan	Thermal Properties Measurement of Natural&Engineered Materials	1	367,500		CU	2010/7/28	A	A
Japan	Dewpoint Potential Meter	1	1,176,000		CU	2010/7/28	A	A
Japan	Sap Flow System	8	1,599,984		CU	2010/7/28	Broken and replaced A	A
Japan	Electromagnetic Current meter	1	535,500		WMRI	2010/7/28	A	A
Japan	Laser Distance Meter	1	164,850		WMRI	2010/3/28	A	A
Japan	AQUA Watcher	4	1,554,000		WMRI	2010/7/28	A	A
Japan	Sap Flow Relative Rate Sensor	5	803,250		CU	2010/7/28	A	A
Local	Liquid Nitrogen Storage Vessel	1		7,000	CU		A	A
Local	Rechargeable ER	1		220	CU		-	-
Local	Tripods	1		345	CU		A	A
Local	Water Level Sensor	15		50,250	WMRI	2010/3/24	3 stolen, 1 broken A, C	A
Local	Water Level Sensor & EC Sensor	15		168,750	WMRI, DRI		1 stolen, 3 broken A., C	A
Local	Baro Sensor	2		8,380	WMRI, DRI		A	A
Local	Data Collection Unit	1		1,700	WMRI		Broken C	
Local	Battery Charger	1		1,250	CU		A	A
Local	25m Cable	1		300	CU		-	-
Local	Inverter 150W	1		190	CU		-	-
Local	Power Inverter 350W	1		250	CU		-	-
JFY 2010								
Japan	Plant Water Status Console 3005-1412 SMEC	1	1,120,350		CU	2010/7/28	A	A
Japan	Thermo Manager	1	271,425		WMRI	2010/7/28	Lost C	
Japan	Velocity Meter Model 2000	1	772,800		WMRI	2010/10/18	A	A
Japan	15cm/3Road Probes for TDR100	20	472,500		WMRI	2010/10/18	A	A
Japan	Leaf Chamber Flow meter with portable Photosynthesis System LI-6400XTR	1	9,079,350		CU	2010/10/18	A	A
Japan	Sap Flow Sensor, Micro Logger	1	1,163,400		CU	2010/7/31	A	A
Japan	Outdoors Box	1	827,610		CU	2010/7/31	A	A
Japan	Velocity Meter Setting	1	73,500		WMRI	2010/8/23	A	A
Japan	USB Serial Cable for ADCP	1	5,775		WMRI	2010/7/9	A	A

Japan	Installation operation charge for Flux Measurement System station	1	1,491,000		CU	2010/6/19	-	-
Japan	Charge Controller for Solar Panel SG-4	1	12,180		SWERI	2010/12/3	A	A
Japan	Compact pH Meter	1	98,280		WMRI, DRI	2010/12/3	A	A
Japan	Laser Leaf Area Meter	1	1,541,137		CU	2012/1/8	A	A
Japan	Chlorophyll Meter SPAD-502Plus	1	260,820		CU	2011/5/23	A	A
Japan	Leaf Porometer	1	567,000		CU	2011/5/23	A	A
Japan	Access Tube	1	305,686		WMRI	2011/4/20	A	A
Japan	Portable spectrophotometer	1	1,211,962		CU	2012/1/8	A	A
Japan	Fraction collector	1	296,940		CU	2012/1/8	A	A
Japan	Laser Range Finder TRUPULSE200	1	112,350		HRI	2011/5/30	A	A
Japan	Mill	1	642,600		HRI	2012/1/8	A	A
Local	Generator	1		425	CU		A	A
Local	Electric Pomp	2		1,200	ARC		A	A
Local	Laptop Computer	6		22,085	CU, ARC, WMRI, DRI	2011/3/28	A	A
Local	Solar Panel (with structure)	4		35,800	CU, SWERI,, WMRI		A	A
Local	Liquid Nitrogen Storage Vessel	1		5,500	CU		A	A
Local	Digital Camera	4		6,840	WMRI, DRI		1 Broken A, C	A
Local	Scanner, Printer	1		420	CU		A	A
Local	GPS	3		3,180	WMRI, DRI, RRTC		1 Lost A, C	A
Local	Dry Oven	3		46,200	CU, RRTC, HRI	2011/3/24	B	B
Local	Engine Motor	1		3,100			A	A
Local	Water Level Sensor	5		20,000	WMRI, DRI		A	A
Local	Water Level Sensor & EC Sensor	1		11,600	WMRI		A	A
Local	Data Collection Unit	1		1,900	DRI		C	
Local	Portable CD/DVD writer	1		350	CU		A	A
Local	Desktop Computer	1		3,970	WMRI		A	A
Local	Pick-up Car	1		131,000	CU		A	A
JFY 2011								
Japan	Thermo logger #1921G	40	142,800		WMRI	2011/7/16	Lost C	
Japan	Sap Flow Meter SFM-1	1	625,703		HRI	2011/8/17	A	A

Japan	Micro-wave digestion CX100	1	5,176,500		RRTC	2012/1/8	A	
Japan	StreamPro ADCP	1	2,499,000		WMRI	2012/1/8	A	A
Japan	Weather Hawk WH-Mainst	2	706,860		CU	2012/1/8	A	A
Japan	Multi Auto counter DC-1M5	1	1,039,500		CU	2012/1/8	Repaired A	A
Japan	pH meter F-54, pH standard solution	2	552,983		CU, RRTC	2012/1/8	A	A
Japan	Glass electrode	4	105,840		CU	2012/1/8	A	A
Japan	Spectrophotometer	1	837,900		CU	2012/1/8	A	A
Japan	Portable pH meter B-212	1	24,098		CU	2012/1/8	A	A
Japan	Centrifuge 5804 14.000rpm	1	696,465		RRTC	2012/1/8	need spare parts C	C
Japan	Cable Protection Tube	1	29,925		CU	2012/1/8	-	-
Japan	DC Fan Motor	1	69,825		CU	2012/1/8	A	A
Japan	Community wind temperature measurement system	1	1,284,150		CU	2012/1/8	A	A
Japan	Thermo logger #1921G	50	152,250		WMRI	2012/1/22	Lost C	
Japan	Sap Flow Meter SFM-1	1	870,581		HRI	2012/1/22	2 Stolen A, C	A
Japan	Immersion Water Level Sensor	4	287,280		WMRI	2012/1/22	1 Stolen A	A
Japan	Tensiometer	3	158,550		CU, SWERI, WMRI		A	A
Japan	Satellite data, Satellite Image data, and ASTER(Advanced Spaceborne Thermal Emission and Reflection Radiometer) data	1	883,470		WMRI, SWERI	2011/6/6	A	A
Local	Digital Balance	4		20,240	CU, HRI, RRTC	May. 2011	A	A
Local	Hot Plate	1		4,125	HRI	May. 2011	A	A
Local	Engine Motor	1		3,100	ARC		A	A
Local	Drill	1		979	CU		A	A
Local	Ultrasonic Flow meter SL500	3		293,667	WMRI, DRI	Dec. 2011	B	B
Local	Distillation System	1		52,000	APRI	2011/12/20		
Local	Acer Projector X1110DLP Model No.QSV0001	1		2,362	WMRI		A	A
JFY 2012								
Japan	EM-C1-203 Laser Leaf Area Meter EM-C1-203CA Conveyer attachment	1	1,599,900		RRTC	Arrived through Faculty on 2012.1.7	A	A

Japan	Dewpoint Generator LI-610 / Spare Parts Kit (1) / Manuals (1)	1	1,720,740		CU	AUH-CAI EY 653/27 Sep 2012 10:05-11:56	A	C
Japan	Digestion Testing Device DAISY II 220V / degestion vessel (4) filter bag F57 (2) / vacuum desiccator 240 / desiccator plate 241 / stopcock 210 - 240	1	694,575		CU	AUH-CAI EY 653/27 Sep 2012 10:05-11:57 (Arrived with damage and replaced)	A	C
Japan	Rain gauge CDC-ECRN-50, CDC-Em5b	1	92,820		WMRI	Dr. Satoh on Nov 2012	A	A
Japan	Rain gauge ECRN-50/100, Em5b/50	1	164,640		WMRI	Dr. Satoh on 14 Dec 2012	A	A
Japan	Water level sensor JW-8300-02M-003 / 0~2m / 12-28VDC / output 1-5V / cable length 3m	3	217,350		WMRI	Dr. Fujimaki on 18 Dec 2012	Damaged C	
Japan	Panasonic Toughbook Windows 7 Pro CF-19BC1ADS	1	299,998		SWERI	Dr. Kubota on 21 Jan 2013	A	A
Japan	Panasonic Toughbook Windows 7 Pro CF-19BC1ADS	1	299,998		WMRI	Dr. Kubota on 21 Jan 2013	A	A
Japan	Oil Expeller Pump KT23-100EL osaka Jack Co.ltd UP-35RH-1MB Nitto Zouki Co.	1	404,250		HRI	Arrived through Faculty on 14 Jan. 2013	A	A
Japan	Analytical Balance 120g01mg 1-9991-01	1	121,380		CU	Arrived through Faculty on 25 Sep 2012	A	C
Japan	Leaf Polo Meter CS-1	1	567,000		RRTC	Passenger lugguage with Dr. Kubota, August 2012	A	A
Local	HP Pavillon G6-1320ee Notebook PC	1		4075.00	CU (CRDRS)	Hand over in August 2012	A	A

Local	HP Pavillon G6-1321ee Notebook PC	1		4075.00	CU (CRDRS)	Hand over in August 2013	A	A
Local	Solinst 3001 Levelogger Junior Edge F15/M5	3		10140.00	WMRI		A	A
Local	Solinst 3001 Levelogger Edge F6/M2	10		49800.00	WMRI, DRI		2 Stolen A, C	A
Local	Solinst 3001 LTC Junior M10/F30	4		43160.00	WMRI, DRI		A, C	A
Local	Solinst 3001 Barologger Edge	4		10800.00	WMRI		1 Stolen A, C	A
Local	Solinst 3001 Standard Communication Package(USB) CD, USB cable	1		1600.00	WMRI		A	A
Local	Solinst 3001 Levelogger Junior Edge F15/M5 Communication package (USB) cable 1 unit	3			WMRI		A	A
JFY 2013								
Japan	StreamPro ADCP	1	2,783,340		DRI		A	A
Japan	Electric Balance 0.1g - 3000g SHIMADZU ELB3000 W/AC STD	1	58,500		CU	Dr. Kubota, July 2013	A	A
Japan	Electric Balance 0.01g - 300g SHIMADZU ELB300 W/AC STD	1	121,380		RRTC	Dr. Kubota, October 2013	A	A
Japan	Chlorophyll Meter Konica Minolta SPAD-502 Plus A1RT-106	1	134,925		CU	Dr. Kubota, December 2013	A	A
Japan	Pressure meter HIOKI LR5042 JW-8300-02M-003 with data logger HIOKI	2	175,140		ARC	Dr. Fujimaki, December 2013	A	A
Japan	Water potential sensor P/N40854 MPS-2	10	481,950		SWERI	Dr. Yoshida, January 2014	A	A
Japan	Data Logger Em 50 5ch	2	190,000		SWERI	Dr. Yoshida, January 2014	A	A
Japan	WinRHIZO Regular STD4800	1	827,400		RRTC	Dr. Kubota, 14 February 2014	A	B
Japan	Tensio Meter DIK-3162	12	9,544		WMRI	Dr. Kubota, 14 February 2014	A	A

Japan	Tensio Meter DIK-8333	12	9,261		WMRI	Dr. Kubota, 14 February 2014 Dr. Kubota, 11 May 2014	A	A
Japan	Augar kit for Tensio meter DIK-1640	1	82,950		WMRI	Dr. Kubota, 14 February 2014	A	A
Japan	EC meter LAQUA twin B-771	2	23,100		CU	Dr. Kubota, 14 February 2014	A	A
Japan	Infrared thermometer IT-550S HORIBA	1	54,600		CU	Dr. Kubota, 11 May 2014	A	A
Japan	Tensio Meter DIK-8334	12	111,132		WMRI	Dr. Kubota, 11 May 2014	A	A
Japan	Tripod	1	5,628		CU		A	A
Japan	Digital measure	1	17,325		CU		A	A
Japan	Soil moisture sensor	3	284,550		CU		A	B
Japan	DC fan	3	31,500		CU		A	A
Local	Solinst 3001 Standard Communication Package (USB)	1			WMRI		A	A
Local	Digital camera CASIO EXILM ZS-20 16.1MP 6x2.7HD	1		666	HRI/ARC		A	A
Local	Water flow meter			10,331	HRI		A	A
Local	Filtration and fertigation unit			36,420	ARC		A	A
Local	Engine pump Al-Weilerfarid			33,800	ARC		A	A
Local	Profile probe Delta - T with 15 access tubes	1		53,064	CU, WMRI		2 tube damaged A, C	A
Local	Water level and EC sensor Solinst 3001 Junior LTC M10/F30	9		101,300	WMRI, DRI		A	A
Local	Ion Selective Electrode Thermo Scientific Orion VERSA STAR™ Advanced Electrochemistry Meter	1		97,405	CU	13,915 USD 1USD=7LE	A	C
Local	Water Level sensor Solinst 3001 junior LT M5/F15	5		19,100	RRTC		A	A
Local	BarologgerSolinst 3001LT F5/M1.5	1		2,800	RRTC		A	A

Local	Solinst 3001 Standard Communication Package (USB)	1			RRTC		A	A
JFY 2014								
Local	Solar Panel PX140 120 W Poly-crystalline photovoltaic module Manufacture- Sunset Germany	4		5,500	CU		A	A
		Total	126,638,011	1,517,463				

(Note 1) CU... Cairo University, SWERI…Soil, Water and Environment Research Institute, WMRI…Water Management Research Institute, HRI…Horticulture Research Institute, APRI…Animal Production Research Institute, RRTC…Rice Research Training Center

(Note 2) Current Condition : A: Good, B: Necessary to repair, and C: Impossible to repair

Utilization : A: High, B: Medium, and C: Low

3. Local Activity Cost Expenditure by the Japanese side

as of Dec. 26, 2014

	Exchange Rate: 1LE = 13 yen			Exchange Rate: 1LE = 14 yen			
Japan Fiscal Year	2009 (Jun. 09 - Mar. 10)	2010 (Apr. 10 - Mar. 11)	2011 (Apr. 11 - Dec. 11)	2012 (Apr. 12 - Mar 13)	2013 (Apr. 13 - Mar 14)	2014 (Apr. 14 - Mar 15)	Total
Amount (LE)	318,429.61	663,267.11	406,478.30	1,297,571.43	1,026,214.29	1,115,770.00	4,827,730.73

4. Training in Japan

No.	Name of participant	Affiliation	Position	Field of training	Period from	Period to	Days	Organizer
1	Prof. Dr. Ezzaldin. O. Abusteit	Faculty of Agriculture, CU	Dean	Kick-off Meeting (Project Director)	2009/12/7	2009/12/13	7 days	University of Tsukuba
2	Prof. Hany A. El-Shemy	Faculty of Agriculture, CU	Professor	Kick-off Meeting (Project Manager)	2009/12/7	2009/12/13	7 days	University of Tsukuba
3	Dr. Amr Farouk AbdelkhalikMoustafa	ARC	Researcher	Kick-off Meeting (Food Production)	2009/12/7	2009/12/13	7 days	University of Tsukuba
4	Dr. Tarek M.SalaheldinMostafa	Faculty of Agriculture, CU	Associate Professor	Kick-off Meeting (Soil Fertility)	2009/12/7	2009/12/13	7 days	University of Tsukuba
5	Mr. Rushdi Al Kilani	Faculty of Agriculture, CU	Associate Professor	Water and Salt Balance	2011/10/3	2011/11/3	32 days	University of Tsukuba
6	Mr. Waleed H .M.Abou El Hassan	WMRI	Researcher	Water and Salt Balance	2011/10/3	2011/11/3	32 days	University of Tsukuba
7	Mr. Mohamed Meleha	WMRI	Chief Researcher	Water and Salt Balance	2011/10/3	2011/11/3	32 days	University of Tsukuba
8	Mr. Sayed SaadNaeem	Field Crops Research Institute, ARC	Researcher	Soil Fertility	2011/10/3	2011/11/3	32 days	University of Tsukuba
9	Ms. Howida Bayome El-habat	Field Crops Research Institute, ARC	Researcher	Soil Fertility	2011/10/3	2011/11/3	32 days	University of Tsukuba
10	Mr. Sayed Ahmed Safina	Faculty of Agriculture, CU	Lecturer	Food Production	2011/10/3	2011/11/3	32 days	University of Tsukuba
11	Mr. Alaa El Din Hassan Mohamed	Animal Production Research Institute, ARC	Chief Researcher	Animal Production	2011/10/3	2011/11/3	32 days	University of Tsukuba
12	Ms. Safaa Ahmed Ghorab	Horticulture Research Institute, ARC	Researcher	Bio Energy	2011/10/3	2011/11/3	32 days	University of Tsukuba
13	Mr. Yousef Mahfouz Hassanin	Faculty of Agriculture, CU	Researcher	Water and Salt Balance	2012/8/19	2012/9/15	28 days	University of

									Tsukuba
14	Mr. Sherif Maher Abdel-MonaemBassiouni	ARC	Researcher	Food Production	2012/10/3	2012/10/31	29 days	University of Tsukuba
15	Mr. Yosri Ibrahim Mohamed Atta	WMRI	Researcher	Food Production	2012/10/3	2012/10/31	29 days	University of Tsukuba
16	Mr. Ahmed Mohamed MohamedAbdelfattah	WMRI	Researcher	Water and Salt Balance	2012/10/3	2012/10/31	29 days	University of Tsukuba
17	Mr. Mahmoud Mohamed Abdalla Mahmoud	ARC	Researcher	Water and Salt Balance	2012/10/3	2012/10/31	29 days	University of Tsukuba
18	Mr. Hassan KoranyIsmail	Faculty of Agriculture, CU	Professor emeritus	Food and Oil Crop Production	2013/8/24	2013/9/4	12 days	University of Tsukuba
19	Mr. ShebISaad Mohamed	Sakha Agriculture Research Station, ARC	Procurator	Food and Oil Crop Production	2013/8/24	2013/9/4	12 days	University of Tsukuba
20	Mr. Aboshady Khaled Ali	Sakha Agriculture Research Station, ARC	Director	Food and Oil Crop Production	2013/8/24	2013/9/4	12 days	University of Tsukuba
21	Mr. ShehataAbdrabboAbdelazim	WMRI	Coordinator	Bio Energy	2013/8/24	2013/9/4	12 days	University of Tsukuba

Annex 4: List of the Input from the Egyptian Side

1. Assignment of Egyptian C/P

No.	Title/ Position	Name	Affiliation	Remarks
1	Project Director	Dr. Ali A. Nigm	Dean of Faculty of Agriculture, CU	From June 2009 until August 2009
2	Project Director	Dr. Ezzaldin O. Abusteit	Dean of Faculty of Agriculture, CU	From August 2009 until Feb. 2012
3	Project Director	Dr. Ahmed Nageeb	Dean of Faculty of Agriculture, CU	From August 2012 until July 2013
4	Project Director	Dr. Mohamed Yousri Hashem	Dean of Faculty of Agriculture, CU	From August 2013 until July 2014
5	Project Director	Dr. Hany A. El-Shemy	Dean of Faculty of Agriculture, CU	From November 2014
6	Project Advisor	Dr. Samir A. Aboulroos	CU	From Dec. 2009
7	Project Manager	Dr. Hany A. El-Shemy	CU	until July 2012
8	Project Manager	Dr. Rushdi El-Kilani	CU	from September 2012
9	Executive Member	Dr. Nahla Z. Abou El-Fatouh	WMRI	until April 2014
10	Executive Member	Dr. Sami R. S. Sabry	FCRI	until July 2012
11	Executive Member	Dr. Malak Farah Gergis	Agr. Research Stations, ARC	until July 2012
12	Executive Member	Dr. Abbas Abd El-Hay El-Shenawy	ARC	until July 2012
13	Executive Member	Dr. Abdel Aziz A.Abdel Aziz	FCRI	from July 2012 until Dec. 2013
14	Executive Member	Dr. Mohamed Soliman	FCRI	from Dec. 2013
15	Executive Member	Dr. Salah Helal	Agr. Research Stations, ARC	from July 2012 until Dec. 2013
16	Executive Member	Dr. Ola El Galaly	Sakha Agr Res Station	from July 2012 until Sept 2012
17	Executive Member	Dr. Khaled Ali Abou Shady	Sakha Agr Res Station	from Sept 2012
Group 1: Water and Salt Balance				
18	Group Leader	Dr. Rushdi El-Kilani	CU	Group 3 (concurrent)
19		Dr. Ehab Ahmed El Sayed	DRI	until Nov. 2012
20		Dr. Yousef M Mahrous	DRI	from Nov. 2012 until Aug 2014
21		Eng. Ahmed Habash	DRI	from Aug.2014
22		Dr. Mahmoud Abdulla	ARC	
23		Dr. Ahmed Abdel Fattah	WMRI	
24		Dr. Yousri Atta Abraham	WMRI	
25		Dr. Magdy Abdel Nabi	DRI	until Nov. 2012 (passed away)
26		Dr. Tarek Mostafa	CU	until Mar. 2010
27		Dr. Akram El-Ganzouri	NWRC	until Mar. 2010
28		Dr. Ashraf El Sayed	DRI	until Mar. 2011
29		Dr. Ahmed Abdel Fattah	WMRI	
30		Eng. Yousef Mahfouz Hassanin	DRI	from July 2012 until July 2014
31		Dr. Mohamed Ismail	SWERI	from June 2013
32		Dr. Ahmed Habash	DRI	from August 2014
Group 2: Water Management				
33	Group Leader	Dr. Talaat El Gamal	WMRI	
34		Dr. GamalFawzy	WMRI	
35		Dr. Mohamed Meleha	WMRI	
36		Dr. Mohamed H. A. Nawar	CU	
37		Eng. Sohair Kamal	WMRI	until Nov. 2012

38		Dr. Waleed H. M. Abou El Hassan	WMRI	Group 3 (concurrent)
39		Dr. Abdrabbo Abdel-Azim A. ShehataAboukheira	WMRI	from July 2012
Group 3: Soil Fertility				
40	Group Leader	Dr. Bassiouni Abdel RazikZayed	ARC	
41		Dr. Sayed SaadNaeem	ARC	
42		Dr. El-Sharkawi G M Haytham	???	until June 2013
43		Dr. Howida Bayome El-habat	ARC	until Mar 2014
44		Dr. Mohamed AkmalOmara	DRI	until Nov. 2012
45		Dr. Haytham El Sharkawi	ARC	until June 2013
46		Dr. Ismail Saad Hassan El-Refaee	ARC	
47		Dr Salah El Behairy	ARC	until Nov. 2012
48		Dr. Ibrahim Hashim	ARC	from June 2013
Group 4: Food Production				
49	Group Leader	Dr. Korany Abdel-Gawad	CU	
50		Dr. Rafea El-Zanaty	CU	until June 2013
51		Dr. Sayed Ahmed Safina	CU	
52		Dr. Said Shehata	ARC	until June 2013
53		Dr. Alaa El-Din Hassan Mohamed	ARC	
54		Dr. Samir Hegazy	CU	until June 2013
55		Dr. Mahmoud Ibrahim Abo Yousef		until June 2013
56		Dr. Sherif Maher		
57		Dr. Mohamed K. Khalil	CU	from Dec. 2011 until Nov. 2012
58		Dr. Helmy Mohamed Youssef	CU	until Nov. 2012
59		Dr. Abdallah Abd El Naby	ARC	
60		Dr. Ahmed Mohamed Abdel MagiedHussien	ARC	
61		Dr. Amr Farouk	ARC	until Dec 2011
62		Dr. Abbas Elshenawy	ARC	until Dec 2012
63		DrAbdelrahmanGhallab	CU	until Dec 2013
64		Dr. SaadShebl	ARC	from June 2013
65		Dr. Azza El Bendari	CU	from June 2013
Group 5: Bio-Energy				
66		Dr. SafaaGhorab	ARC	to be integrated to Group 4
67		Dr. Abdel Rahman Ghallab	CU	until Nov. 2011
68		Dr. MoahmedHanafy	CU	until Nov. 2011
69		Dr. Sami M. Younis	CU	until Nov. 2011
70		Dr. Mohamed Ghonieny	CU	until Nov. 2011
71		Dr. Mohamed S. Omran	CU	until Nov. 2011
72		Dr. Kamal Mostafa Ismail	ARC	until Nov. 2011
73		Dr. MaisaMonierMegahed	ARC	until Nov. 2011

2. Provision of Facility and Equipment

No.	Item	Organization	Remarks
1	Administration office in CU with necessary utilities for the Project	CU	
2	Laboratory office with necessary utilities for the Project	CU	
3	Administration office in ARC Sakha Research Station	ARC	
4	Experimental land with necessary facility in WMRI Zankalon Station	NWRC	
5	Experimental land with necessary facility in ARC Sakha Research Station	ARC	
6	Necessary arrangement for field experiment in ARC Sakha Research Station	ARC	
7	Necessary arrangement for field experiment in WMRI Zankalon Station	WMRI	
8	Meeting venue with necessary facility for Joint Steering Committee	CU	
9	Meeting venue with necessary facility for a lecture and the round table discussion	ARC	
10	Meeting venue with necessary facility for the round table discussion	NWRC	
11	Laboratory office with necessary utilities for the Project	ARC	

3. Operational Cost Sharing

No.	Item	Organization	Remarks
1	Travel allowance and accommodation expenses for Egyptian Researchers	CU, NWRC, ARC	
2	Cultivation expenses in ARC Sakha Research Station since winter 2012	ARC	Machinery, labors, seeds, fertilizer, etc.
3	Cultivation expenses in WMRI Zankalon Station (Cost share)	NWRC	Machinery, labors, seeds, fertilizer, etc.
4	Laboratory experimental expenses	ARC	Labor, chemicals
5	Field experimental expenses in the Faculty farm	CU	Machinery, labor, seeds, fertilizer, etc.
6	Project car driver with basic salary	CU	

4. Cost Sharing from WMRI

		WMRI		JICA		
Season	Crop	Amount (LE)	Percentage	Amount (LE)	Percentage	TOTAL
2010 Winter	Sugar beet	3,230	68.40%	1,492	31.60%	4,722
2011 Summer	Maize	29,510	60.78%	19,043	39.22%	48,553
2011 Winter	Clover	6,396	25.20%	18,980	74.80%	25,376
2012 Summer	Maize	10,850	43.07%	14,340	56.93%	25,190
2012 Winter	Fava bean	12,110	38.42%	19,407	61.58%	31,517
2013 Summer	Maize	17,920	38.91%	28,140	61.09%	46,060
2013 Winter	Clover, wheat, fava bean	24,080	35.90%	43,000	64.10%	67,080
2014 Summer	Cotton, Maize, Intercrop	47,840	27.66%	125,110	72.34%	172,950
		151,936	**36.05%**	**269,512**	**63.95%**	421,448

Annex 5: Fulfillment of Indicators

Output 1: Evapotranspiration and salt/water balance in the Nile Delta are clarified.	
Indicators	Achievement
(Meska level)	
(Indicator 1-1) Fluctuation of transpiration and evaporation by using the eddy correlation system from the field under the long-interval irrigation treatments is quantified and agreed with the previous studies.	The Project found out that extended irrigation interval method was not highly effective; because extended irrigation interval method did not always show significant effects on water saving and the other promising irrigation methods were identified. Instead of the method, the Project proposed other water saving methods including strip irrigation, drip irrigation, etc. and ET values of those methods were quantitatively clarified.
(Indicator 1-2) The water use efficiency (yield per unit water) in conventional and proposed water saving irrigations is quantitatively compared.	The research activity was implemented as a research activity in Group 4. Water saving effects expressed as maize yield increase per unit water amount indicated that maize yield increase under strip irrigation was 33% and that under drip irrigation by 181%.
(Indicator 1-3) The relation between windbreak porosity and reduction of evapotranspiration is quantified for Casualina and Eucalypts trees.	The Project concluded that it was not so effective to identify the relationship between ET reduction and porosity rates of windbreak trees since it evaluated porosity rates of windbreak trees in the delta at 14 sites, thus obtaining the values of 41-53% (averaged as 47%), which is rather constant. Therefore, the Project decided not to investigate the further relation between windbreak porosity and reduction of evapotranspiration according to the necessity. The porosity rate obtained in Al Krakat field, which was the field of research target, was 44%; it was close to the average of porosity rates. The experiment results showed that the ET value was decreased by 22% over the horizontal distance of 10 times the tree height.
(Canal / Delta level)	
(Indicator 1-4) The water/salt balance model for canal/drain command area is developed and extended to the delta area.	Mass-balance of water and dissolved salt in the pilot drainage site showed the water management process of (i) separation of irrigation water into surface drainage and subsurface drainage, (ii) precipitation of total dissolved solids (TDS) by ET in subsurface drain (iii) dilution by surface drain, (iv) re-irrigation and reflow by water recycling from drain and (v) re-precipitation. The EC values changed the following process: 0.4 dS/m, average value of irrigation water, tripled as 1.2 dS/m in subsurface drain condensed by evapotranspiration (ET), 1.0 dS/m diluted by surface drain (including water leakage), 1.3 dS/m caused by inflow of drain (3.5 dS/m) from the areas where drain was reused. The EC value of irrigation water in main canal ranged from 1.2 to 1.3 dS/m. The indicated model represented increase in EC value in irrigation water can be explained by the process of concentrating and

	diluting drain and re-concentrating in the areas where drain was reused. However, the Project did not apply the suggested model to the whole delta area due to change in research plan of the Project.

Output 2: An improved plan of irrigation management at the different canal levels in the Nile Delta is developed.	
Indicators	Achievement
(Meska level)	
(Indicator 2-1) Analysis of monitoring data on fluctuations of water levels, frequency of pumping and pumping volume at the pilot Marwa/Meska is presented.	The Project monitored and analyzed fluctuations of water levels, frequency of pump operation and pumped volume of water at the pilot meska areas and analyzed the monitored results. The results showed that there was a clear difference in farmers' behavior (including the difference between paddy and no-paddy areas) between areas where a limited water intake time by rotation irrigation was observed and areas near to canals where farmers could take irrigation water at all time.
(Indicator 2-2) Interaction of observed fluctuations above with the capacity of Marwa, the number of farmer and area of farmland is identified.	The concept of "relative water intake capacity," expressed as the figure of pump capacity divided by irrigated area, was proposed for an indicator. This concept, together with upstream-downstream concept, can logically explain the fluctuation of water level in meska and relative water intake capacity that can determine the water intake ability of farmers; those are determinant factors.
(Indicator 2-3) Fuel efficiency for traditional pumping and improved pumping methods at the pilot Marwa/Meska is quantified.	The Project determined not to measure fuel efficiency comparison for traditional pumping and improved pumping methods since no obvious difference in fuel efficiency between the two pumping methods was identified based on the theoretical consideration and interview with relevant farmers.
(Meska/Canal/Delta levels)	
(Indicator 2-4) Impacts of water saving options at the branch canal level are assessed under different scenarios by using the results above.	Two possible methods for the implementation of decreasing water delivery were considered to reduce (i) irrigation time with leaving amount of irrigation water as it is and (ii) amount of irrigation water leaving irrigation time as it is. The first method had effects mainly on downstream meska and the second method has effects mainly on marwa and meska where relative capacity of water flow was lower than the other areas. Furthermore, as for the intensive implementation of recycling drainage water in branch canal, it was revealed that water saving would increase rate and frequency of recycling drainage water in downstream areas, while it would not affect upstream areas and thus effects of water saving was concentrated on downstream areas.

Output 3: Methods for controlling salinity and fertility of soil are developed.	
Indicators	Achievement
(Meska/Canal levels)	
(Indicator 3-1) Monitoring data on distribution and intensity of salt accumulation at paddy and non-paddy fields in the mid-delta are analyzed and compared with previous studies.	The Project obtained the relevant document on the current situation of salt accumulation in soil and found out that (i) salt accumulation in downstream areas in the delta was more intensified than in upstream areas in the delta, (ii) salt accumulation was observed in some area in spots in upstream areas in the delta. The Project demonstrated that findings related water intake management situation of farmers and drainage water reuse. Furthermore, salt accumulation in soil (indicated as EC value of soil) was linearly related with EC value of used canal water. Salt accumulation in downstream areas can be explained by the quality of irrigation water, not by the intrusion of the sea water.
(Indicator 3-2) Monitoring data on spatial distribution and temporal fluctuation of ground water level, flow and EC value of the tile drainage of the pilot fields are analyzed.	The Project measured the ground water level at the Sakha experimental field between absorption lateral pipes and confirmed the fluctuation of ground water level showing that the ground water level rises up to 0.7m from the ground surface after irrigation and descends down to 1.3m from the ground surface in two weeks. Furthermore, it was obviously revealed that drain discharge from absorption lateral pipes abruptly decreased in about three days after irrigation or rainfall. Finally, it was confirmed that absorption lateral pipes effectively exhibited positive desalinization effects even on positions at a distance of absorption lateral pipes such as positions in the middle of absorption lateral pipes since it was found out that horizontal inclination of the groundwater table was gentle/ obtuse and horizontal distribution of the salt accumulation in soil of the root zones was relatively even. It was indicated that discharge of subsurface water was 2 mm/d in summer and 1 mm/d in winter as base amount of flowing water, temporary increase in amount of flowing water immediately after being irrigated, there was no direct relation between EC value and amount of flowing water, which indicated EV value is stable (1.2 dS/m) as a whole.
(Indicator 3-3) Methods of improving tile drainage to control salinity are investigated.	The Project conducted interview survey on functions of subsurface drain facilities for beneficiaries and the relevant technical staff in addition to fact-finding survey, which indicated that they relatively highly evaluated effects of the facilities. On the other hand, the Project was aware of the necessity of monitoring of facility and developed structure of operation and maintenance for facilities since taking concrete measures for maintenance, restoration and renovation of wore-out facilities would be future challenges. The most serious problems with regards to management of subsurface drain facilities were extremely high water level in main drainage (Altitude of benefitted farming areas minus water level in main drainage < 2.5m) and no obvious consistency of cropping pattern and rotation. Consequently, expected functions of subsurface drain were not demonstrated and the growth of cultivated crops is prevented. Based on the survey results, the Project found out that lowering the water-table in the main drains was effective.

	Furthermore, it found out that the rehabilitation of subsurface drains was highly effective.
(Indicator 3-4) Parameters for water, salt, heavy metals and other contaminants movement in soils at the experimental field are identified.	The Project measured water contamination and solute movement characteristics in soil of the delta. Due to the measurement, it was possible for the Project to gain numerical prediction of water contamination and solute movement characteristics once stress response function has been identified. Stress response function of crops will be determined since the obtained data is in the process of analysis.
(Indicator 3-5) Decrease of salinity level after using farmland as paddy field is quantified.	The Project did not confirm lowered salt in soil in paddy areas according to the field survey results collected data in 15 sites. As a result of comparison of salinity levels between paddy area and maize cropping field at the Sakha field, rice cultivation was relatively effective to prevent the build-up of salinity.
(Indicator 3-6) Water permeability and physical parameters of soils with the application of calcium sulfate (Gypsum) and organic matter in crop fields is quantified.	The Project conducted *in situ* column experiments and field experiments on improved soil physical property by application of calcium and rice husks. The Results indicated that there were no statistically significant effects of water contamination, pH value of soil, water-soluble sodium concentration, etc. on soil physical property. Increasing of macro pore and buffering capacity of soils by mixing rice husk of 20t/ha was considered to be effective for lowering value of EC of the soil. Furthermore, as for sand content, it was confirmed by field survey and experiments that increase in EC value could be prevented even on the condition that the EC value of irrigation water was more than 1.5 dS/m in case the sand content of soil was about 50%.
(Delta level)	
(Indicator 3-7) A simulation model of water, salt, heavy metals and other contaminants movement in soils at the experimental field is developed and extended to delta areas of similar soils.	Even though the Project did not grasp the deviation of water contamination and solute movement characteristics in soil of the delta, a suggested simulation model (name of the model? To be added) could be applied to the other areas in the delta since there was no obvious difference observed in those data at Zankalon and Sakha. Actually, it is difficult to gain numerical prediction of heavy metal movement by using the simulation model. The numerical model WASH_2D was not originally designed to apply to topographical pattern of ridge-and-furrow shape. It is preferable that adopting a linear approximation method on furrow irrigation or applying the model to other cases except furrow irrigation.

Output 4: Appropriate crop production and irrigation management systems at the farm level are developed.	
Indicators	Achievement
(Laboratory level)	
(Indicator 4-1) Salt tolerance of cultivated varieties of major crops is quantified by using both pot (and lysimeter)	The Project conducted experiments on salt tolerance of cultivated varieties of major crops (wheat, maize and rice). The Project found out that there were significant differences among development stages of each variety for wheat, maize and rice.

experiment(s).	
(Meska/Canal levels)	
(Indicator 4-2) Appropriate cropping pattern corresponding to the future water availability is proposed based on survey data on cropping pattern at the target area.	The Project observed an annual cropping pattern in water management areas. However, as for water management for the future, the Project did not have to consider cropping pattern changes in the future since the Project proposed an option for water use that did not largely affect cropping/cultivation even at the end of canal by strengthening reuse of drainage water and not increasing salt concentration in irrigation water over the whole area of delta. It should be noted that the target areas of the research (baseline survey) were paddy areas, where more than half of the farmers virtually have an intention to select rice as a summer crop and wheat or sugar beet as winter crop. Therefore, there may be a variety of discussions on cropping options, including allowance of rice crops once in a few years as proposed, in analyzing the future decision-making of farmers on cropping in the areas where rice crops is not suitable or the areas where rice cultivation is prohibited.
(Indicator 4-3) Crop yield and quality under different irrigation treatments are identified.	As for yield of crops, strip irrigation was proposed as an easily applicable and promising water saving method for the future. It shows higher yield as well as water saving. They are attributed to the better aeration to the root zone of plants. However, it has some non-applicable crops for strip irrigation. For non-applicable crops, future technical developments based on the principle of avoiding water logging and water saving are recommended. As for the quality of crops, there was no significant difference in quality of crops between strip and drip irrigations. The Project identified high sugar content of sugar beet cultivated under the drip irrigation system. wheat, maize and rice.
(Indicator 4-4) Feed value of straws (rice, wheat, maize) grown under different irrigation treatments is measured and an appropriate feeding design is developed.	The Project reconfirmed in the field experiment at the Sakha field that the digestive rate of animals for byproducts (stems and leaves) of crops (maize) becomes low under the circumstances of Egypt. An environment-controlled experiment showed that the lowered digestive rate attributes to high temperature and a low moisture in the soil. Furthermore, the experiment demonstrated that byproducts of crop (maize) cultivated by drip irrigation showed less digestive rate of fibers compared with crops by the other irrigation methods. The experiment also indicated that high temperature environment in Egypt and dried environment by drip irrigation caused lowered digestive rate of fibers in comparison with digestive rates obtained by the other irrigation methods. As for new intercropping system proposed in this project, the Project conducted the component analysis and digestion test of byproducts and forage legume. The results indicated that the nutritive value and digestive rate of livestock feed of clover mixed with stem and leaves produced by intercropping have been increased. Thus it suggested the possibility of improving nutritive value and digestive rate of byproducts produced in the environment of Egypt.

(Indicator 4-5) Yield of bio-fuel crops under different irrigation treatments and planting densities is measured and an appropriate production method is suggested.	The Project conducted experiments on comparison of yields of different five oil crops (jatropha, jojoba, castrobean, canola and sunflower) under different canal water and different plant spacing. After that, the Project analyzed appropriate irrigation water amount and plant spacing based on obtained the data up to 2012. The Project currently continues to analyze the data obtained in 2013 and 2014. The results of the analyses are scheduled to be presented by the end of the Project (March 2015). The Project found out that the water productivity of annual plants (canola and sunflower) were higher than those of Jatropha, jojoba, and castorbean according to the results obtained by 2014.

Project purpose: To propose the methods which realize efficient and sustainable agricultural production with efficient water management to respond the rapid population growth.	
(Indicator 1) Difference of evapotranspiration and crop yield under conventional and different water saving irrigation treatments is quantified.	The Project has chosen the conventional irrigation (furrow irrigation), strip irrigation, drip irrigation and extended interval and mulching as means of potential irrigation methods and rice, maize and cotton of summer season crops and wheat, sugar beet, berseem (Egyptian clover) and fava beans for winter crops for test. The Project tested possible and effective combination of crop and irrigation method for water-saving. ET value for each combination was obtained as the coefficient "kc", the coefficient to the value of the standard ET value. By using the calculation method, the Project obtained high values of 1.30 for rice, 1.07 for wheat, and low values of 0.75 for sugar beet and 0.84 for maize. As for ET values of maize in comparison with irrigation methods, the Project obtained the kc of 0.57 in strip irrigation; 0.90 in extended irrigation interval and 0.45 in drip irrigation. The yield is expressed by the ratio of maize yield to that in the traditional (furrow) irrigation; strip irrigation showed increase by 27% and drip irrigation by 55%. Sugar yield of sugar beet was increased by 33%. The Project successfully identified the differences in the proposed applicable irrigation method for water saving in cultivation of major crops in Egypt.
(Indicator 2) An optimal water saving irrigation treatment is identified at the Marwa/Meska level by clarifying water management approaches, including water management scheduling, under different irrigation treatments.	The Project analyzed water management system in the following comparisons: (i) comparison between conventional irrigation and improved irrigation by the Irrigation Improvement project (IIP), (ii) between paddy areas and non-paddy areas, and (iii) between upstream areas and downstream areas in the canal. The Project has found the following; 1) the level of collaboration activities under improved irrigation system is higher than that in the conventional irrigation system, 2) farmers in non-paddy areas take same irrigation amount regardless the water availability, 3) farmers in paddy areas attempt to take as much irrigation water as they can, and 4) inequality in water availability between farmers in downstream and upstream

	areas. It was found out that farmers in downstream areas suffered the following disadvantages: 1) they were forced to do night irrigation for summer crops, 2) they have to irrigate with polluted water and 3) they have to pay additional cost for ground water intake to compensate for a shortage of irrigation water. These recognition has led to the conclusion that rotation irrigation is suitable to paddy area while continuous water delivery is suitable to non-paddy area.
(Indicator 3) An optimal method for the reuse of drainage water is identified in the middle delta.	The Project noted that the total separation of irrigation and drainage canals specially characterizes the delta. It has led to the proposal of mixing drainage water from upstream areas in the main canals of the delta as the optimal method for water reuse. It was because, if this method is not adopted, farmers are requested to manage water recycling by themselves. Consequently, they do not practice mixing of drainage water in each branch canal where they can take irrigation water. On the other hand, reuse of drainage water would be concentrated in downstream areas of branch canal. As a result, inequity between farmers would be intensified and stability of water management would be impaired.
(Indicator 4) Optimal cropping patterns are identified according to available water resources.	At the field level, strip irrigation was suggested as a water saving method that is practically applicable. This method could reduce the use of water by more than 25% by increasing or not reducing crop yield. At the canal level, the EC value of water in irrigation canal was 0.4 dS/m and that of irrigation water in branch drain where subsurface drain and surface drain are mixed in flow was 1.0-1.2 dS/m. It indicated that about 30-40% of irrigated water in the area was drained and thus more than 20% of drainage water was currently reusable. However, from the viewpoint of equity between upstream and downstream areas, the Project proposed that it is appropriate to mix drainage water into irrigation canal from the upstream part of main canal.

Annex 6: Policy and Research Recommendations

January 28, 2015

Proposal from the Water-saving Agricultural Technology (WAT) Project (II)

Policy Recommendation for Water Management in Egypt

When a country has reached the absolute limit of its water resource availability and if the majority of water use is by the irrigation sector, one of the widely recognized methods to meet new water demands is to increase the irrigation efficiency in traditionally managed irrigation systems, e.g., squeezing water out of existing irrigation systems and transferring it to new water users (Brown 2003). Under the absolute limit of water availability, the new construction of dams or reservoirs is now meaningless; the situation is different from the past. Nowadays, the new extraction of water is impossible without jeopardizing sustainability (such as by lowering the groundwater table or using fossil water) and/or the natural environment (such as in the case of the extinction of the Aral Sea).

Egypt typifies this situation. To meet its current food demand, Egypt has been reclaiming agricultural lands outside the traditional production regions of the Nile Valley and Delta, and it has been trying to send water to the desert areas (Arab Republic of Egypt Ministry of Water Resources and Irrigation 2005). In the Toshka development, for example, 5 billion cubic meters (BCM) of fresh water is expected to be used in the coming years in Egypt, and the El Salam canal also needs 2 BCM of fresh water in addition to drainage water. Such a new water demand must be met by reducing the water allocation to the traditional systems, and this requires the improvement of irrigation efficiency in the Delta. The government of Egypt has historically developed institutional and organizational frameworks and technical packages with which various projects have been implemented. They seem to be on the right track, but the methods being used should still be reviewed to ensure that they are as effective as possible, and to determine how the methods can be applied in the future. In addition, all of the relevant discussions should be based on the observed reality in the field.

1. Impacts of water saving on water management in the Middle Delta

In the Middle Delta in Egypt, a considerable amount of water that is still usable for irrigation is released to the Mediterranean Sea at present. This suggests that more water saving can be accomplished in the Delta. However, what impacts of water saving on the irrigation management in the Delta can be expected? Here, 'water saving' means that the present allocation of irrigation water to the delta is reduced and the drainage water is more intensively reused to compensate for the decreased amount of water, in order to maintain the current levels of agricultural production.

The present water recycling methods in the delta have been introduced officially or unofficially where it is necessary and feasible. Under the condition of total separation of irrigation and drainage canals in the Delta, which is one of special characteristics of the Delta, such reuses of water are performed mainly in the downstream part of the main canals, lateral canals and meskas. Farmers in the upstream parts of branch canals can enjoy good-quality water even > 100 km away from Cairo; it is one of the positive aspects of the separation of irrigation and drainage. When the water allocation to main canals is reduced, and if the current principles and methods of water recycling are continued, the negative impacts will surely be concentrated at every level of the irrigation systems downstream, and farmers upstream of irrigation canals will continue enjoying good quality and quantities of water.

First, as a result of a decreased amount of water delivered to irrigation canals, the fresh water may not reach the end of the canals. This would increase the range of water recycling, and more farmers would have to depend on the drainage water although they previously had fresh water. A previous WMRI (Water Management Research Institute, Ministry of Water Resources and Irrigation) study illustrated that reducing the water supply by 2.5% at the head of the Mit Yazid canal in the Middle Delta resulted in a 42% reduction of water availability at the tail-end region that was already suffering from a water shortage. . It shows that the decreased amount of fresh water would not be shared equally by all of the farmers concerned; rather, it would be shared only by the downstream farmers.

Second, the farmers who are presently depending on recycled water would have to rely more heavily on the drainage water. As seen in **Fig. 1**, at present some drainage water mixing is performed as necessary. Because of the decreased allocation of fresh water, these farmers must count on the degraded water more often.

Third, the farmers who take irrigation water directly from a drain (and not by mixing with fresh water) would suffer from further degraded water in the drain. This is because the lower quality of mixed irrigation water applied in the upstream part results in further-degraded drainage water downstream.

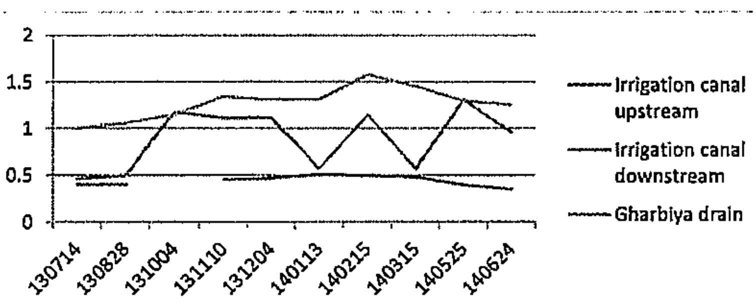

Fig. 1. Fluctuation of Electric Conductivity (EC) in irrigation water downstream of the Abshan Canal, a branch canal taking water from the Bahr Terra main canal. In the downstream part of the Abshan Canal, the drainage water is introduced from the Gharbiya Drain when the quantity of water from the irrigation canal becomes low. Thus the salinity in the irrigation water fluctuates between two salinity values: that of the original irrigation water and that of the drainage water.

In this regard, we should be aware that the water in the drain would surely be greatly decreased in quantity and badly degraded in quality due to the decreased allocation of water to the delta. The macroscopic water balance tells us that drained water is the residue of applied water after evapotranspiration (consumptive use) in the delta. The relationship between the amounts of applied water and drainage water is not linear. The quantitative reduction in the applied water must be nearly the same as the reduction in the drainage water. Suppose 60% of the applied water is consumed in the delta and the remaining 40% is then drained: a 10% reduction in applied water (water saving) will result in a 25% reduction of drainage water. Similarly, 20% water saving will result in a 50% reduction of drainage water. Such water saving will also have serious impacts on water quality, especially if the pollution load of specific material, such as heavy metals and coliform, is constant: the concentration of a pollutant would be rapidly increased by fourfold in the case of a 50% reduction of drainage water. As for the salt condensation ratio of irrigation water, the ratio of 2.5 times at present will increase to 4.0 times at the 20 % reduction in the applied water quantity. Considering other sources of salt, the EC will be increased from 1.9 dS/m to more than 2.5 dS/m in the Gharbiya Drain. The water may not be suitable for direct irrigation. Even if the concentration of another pollutant is lower than the standard value at present, it does not guarantee the future suitability of water recycling.

Such physical impacts would create social impacts. First, because of the highly polluted water, farmers in some regions — especially those who are directly using drainage water — might not be able to continue producing food any longer, resulting in the loss of their income source. The health problems that result from polluted water are already a serious concern for these farmers. The farmers in downstream areas, at a disadvantage, have been accepting low-quality water because the water quality is still at an acceptable level. The future situation will be totally different. Strong complaints are expected to be heard from downstream water users.

Second, the water saving will intensify the present inequity in water management among farmers, especially between upstream and downstream farmers. **Figure 2** presents a simple conceptual model of the negative impact distribution at present and in the future. The model shows that most of the negative impact is concentrated in the downstream part of canals, which is understandable. The conflict between farmers is one of the factors that make cooperation among farmers difficult. If no effective counteractions are taken, the water saving in the Delta could constitute a threat to the successful cooperation of farmers in establishing and managing the Water User Association (WUA) by intensifying the water management conflicts.

The most serious potential problem is that the delta farmers may openly start complaining to the government about the policy to transfer water to the desert areas. Such complaints should be avoidable because the policy itself is rational and inevitable for Egypt, as mentioned above. To avoid dissension, the policy should mitigate the inequity among the delta farmers and preferably improve the situation downstream (as indicated in **Fig. 2**). A considerable negative impact on the Delta is unavoidable by the water saving, and thus the policy issue is to decide who in the Delta should shoulder the impact, and how the impact should be handled. The most preferable policy would be the sharing of the negative impact by all of the people in the Delta.

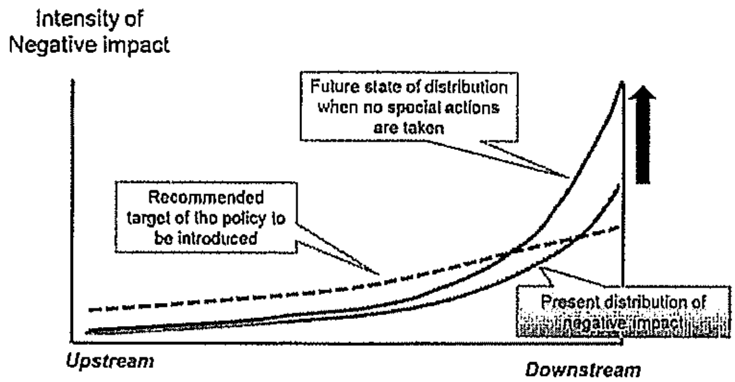

Fig. 2. Conceptual explanation of present and future regional distributions of the negative impact of water scarcity in the Delta.

2. Policy to be introduced

For the secure implementation of water management in the future, three distinct policies are proposed that were induced from our analysis of the present water management described above: (1) methods of water-recycling intensification, (2) the intervention of the government in the meska-level activity, and (3) the redistribution of desert development benefits.

(1) Methods of water-recycling intensification

Water recycling should be intensified in the Delta if the fresh water allocation is reduced because the farmers involved cannot accept any water deficit in quantity while they rather accept qualitatively degraded water. However, the recycling or mixing of drainage water with fresh water should be performed from the upstream part of main canals in the delta. This may be a major change to the traditional method of water recycling in places where it is necessary and possible. This proposal is designed to realize a more equitable distribution of the negative impacts generated by water saving. With such a distribution, even the upstream farmers would use water that is degraded in quality, although the quality would still be rather good and the water provided downstream will not be reduced at all or even increased as long as the main canals have the capacity for that. However, some technical and social problems would arise, as follows.

A topographical issue is of concern. There are not many main drains in the upstream part of the Delta that are suitable for the diversion of water, in terms of the topographical conditions. The development of new connecting canals may be necessary to introduce drainage water to irrigation canals. A second challenge is the water quality problem in the main irrigation canals, because the mixing of drainage water into the main canals may contradict the present health protection policy, which bans the mixing of drainage water in the main canals if the water is to be used downstream for drinking. Strict application of this policy is preferable and has actually been effective for maintaining the health of the people using the water. However, at the same time this health issue will put a strong restriction on water management in the future. Some technical countermeasures to solve this problem are needed. Initially, we should select the drainage canals that have less pollution, and their catchment areas should be designated as special areas for the intensive treatment of sewage.

The topographical problems in terms of the canal construction cost and the preservation of drinking water may be difficult challenges, but they must be overcome.

(2) Intervention of government in the meska-level activity

There have been no concrete cooperative organizations at the meska level in the traditional irrigation system in the Delta. Especially in terms of the water distribution arrangement, we see very few such organizations at the meska level, except in some Irrigation Improvement projects(IIPs) such as Bahr El Nour, where no water distribution arrangement at the branch-canal level is used.

All of the irrigation benefit is coming from production at the field level. When a certain amount of water is given to a irrigation project, the total yield will be maximized when the water is equitably distributed and flexibly shared according to the needs among the farmers involved. For this reason the cooperation of farmers is strongly needed. In reality, however, we cannot depend on the spontaneous cooperation of farmers for the equitable sharing of water or for the sharing of a newly created disadvantage.

The Egyptian government has been maintaining strict rules for the demarcation of canal management responsibilities between the government and farmers. However, if farmers have no capacity for self-management (El-Gamal et al. 2014), some government intervention is required to maintain and improve water use efficiency (Satoh et al. 2014). This does not necessarily require the abandonment of the present system of demarcation. Japan, which is well known for its successful irrigation management, also needs government guidance for cooperative water management by farmers while preserving the principle of self-management (Satoh et al. 2013). This arrangement is supported by a government subsidy system. This system may be instructive for Egypt, and it could be implemented by supporting only groups of farmers that have agreed to cooperate with each other. It should be noted that the water management improvement deserves subsidy in Egypt.

(3) Redistribution of desert development benefits

Impartial water allocation would bring about the maximum yields in irrigated agriculture, in principle. This is explained theoretically using the Law of Diminishing Returns as shown in **Fig.3** (Satoh et al. 2007). Under the simplified assumption of the same soil, area and farmer-ability conditions in the two regions *A* and *B*, unequal irrigation rates to the regions (I_A and I_B) will result in average yields at *Yav*, whereas completely equal water allocation will achieve the average maximum yield at *Ymax*.

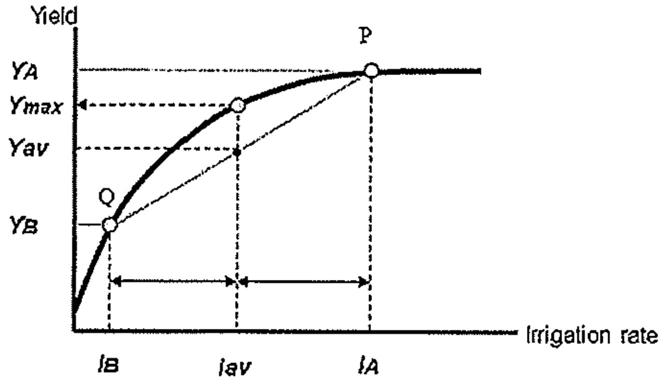

Fig. 3. Law of diminishing returns for irrigation management (Satoh et al. 2007).

In reality, inequitable water allocation is widespread, and it reduces the total production of food. The equitable distribution of water among farmers could thus be a target for government policy, which should be developed with the consensus of farmers in the WUA. This idea also explains the rationale for the transfer of water from the Nile Delta to the desert areas in Egypt, because when the water demand in the Delta emerges, the relationship between the Delta and the deserts can be regarded as an example of large-scale impartial water allocation in the country. The reallocation of water will give the government better income or benefits. That is why it should be implemented even after considering the huge cost for the development.

This conclusion is very simple for the government, or even for a private company controlling everything in the project. However, it should be noted that maximization of the national benefit is achieved by the high beneficial gain for newcomers and the lesser magnitude of loss for the current water users. Different parties stand to gain and to lose. It should be borne in mind that the simple maximization requests the delta farmers to accept a worsened quality of life due to the degradation of their water's quantity and quality or to greater expenditures to maintain their lives at the same level as before.

The reallocation of water needs to eventually be accepted by the delta farmers, because it is very important for the country and because the water is, in principle, a social property. However, a policy that creates a significant difference in benefits and losses among the people in a society may not be easily accepted in reality. In particular, in cases in which the loss is concentrated in some specific groups such as downstream farmers in the Delta, there will be many obstacles to the successful implementation of the policy. To avoid these obstacles, it would be helpful to popularize the idea that some national benefits and disadvantages should be shared among all of the people involved.

A strategic policy to be introduced is to set aside a part of the profit gained from the desert development and then use it to improve the water situation in the Delta, including the promotion of the development of the WUA1 This is especially important because the set-aside profit can be used as a source of funding for the above-described governmental intervention.

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January 27, 2015

Proposal from the WAT Project (I)

Research Recommendations for Crop Production and Soil Management

We have carried out several studies as part of our project to develop water-saving methods that do not produce any reduction in crop yield (or that even increase the crop yield) and that do not use an excessive amount of water for crops. Based on the results of our studies, we propose the following points.

- We recommend the strip irrigation method, which saves 13%–31% of the water and can maintain or even increase crop yields. This method reduces waterlogging problems for crop roots, with better aeration in the soil. We propose further investigations of waterlogging issues toward the goal of better crop production in the Nile Delta, plus studies to find practical methods to control wetted zones in the soil and avoid waterlogging.
- The drip irrigation method saves applied water, increases the yield of several crops, and improves the quality (sugar contents) of sugar beets. However, the economic aspects of this method should be assessed in light of its high construction and operation costs.
- The effects of an extended irrigation interval depend on the area and soils, and the effects under a variety of conditions in different locations should be studied further.
- We recommend the use of windbreak trees on the north side of farmers' fields to control evapotranspiration (ET) from the fields. In our investigation, crop yields were not affected by wind-break trees.
- Some ideas need to be introduced to find a way to reduce the water loss from soil surface during the period without crops.
- A promising way to increase irrigation efficiency and land productivity is a new intercropping method, i.e., planting a second crop (e.g., legumes) on the same ridge in a zigzag manner or by filling the gaps between the main crops. This method is beneficial specifically for small-scale farmers. It merits additional investigation.
- Paddy cultivation has the effect of leaching salt from root zones. We recommend cultivating rice once every few years in a crop rotation in the areas where salt accumulation is expected to reach dangerous levels in the future. Detailed investigations are needed to identify the optimal frequency and conditions for the implementation of this method, which will be aided by the measurement of ET data in paddy fields.
- We found that when irrigation water is mixed with drainage water, the EC of the mixed water less than 1.0 dS/m showed good soil condition under various environments, including the ratio of sand content, crop type and drainage system condition. Further studies leading to the development of guidelines on water EC after such mixtures for soil conservation are recommended.

[I] Water-saving cultivation

Two possible approaches to achieve our target of water-saving crop production are (1) to minimize the wetting zone, e.g., by strip irrigation or drip irrigation, and (2) to reduce the frequency of irrigation events, e.g., by extending the irrigation intervals. The water-saving irrigation methods can also avoid waterlogging in heavy clayey soils.

1. Water-saving irrigation method

Strip irrigation method: Irrigation by fewer irrigation ditches with wider planting beds (Fig. 1). This planting method is a modification of a method originally proposed by Atta (2007). The number of irrigation ditches is one-half that used in the conventional furrow irrigation method, but the planting density remains the same. We recommend this method for irrigating upland crops.

- Approximately 25%–31% of the irrigation water was saved, and the maize yield was about the same as that achieved by furrow irrigation or increased by 27%. Therefore, water productivity (WP) was much higher under the strip irrigation method. It was increased by 27%–70%.
- In winter, 13%–16% of the irrigation water was saved.
- With the strip method, the water applied per maize grain harvested was saved by 0.12–0.40 m^3 water/kg grain.
- The total ET from the field during maize cultivation was reduced by 32% compared to that obtained with furrow irrigation.
- The reason for the increased maize yield is probably the better aeration in the soil, in which roots could grow better; this was confirmed by the testing of fava bean crops in our study. The crop roots may suffer from waterlogging effects for some period after furrow irrigation in the heavy clayey vertisols in the Nile Delta.
- However, the advantage of strip irrigation depends on the crop and its root system. There was no clear effect on wheat, whereas the yield of fava beans was increased by 27% by strip irrigation with better root development.
- Other physiological functions such as photosynthesis could be affected during the waterlogged period as well.
- The strip method is easy for farmers to apply, without any extra costs. Farmers should be encouraged to introduce this method to their fields, at least in some parts of the fields initially.

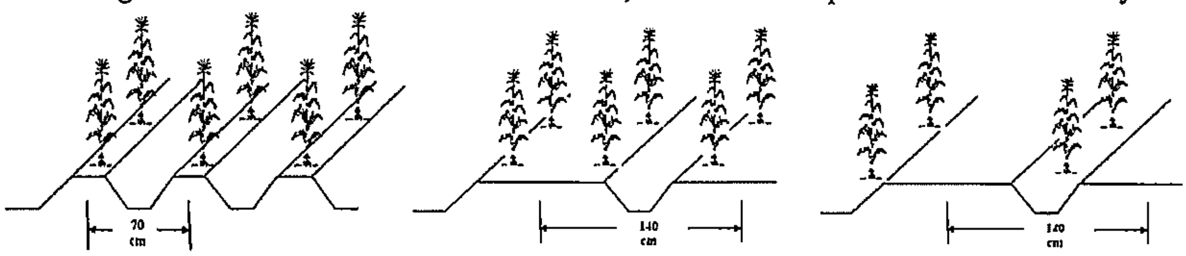


Fig. 1. Conventional furrow irrigation (left), strip irrigation (center), and original Atta method for maize.

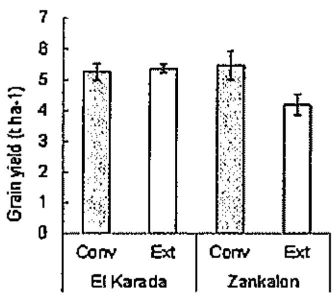
Drip irrigation

- In our study using maize, we found that the drip irrigation method reduced the amount of water by 66% and increased the grain yield by 55% compared to the surface furrow irrigation method.
- The drip irrigation method also increased the root yield of sugar beet by 15% and the sugar content by 16%.

- The drip irrigation that we tested used a fertilizer application regimen that differs from those of conventional furrow irrigation. This point should be studied further.
- The total ET from the field during the cultivation period was also reduced by 47%, and the mean daily ET was approx. 2.0 mm.
- Drip irrigation is regarded as an effective water-saving method, but the cost of installing a drip irrigation system is quite high. Economic analyses to estimate the benefits and costs offered by this method should be conducted.
- The soil salinity under drip irrigation must also be considered. In our study, the EC of soil just under the laterals increased to 6.4 dS/m, whereas that in between the laterals stayed consistent at 4.2 dS/m.

Extended irrigation interval

- With an extended irrigation interval, irrigation water was saved by 8-11 %.
- The extended irrigation interval has different effects on crop growth in different soils (Fig. 2).
- Extending the irrigation interval from 2 weeks to 3 weeks did not affect the maize yield in the soil with > 60% clay content in which the water-holding capacity was very high and the water table was high (approx. 70 cm). However, extending the interval decreased the maize yield grown in the soil with 40% clay content (Fig. 2).
- Therefore, for the introduction of an extended interval (approx. 1 week in summer cultivation), the soil's physical properties in the field and the condition of the water table must be carefully considered.



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Conv: approx. 14-day interval
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- We observed no effect of decreasing ET from the field.
- Another point to be considered is soil salinity, which is often enhanced by extended irrigation as well. When the irrigation interval was extended by 1 week, the soil salinity rose from 3.9 to 11.3 dS/m where the ground water table was high at 70 cm (El Karada field).

Rice cultivation

- An alternative drying-wetting irrigation regimen can be effective for water-saving, soil fertility and rice yield under careful water management.
- When we increased the irrigation interval from the conventional 4 days to 7 and 11 days, 50% and 68% of the water was saved, respectively. However, the rice grain yield was decreased by 20% and 65%, the main cause of which was the reduced number of tillers and panicles.
- This year we conducted a similar experiment with an irrigation regimen planned according to the growing stage. The results indicated that we can save water after the tillering stage has been completed. However, the final conclusion is still under analysis.
- The total ET from a paddy with ordinal water management was 76% higher than that from the maize field. The total ET of the rice was 678 mm, whereas that of the maize was 386 mm. The mean daily ET was 5.1 mm/day.
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- We tried a new style of intercropping farming by planting a second crop (legumes) on the same furrow in a zigzag manner or by filling the gaps between the main crops (Fig. 3).
- This system can provide high land-use efficiency and water-use efficiency by reducing evaporation from the soil. The land equivalent ratio (LER) was improved to 1.17.
- The maize yield tended to increase when the maize was intercropped with Egyptian clover in late summer.
- The byproduct of the crops can also make an excellent feeds for animals. We have confirmed that goats fed byproducts of wheat/Egyptian clover intercropping can produce 10% more milk than those fed monocropped clover. This was due to the well-balanced nutrients and easily digestible properties of the mixture of the feeds.
- Additionally, the intercropping system is a good way to introduce some crops, such as soybean, to farmers by soybean/maize intercropping.
- The intercropping system does have some disadvantages: the complicated control of pests, disease and weeds, and labor-intensive work in intercropping farms. The system could thus be more suitable for small-scale farmers.

Fig. 3. A new intercropping method in summer (left) with maize/soybean and in winter (right) with wheat/Egyptian clover.

3. Other suggestions for water-saving

- We found that the total ET when there were no crops in the fields was 14% of the whole-year ET, which was 140 mm. We plan to find a way to avoid this water loss during this fallow period.

[II] Windbreak trees to reduce the evapotranspiration rate

- We recommend growing windbreak trees on the north side of fields (Fig. 4).
- Setting windbreak trees reduces the wind speed and ET for a distance up to 10 times the trees' height.
- The reduction of ET was approx. 30% during the fallow period and 20% during the maize season compared to the field without windbreak trees (Fig. 5).
- The amount of ET by the trees was negligible (Fig. 5).
- Farmers are usually concerned about the potential yield reduction due to shade from trees, but in this proposed method the trees are on the northern side of fields to break the frequent wind from the north, and there would thus be little or no shade on the crops in

Fig. 4. Windbreak trees at the north edge of a field.

this arrangement.

- No yield reduction was detected by our actual measurement of the maize yield in the farmer's field next to the trees.
- However, the effects of windbreak trees on the crop growth and yield still need to be tested in several locations. Windbreak trees' benefits and costs should be further evaluated. The use of windbreak trees for wood production can also be considered.

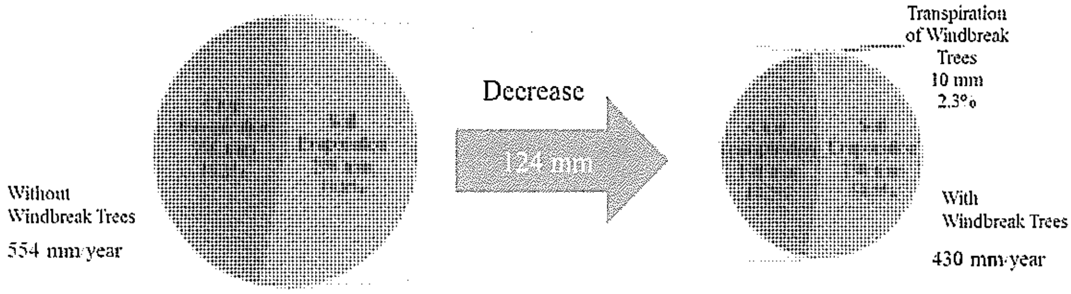


Fig. 5. Change of ET during the maize growing period by windbreak trees

[III] Soil salinity

Leaching to relocate accumulated salt beyond the plant root zone is needed to ensure the reasonable growth of crops. Rice cultivation is known to have leaching effects on soil salinity, especially in the northern part of the Delta where 60% of the farm land is salt-affected soil. Selecting cultivars for salt-tolerant properties is also one of the keys to overcome this issue.

1. Leaching effects of rice cultivation

- In our experimental fields, we confirmed the clear advantage of rice cultivation for leaching salt from the surface soil, compared to maize cultivation (Fig. 6), although some surveys in actual farmers' land did not detect a clear effect of paddy cultivation on soil salinity.
- Although it is widely believed that rice cultivation usually needs much more irrigation water than upland crops, the actual ET was approx. 5 mm/day, which is not as high as we expected.
- It is challenging to achieve both water-saving and soil salinity control at the same time because the less water that is applied, the more salts accumulate. We therefore recommend crop rotation with various crops (including rice) for sustainable crop production, for farms in both the upper and middle delta where the soil is affected by salt in an irregular pattern.

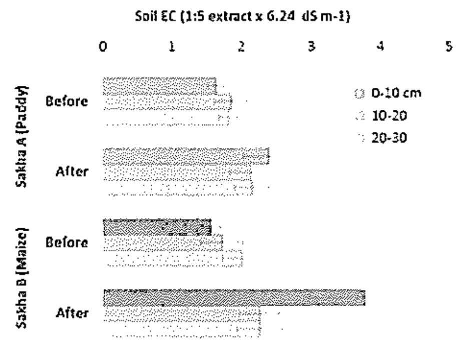


Fig. 6 Effects of paddy cultivation on soil EC

2. Selection of salt-tolerant cultivars

- We compared several wheat cultivars to investigate the physiological mechanisms of salt tolerance. The different cultivars had different responses in germination, photosynthesis and dry matter production. By studying different aspects and growth stages, the mechanism of crops' adaptation to high-salinity soil will be clarified. We are analyzing the results of this study, and we hope to identify one or more indicators for selecting salt-tolerant varieties.

3. Using drained water for irrigation

When drained water is to be mixed with irrigation water for fields, we need to consider the following.

- When the EC of the mixed water is less than 1.0 dS/m, the soil EC is not much affected even if the sand content is low (approx. 10%).
- When the EC of the mixed water is greater than 1.5 dS/m, Ca amendment materials, e.g., gypsum or crushed shells, should be applied to reduce the soil Na/Ca ratio, except in some special conditions such as highly sandy soil (e.g., > 50% sand content).
- In the Nile Delta, drained water to mix with high-quality irrigation water (EC: 0.4-0.45 dS/m) can be used with caution (not to exceed EC 1.0 dS/m). The regular monitoring of mixed irrigation water is therefore necessary.
- The installation of a subsurface drainage system and its maintenance are essential to ensure the above-mentioned effects.

Reference

Atta, Y.I. 2007. Improving growth, yield and water productivity of some maize cultivars by new planting method. Egypt Journal of Application Science, 22(11): 1-16.

Appendix

Table of summery of irrigation methods studied in the project

Irrigation method	Advantage	Disadvantage	Suggested further research
Strip	Water-saving without yield reduction	▶ If water was reduced about 30%, the reduction in crop yield may occur	▶ The effects are depending on the crop (root system) which needs to be confirmed with targeted crops
Extended interval	Water-saving	▶ When the soil is not very clayey (less than 45% clay) yield reduction may occur ▶ Enhance soil salinity	▶ The effects need to be confirmed in different location (soil type)
Drip irrigation	Water-saving with higher yield and quality	▶ It required high cost ▶ Enhance soil salinity	▶ Economical evaluation needs to be carried out
Alternative dry-wet irrigation in paddy	Water-saving	▶ The yield was reduced by less tillering	▶ Need to test the timing of drying treatment

Recommendations to the Government of Egypt from SATREPS Nile Project (2009-2015)

For Efficient and Sustainable Agriculture and Better Water Management in the Nile Delta

March 2015

0

SATREPS is a scheme of Science and Technology Research Partnership for Sustainable Development funded by JST and JICA started in 2008. Under this scheme the Project "Sustainable System for Food and Bio-energy Production with Water-Saving Irrigation in the Egyptian Nile Basin" was implemented during 6 years from 2009 to 2015. Its activities were conducted under the collaboration among University of Tsukuba, Tottori University, Cairo University, National Water Research Center, Ministry of Water Resources and Irrigation, and Agricultural Research Center, Ministry of Agriculture and Land Reclamation of Egypt.

JST: Japan Science and Technology Agency
JICA: Japan International Cooperation Agency

These recommendations are made based on the research results of the project.

(Dr. Masayoshi Satoh, satoh.masayoshi@gmail.com)

Contents

I. Research Recommendations for Crop Production and Soil Management

We have carried out several studies as part of our project to develop water-saving methods that do not produce any reduction in crop yield (or that even increase the crop yield) and that do not use an excessive amount of water for crops. Based on the results of our studies, we propose the following points.

- We recommend the strip irrigation method, which saves 13%–31% of the water and can maintain or even increase crop yields. This method reduces waterlogging problems for crop roots, with better aeration in the soil. We propose further investigations of waterlogging issues toward the goal of better crop production in the Nile Delta, plus studies to find practical methods to control wetted zones in the soil and avoid waterlogging.
- The drip irrigation method saves applied water, increases the yield of several crops, and improves the quality (sugar contents) of sugar beets. However, the economic aspects of this method should be assessed in light of its high construction and operation costs.
- The effects of an extended irrigation interval depend on the area and soils, and the effects under a variety of conditions in different locations should be studied further.
- We recommend the use of windbreak trees on the north side of farmers' fields especially for short crops to effectively control evapotranspiration (ET) from the fields. In our investigation, crop yields were not affected by wind-break trees.
- Some ideas need to be introduced to find a way to reduce the water loss from soil surface during the period without crops.
- A promising way to increase irrigation efficiency and land productivity is a new intercropping method, i.e., planting a second crop (e.g., legumes) on the same ridge in a zigzag manner or by filling the gaps between the main crops. This method is beneficial specifically for small-scale farmers. It merits additional investigation.
- Paddy cultivation has the effect of leaching salt from root zones. We recommend cultivating rice once every few years in a crop rotation in the areas where salt accumulation is expected to reach dangerous levels in the future. Detailed investigations are needed to identify the optimal frequency and conditions for the implementation of this method, which will be aided by the measurement of ET data in paddy fields.
- We found that when irrigation water is mixed with drainage water, the EC of the mixed water less than 1.0 dS/m showed good soil condition under various environments, including the ratio of sand content, crop type and drainage system condition. Further studies leading to the development of guidelines on water EC after such mixtures for soil conservation are recommended.

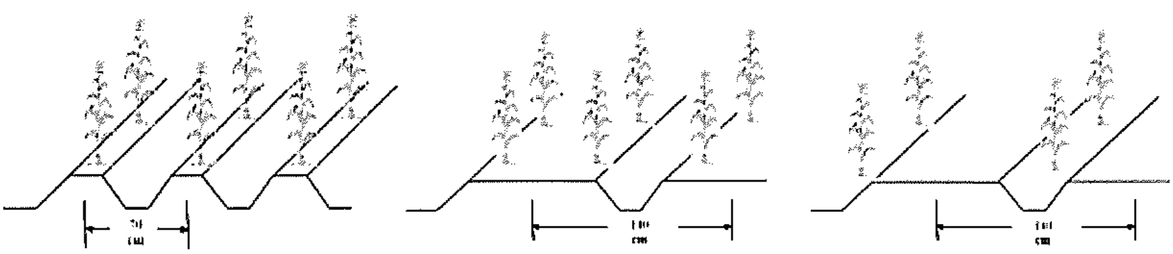
[I] Water-saving cultivation

Two possible approaches to achieve our target of water-saving crop production are (1) to minimize the wetting zone, e.g., by strip irrigation or drip irrigation, and (2) to reduce the frequency of irrigation events, e.g., by extending the irrigation intervals. The water-saving irrigation methods can also avoid waterlogging in heavy clayey soils.

1. Water-saving irrigation method

Strip irrigation method: Irrigation by fewer irrigation ditches with wider planting beds (Fig. 1). This planting method is a modification of a method originally proposed by Atta (2007). The number of irrigation ditches is one-half that used in the conventional furrow irrigation method, but the planting density remains the same. We recommend this method for irrigating upland crops.

- Approximately 25%–31% of the irrigation water was saved, and the maize yield was about the same as that achieved by furrow irrigation or increased by 27%. Therefore, water productivity (WP) was much higher under the strip irrigation method. It was increased by 27%–70%.
- In winter, 13%–16% of the irrigation water was saved.
- With the strip method, the water applied per maize grain harvested was saved by 0.12–0.40 m^3 water/kg grain.
- The total ET from the field during maize cultivation was reduced by 32% compared to that obtained with furrow irrigation.
- The reason for the increased maize yield is probably the better aeration in the soil, in which roots could grow better; this was confirmed by the testing of fava bean crops in our study. The crop roots may suffer from waterlogging effects for some period after furrow irrigation in the heavy clayey vertisols in the Nile Delta.
- However, the advantage of strip irrigation depends on the crop and its root system. There was no clear effect on wheat, whereas the yield of fava beans was increased by 27% by strip irrigation with better root development.
- Other physiological functions such as photosynthesis could be affected during the waterlogged period as well.
- The strip method is easy for farmers to apply, without any extra costs. Farmers should be encouraged to introduce this method to their fields, at least in some parts of the fields initially.



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2

Drip irrigation

- In our study using maize, we found that the drip irrigation method reduced the amount of water by 66% and increased the grain yield by 55% compared to the surface furrow irrigation method.
- The drip irrigation method also increased the root yield of sugar beet by 15% and the sugar content by 16%.
- The drip irrigation that we tested used a fertilizer application regimen that differs from those of conventional furrow irrigation. This point should be studied further.
- The total ET from the field during the cultivation period was also reduced by 47%, and the mean daily ET was approx. 2.0 mm.
- Drip irrigation is regarded as an effective water-saving method, but the cost of installing a drip irrigation system is quite high. Economic analyses to estimate the benefits and costs offered by this method should be conducted.
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- With an extended irrigation interval, irrigation water was saved by 8-11 %.
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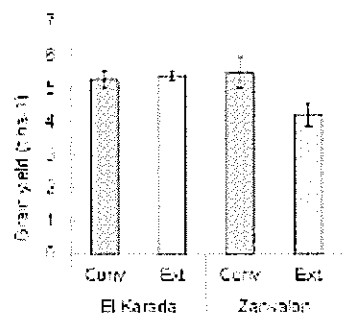

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- This year we conducted a similar experiment with an irrigation regimen planned according to the growing stage. The results indicated that we can save water after the tillering stage has been completed. However, the final conclusion is still under analysis.
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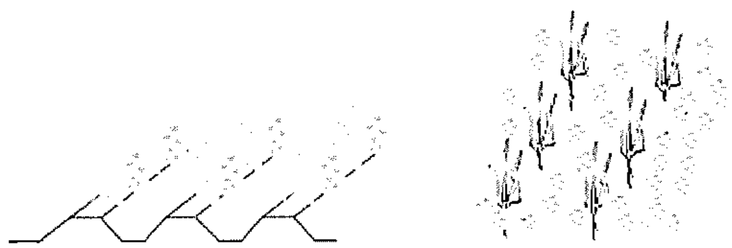

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We recommend growing windbreak trees on the north side of fields (Fig. 4).

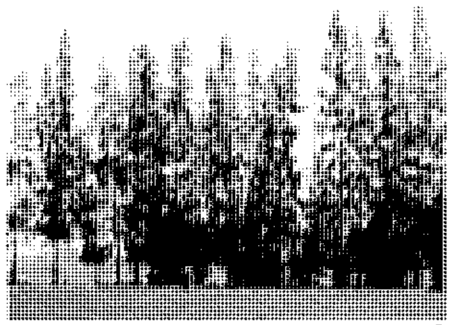

Fig. 4. Windbreak trees at the north edge of a field.

- Setting windbreak trees reduces the wind speed and ET for a distance up to 10 times the trees' height.
- The reduction of ET was approx. 4.5% for a short crop during the summer season cultivated in a 200 x 200 m field with 14-m high Casualina windbreaks compared to the field without windbreak trees. If the size of field is reduced to 100 m in N-S direction, reduction increased to 7%. Reduction cannot be expected for a tall crop such as maize. During fallow season, small reduction is expected for flat soils, but for furrow/ridge soils reduction is not possible.
- The amount of ET by the trees was negligible (Fig. 5).
- Farmers are usually concerned about the potential yield reduction due to shade from trees, but in this proposed method the trees are on the northern side of fields to break the frequent wind from the north, and there would thus be little or no shade on the crops in this arrangement.
- No yield reduction was detected by our actual measurement of the maize yield in the farmer's field next to the trees.
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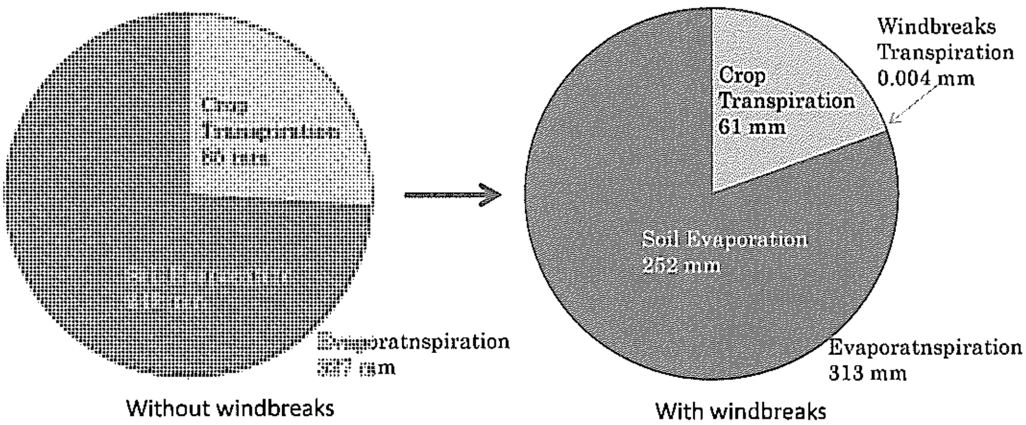

Fig. 5. Change of evapotranspiration in a crop field (200 x 200 m) after the introduction of windbreak trees. (Short crops, summer growing season)

[III] Soil salinity

Leaching to relocate accumulated salt beyond the plant root zone is needed to ensure the reasonable growth of crops. Rice cultivation is known to have leaching effects on soil salinity, especially in the northern part of the Delta where 60% of the farm land is salt-affected soil. Selecting cultivars for salt-tolerant properties is also one of the keys to overcome this issue.

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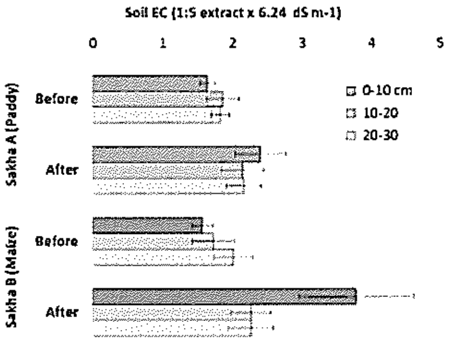

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3. Using drained water for irrigation

When drained water is to be mixed with irrigation water for fields, we need to consider the following.

- When the EC of the mixed water is less than 1.0 dS/m, the soil EC is not much affected even if the sand content is low (approx. 10%).
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Reference

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II. Policy Recommendation for Water Management in Egypt

When a country has reached the absolute limit of its water resource availability and if the majority of water use is by the irrigation sector, one of the widely recognized methods to meet new water demands is to increase the irrigation efficiency in traditionally managed irrigation systems, e.g., squeezing water out of existing irrigation systems and transferring it to new water users (Brown 2003). Under the absolute limit of water availability, the new construction of dams or reservoirs is now meaningless; the situation is different from the past. Nowadays, the new extraction of water is impossible without jeopardizing sustainability (such as by lowering the groundwater table or using fossil water) and/or the natural environment (such as in the case of the extinction of the Aral Sea).

Egypt typifies this situation. To meet its current food demand, Egypt has been reclaiming agricultural lands outside the traditional production regions of the Nile Valley and Delta, and it has been trying to send water to the desert areas (Arab Republic of Egypt Ministry of Water Resources and Irrigation 2005). In the Toshka development, for example, 5 billion cubic meters (BCM) of fresh water is expected to be used in the coming years in Egypt, and the El Salam canal also needs 2 BCM of fresh water in addition to drainage water. Such a new water demand must be met by reducing the water allocation to the traditional systems, and this requires the improvement of irrigation efficiency in the Delta. The government of Egypt has historically developed institutional and organizational frameworks and technical packages with which various projects have been implemented. They seem to be on the right track, but the methods being used should still be reviewed to ensure that they are as effective as possible, and to determine how the methods can be applied in the future. In addition, all of the relevant discussions should be based on the observed reality in the field.

1. Impacts of water saving on water management in the Middle Delta

In the Middle Delta in Egypt, a considerable amount of water that is still usable for irrigation is released to the Mediterranean Sea at present. This suggests that more water saving can be accomplished in the Delta. However, what impacts of water saving on the irrigation management in the Delta can be expected? Here, 'water saving' means that the present allocation of irrigation water to the delta is reduced and the drainage water is more intensively reused to compensate for the decreased amount of water, in order to maintain the current levels of agricultural production.

The present water recycling methods in the delta have been introduced officially or unofficially where it is necessary and feasible. Under the condition of total separation of irrigation and drainage canals in the Delta (which is one of the special characteristics of the Delta), such reuses of water are performed mainly in the downstream part of the main canals, lateral canals and *meskas*. Farmers in the upstream parts of branch canals can enjoy good-quality water even > 100 km away from Cairo; this is one of the positive aspects of the separation of irrigation and drainage. When the water allocation to main canals is reduced, and if the current principles and methods of water recycling are continued, the negative impacts will surely be concentrated at every level of the irrigation systems downstream, and farmers upstream of irrigation canals will continue enjoying good quality and quantities of water.

First, as a result of a decreased amount of water delivered to irrigation canals, the fresh water may not reach the end of the canals. This would increase the range of water recycling, and more farmers would have to depend on the drainage water although they previously had fresh water. A previous study by the WMRI (Water Management Research Institute, Ministry of Water Resources and Irrigation) illustrated that reducing the water supply by 2.5% at the head of the Mit Yazid canal in the Middle Delta resulted in a 42% reduction of water availability at the tail-end region that was already suffering from a water shortage (WMRI 2010). It shows that the decreased amount of fresh water would not be shared equally by all of the farmers concerned; rather, it would be shared only by the downstream farmers.

Second, the farmers who are presently depending on recycled water would have to rely more heavily on the drainage water. As seen in **Figure 1**, at present some drainage water mixing is performed as necessary. Because of the decreased allocation of fresh water, these farmers must count on the degraded water more often.

Third, the farmers who take irrigation water directly from a drain (and not by mixing with fresh water) would suffer from further degraded water in the drain. This is because the lower quality of mixed irrigation water applied in the upstream part results in further-degraded drainage water downstream.

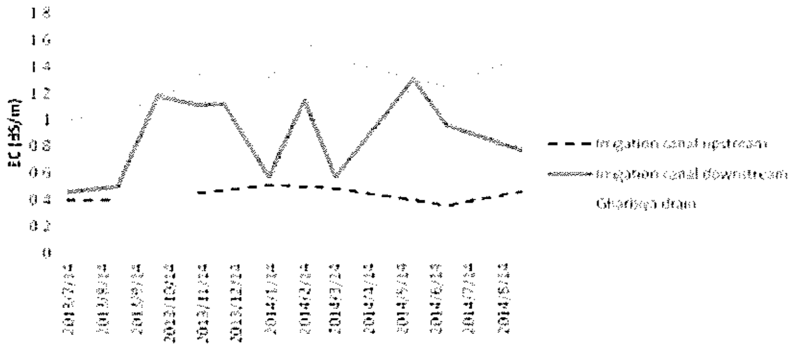

Fig. 1. Fluctuation of electric conductivity (EC) in irrigation water downstream of the Abshan Canal, a branch canal taking water from the Bahr Terra main canal. In the downstream part of the Abshan Canal, the drainage water is introduced from the Gharbiya Drain when the quantity of water from the irrigation canal becomes low. Thus the salinity in the irrigation water fluctuates between two salinity values: that of the original irrigation water and that of the drainage water.

In this regard, we should be aware that the water in the drain would surely be greatly decreased in quantity and badly degraded in quality due to the decreased allocation of water to the delta. The macroscopic water balance tells us that drained water is the residue of applied water after evapotranspiration (consumptive use) in the delta. The relationship between the amounts of applied water and drainage water is not linear. The quantitative reduction in the applied water would result in the reduction in the drainage water by the same amount. Suppose 60% of the applied water is consumed in the delta and the remaining 40% is then drained: a 10% reduction in applied water (water saving) will result in a 25% reduction of drainage water. Similarly, 20% water saving will result in a 50% reduction of drainage water. Such water saving will also have serious impacts on water quality, especially if the pollution load of specific material, such as heavy metals and coliform, is constant: the concentration of a pollutant would be rapidly increased by fourfold in the case of a 50% reduction of drainage water. As for the salt condensation ratio of irrigation water, the ratio of 2.5 times at present will increase to 4.0 times at the 20% reduction in the applied water quantity. Considering other sources of salt, the EC will be increased from 1.9 dS/m to more than 2.5 dS/m in the Gharbiya Drain. The water may not be suitable for direct irrigation. Even if the concentration of another pollutant is lower than the standard value at present, it does not guarantee the future suitability of water recycling.

Such physical impacts would create social impacts. First, because of the highly polluted water, farmers in some regions — especially those who are directly using drainage water — might not be able to continue producing food any longer, resulting in the loss of their income source. The health problems that result from polluted water are already a serious concern for these farmers. The farmers in downstream areas, at a disadvantage, have been accepting low-quality water because the water quality is still at an acceptable level. The future situation will be totally different. Strong complaints are expected to be heard from downstream water users.

Second, the water saving will intensify the present inequity in water management among farmers, especially between upstream and downstream farmers. **Figure 2** presents a simple conceptual model of the negative impact distribution at present and in the future. The model shows that most of the negative impact is concentrated in the downstream part of canals, which is understandable. The conflicts between farmers are one of the factors that make cooperation among farmers difficult. If no effective counteractions are taken, the water saving in the Delta could constitute a threat to the successful cooperation of farmers in establishing and managing the Water User Association (WUA) by intensifying the water management conflicts.

The most serious potential problem is that the delta farmers may openly start complaining to the government about the policy to transfer water to the desert areas. Such complaints should be avoidable because the policy itself is rational and inevitable for Egypt, as mentioned above. To avoid dissension, the policy should mitigate the inequity among the delta farmers and preferably improve the situation downstream (as indicated in **Fig. 2**). A considerable negative impact on the Delta is unavoidable by the water saving, and thus the policy issue is to decide who in the Delta should shoulder the impact, and how the impact should be handled. The most preferable policy would be the sharing of the negative impact by all of the people in the Delta.

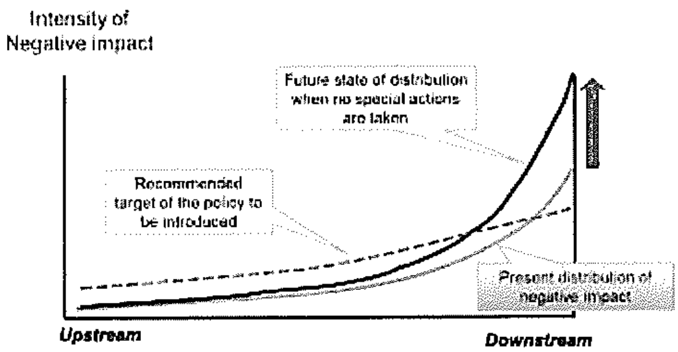

Fig. 2. Conceptual explanation of present and future regional distributions of the negative impact of water scarcity in the Delta.

2. Policy to be introduced

For the secure implementation of water management in the future, three distinct policies are proposed that were induced from our analysis of the present water management described above: (1) methods of water-recycling intensification, (2) the intervention of the government in the *meska*-level activity, and (3) the redistribution of desert development benefits.

(1) Methods of water-recycling intensification

Water recycling should be intensified in the Delta if the fresh water allocation is reduced because the farmers involved cannot accept any water deficit in quantity; they would rather accept water that is degraded in quality. However, the recycling or mixing of drainage water with fresh water should be performed from the upstream part of main canals in the delta. This may be a major change to the traditional method of water recycling in places where it is necessary and possible. This proposal is designed to realize a more equitable distribution of the negative impacts generated by water saving. With such a distribution, even the upstream farmers would use water that is degraded in quality, although the quality would still be rather good and the water availability downstream will not be reduced at all or could even be increased as long as the main canals have the capacity for it. With this method the water could be saved by around 20% while maintaining EC in the drainage canals at 3-4 dS/m. However, some technical and social problems would arise, as follows.

A topographical issue is of concern. There are not many main drains in the upstream part of the Delta that are suitable for the diversion of water, in terms of the topographical conditions. The development of new connecting canals may be necessary to introduce drainage water to irrigation canals. A second challenge is the water quality problem in the main irrigation canals, because the mixing of drainage water into the main canals may contradict the present health protection policy, which bans the mixing of drainage water in the main canals if the water is to be used downstream for drinking. Strict application of this policy is preferable and has actually been effective for maintaining the health of the people using the water. However, at the same time this health issue will put a strong restriction on water management in the future. Some technical countermeasures to solve this problem are needed. Initially, we should select the drainage canals that have less pollution, and their catchment areas should be designated as special areas for the intensive treatment of sewage.

The topographical problems in terms of the canal construction cost and the preservation of drinking water may be difficult challenges, but they must be overcome.

(2) Intervention of government in the *meska*-level activity

There have been no concrete cooperative organizations at the *meska* level in the traditional irrigation system in the Delta. Especially in terms of the water distribution arrangement, we see very few such organizations at the *meska* level, except in some Irrigation Improvement Projects (IIPs) such as Bahr El Nour, where no water distribution arrangement at the branch-canal level is used.

All of the irrigation benefit is coming from production at the field level. When a certain amount of water is given to an irrigation project, the total yield will be maximized when the water is equitably distributed and flexibly shared according to the needs among the farmers involved. For this reason the cooperation of farmers is strongly needed. In reality, however, we cannot depend on the spontaneous cooperation of farmers for the equitable sharing of water or for the sharing of a newly created disadvantage.

The Egyptian government has been maintaining strict rules for the demarcation of canal management responsibilities between the government and farmers. However, if farmers have no capacity for self-management (El-Gamal et al. 2014), some government intervention is required to maintain and improve water use efficiency (Satoh et al. 2014). This does not necessarily require the abandonment of the present system of demarcation. Japan, which is well known for its successful irrigation management, also needs government guidance for cooperative water management by farmers while preserving the principle of self-management (Satoh et al. 2013). This arrangement is supported by a government subsidy system. This system may be instructive for Egypt, and it could be implemented by supporting only groups of farmers that have agreed to cooperate with each other. It should be noted that the water management improvement in Egypt deserves subsidies.

(3) Redistribution of desert development benefits

Impartial water allocation would bring about the maximum yields in irrigated agriculture, in principle. This is explained theoretically using the Law of Diminishing Returns as shown in Fig**ure** 3 (Satoh et al. 2007). Under the simplified assumption of the same soil, area and farmer-ability conditions in the two regions *A* and *B*, unequal irrigation rates to the regions (I_A and I_B) will result in average yields at Yav, whereas completely equal water allocation will achieve the average maximum yield at Ymax.

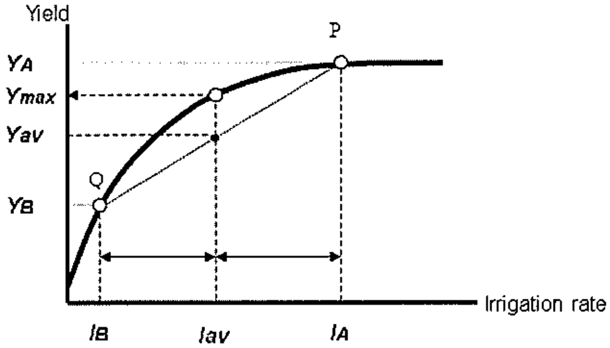

Fig. 3. Law of diminishing returns for irrigation management (Satoh et al. 2007).

In reality, inequitable water allocation is widespread, and it reduces the total production of food. The equitable distribution of water among farmers could thus be a target for government policy, which should be developed with the consensus of farmers in the WUA. This idea also explains the rationale for the transfer of water from the Nile Delta to the desert areas in Egypt, because when the water demand in the Delta emerges, the relationship between the Delta and the deserts can be regarded as an example of large-scale impartial water allocation in the country. The reallocation of water will give the government better income and/or benefits, and that is why the reallocation should be implemented despite the huge cost of the development.

This conclusion is very simple for the government, or even for a private company controlling everything in the project. However, it should be noted that maximization of the national benefit is achieved by the high beneficial gain for newcomers and the lesser magnitude of loss for the current water users. Different parties stand to gain and to lose. It should be borne in mind that the simple maximization requests the delta farmers to accept a worsened quality of life due to the degradation of their water's quantity and quality or to greater expenditures to maintain their lives at the same level as before.

The reallocation of water needs to eventually be accepted by the delta farmers, because it is very important for the country and because the water is, in principle, a social property. However, a policy that creates a significant difference in benefits and losses among the people in a society may not be easily accepted in reality. In particular, in cases in which the loss is concentrated in some specific groups such as downstream farmers in the Delta, there will be many obstacles to the successful implementation of the policy. To avoid these obstacles, it would be helpful to popularize the idea that some national benefits and disadvantages should be shared among all of the people involved.

A strategic policy to be introduced is to set aside a part of the profit gained from the desert development and then use it to improve the water situation in the Delta, including the promotion of the development of the WUA1 This is especially important because the set-aside profit can be used as a source of funding for the above-described governmental intervention.

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地球規模課題対応国際科学技術協力プログラム（SATREPS）
研究課題別終了時評価報告書

１．研究課題名

ナイル流域における食糧・燃料の持続的生産（2009 年 6 月－2015 年 3 月）

２．研究代表者

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２．２．相手側研究代表者：Mohamed Ibrahim（カイロ大学農学部　教授）

３．研究概要

年間降水量がわずか 50mm 程度しかないエジプトでは、水源をほぼ全面的にナイル川に依存している。アスワン・ハイ・ダムが建設された 1971 年以来、ナイル川の水量を完全にコントロールするシステムが採られてきたが、人口増と農地の拡大による水需要の増大によって、エジプトの水需給は逼迫してきている。農地の一部では、灌漑水の蒸発により塩分が集積しているところもある。このような状況下で、エジプト政府は、さらに南部トシュカ地域およびシナイ半島の農地開発のため、水の一部をそこにまわすことを計画している。

本プロジェクトの目的は、ダムの建設によってナイル川の洪水（とそれにともなう肥沃な土壌の供給と塩分の除去）がなくなって半世紀近く経ったエジプト農業の現状を把握するとともに、このような水資源環境下でのエジプトの農業の持続的発展に向けて、ナイル・デルタの農地における節水の可能性と、効率的かつ持続的な灌漑・農業の将来像を検討し提言することである。

具体的な研究項目は以下の４つである。

１、灌漑方法による蒸発散量変化の解明（水・塩収支グループ）

２．土壌中の水・物質移動の解明と塩類集積の回避策の検討（土壌肥沃性グループ）

３．節水栽培に対する作物の反応の解明と栽培法の開発（食糧生産グループ）

４．水管理・水塩収支と用水反復利用の強化策の検討（水管理グループ）

４．評価結果

総合評価　（Ａ＋：所期の計画をやや上回る取り組みが行われ、大きな成果が得られた）

2011 年のアラブの春およびその後の政情不安により研究の推進が妨げられたものの、１年間の研究期間の延長により大きなインパクトが期待できる成果が得られた。

節水技術と流域間の水量および水質の格差を是正する施策を導入することにより、収穫量を確保しつつ、ナイル流域の農業に要する水量を最大 20～30%程度削減できる見通しを得た。効果の定量的評価結果には一部まだ不確かさがあるが、これらの研究成果は技術

(Research) および政策 (Policy) の２部からなる提言書にまとめられ、水資源灌漑省 計画局長、国立水研究センター長、農業協同組合省、農業研究センター長などへ提出される予定である（３月実施)。

節水技術の開発、それを効果的に実施するための施策の検討及びそれらをまとめた提言書の作成とともに、農地の観測、分析・評価などの科学的知見に基づく農政を可能とする基盤が整備されたことも評価される。

以下に、評価項目における特筆すべき内容を列挙する。

４－１．地球規模課題解決への貢献

【課題の重要性とプロジェクトの成果が課題解決に与える科学的・技術的インパクト】

乾燥農耕地の節水は、対象国エジプトのみならず多くの国が抱えている課題である。本プロジェクトで改良、開発され、提案された技術、政策は、ナイル流域の農耕地において最大 20～30%節水できる可能性を示したもので、大きなインパクトを持つ。個々の土地利用や農業手法の水収支などに関する検討は、これまでも行われてきたが、地域全体を総合的に検討したことはユニークで貴重である。さらに、本プロジェクトで科学的に解明され実証された様々なスケールの節水法は、エジプト政府に対する提言の形でまとめられている。この提言に対してエジプト側カウンターパートや政府関係機関は強い関心を示しており、成果の社会実装へ向けて進展することが期待される。

【国際社会における認知、活用の見通し】

エジプトのアスワン・ハイ・ダムの建設とその後の水管理は、乾燥地域における農業用水を中心とした水資源管理の代表的な事例として国際的にも注目されており、今後成果を国際的に発表したり、エジプト政府が実施したりすることによって、国際的にも認知が高まると予想できる。また、本プロジェクトの成果を国際的に発信してゆくことで、幅広い成果の活用も期待できる。

【他国、他地域への波及】

本プロジェクトで開発あるいは検証された様々な節水法は、作物により適・不適はあるが、ナイル・デルタだけではなく、他の乾燥地や半乾燥地における農業用水の管理、塩分管理のモデルとなりえるものである。また、粘性土における精密な測定事例として、国際連合食糧農業機関(FAO)の作物別の必要用水量の基準値ガイドラインに反映されることが期待される。

【国内外の類似研究と比較したレベル】

乾燥地域における農業の種々の節水技術の効果と課題が検討され、実施策まで含め総合的に研究した例はなく、国際的に高く評価されるものである。また、本プロジェクトで用いられた水収支

の推定法は、我が国などでは既に確立された手法であるが、これを乾燥地帯であるナイル川デルタ地域に適用し、実証したことは新規性が認められる。

４－２．相手国ニーズの充足

【課題の重要性とプロジェクト成果が相手国ニーズの充足に与えているインパクト】

年約 2%の人口増加に伴なう食料需要の増大とそのための農地の拡大を要し、水の需給も逼迫しているエジプトにおいては、政府は農地の拡大とその前提となる農業用水の確保が重要な課題となっている。本プロジェクトで開発、提案された技術、システムの多くは初期投資が不要かあるいは安価なものである。農家が以前から実践している簡便な節水方法についてもその有効性と実施上の留意点を科学的に証明し、最適化を可能とした。このように本プロジェクトの成果は、行政ニーズに的確に答えたもので、そのインパクトは大きい。

【課題解決、社会実装の見通し】

本プロジェクトで得られた成果に基づく提言が、エジプトの農業及び政府の政策にどれだけ反映されるかについて確定的なことはいえないが、提言は政府の基本的な方針と合致しており、関係者からは肯定的な感触を得ている。今後もエジプト側研究者、政策担当者との連携を維持し、エジプトの研究者によるデータの集積、検討が継続され、その合理性、経済性がより明確になることにより、今回の成果が社会実装されることが期待できる。

【継続的発展の見通し(人材育成、組織、機材の整備等】

人材育成面では、エジプト側のプロジェクトアシスタントが１名日本に留学しているほか、2 名が修士課程から博士課程へ進学を希望しており、人数は多くはないが、一定の成果がある。一方、日本側の長期滞在ポスドクは確実に成長して職を得ており、日本及びエジプトのチャンネルが維持できるものと考えられる。

組織面では、政策担当部署と研究機関のネットワークは構築されたが、政情と組織的実行力の安定性に欠けるところがあり、継続的に発展できるかはやや不透明である。

機材の整備等では、渦相関法による水収支測定や超音波ドップラー断面流速分布計(ADCP)などは、エジプトへの初導入であったが、今後、関係機関が維持することになっており、この面の継続的発展は期待できると思われる。

【成果を基とした研究・利用活動が持続的に発展してゆく見込み（政策等への反映、成果物の活用など)】

主要な成果は提言書の形で、エジプト政府に届けられており（３月時点)、2018 年からの水資源プランに反映したいという政府関係者の発言もあるので、社会実装は進むものと考えられる。研究自体が継続され発展するためには、今回のカウンターパートとなったカイロ大学、エジプト農業研究センター（ARC)、排水研究所（DRI)、水管理研究所（WMRI）などが予算を確保し、フィールド実験を継続することが必要になる。エジプトにおける研究

機関の共同体制は確立したものの、それを今後維持して行くという点では、日本側の継続的な関わりが必要と思われる。

４－３．付随的成果

【日本政府、社会、産業への貢献】

エジプトを初めとした中東諸国に対する社会インフラ整備、農業振興の支援は、日本政府の重要な政策であると共に、政府機関及び企業が今後関与してゆくベースとなり得るものである。

【科学技術の発展】

個々の土地利用や農業手法に関する水や塩分収支に関しての研究はなされた例があるが、新たな節水技術の定量的評価および地域全体としての最適化と地域住民の衡平性を保つ施策などを含めた研究として貴重な成果を挙げたと言えよう。

【世界で活躍できる日本人人材の育成（若手、グローバル化対応）】

このプロジェクトで長期滞在したポスドク１名が助教となったほか、学術振興会の特別研究員、農水省関連の独立行政法人研究所などに職を得ており、また、大学院生も海外コンサルタント会社へ就職し、修士院生もイギリスの大学院に入って国際開発論を勉強中など、海外での研究経験者は確実に育っていると評価できる。

【知財の確保や、国際標準化への取組、生物資源へのアクセスや、データ入手方法】

本研究の性格として知財などにはあまり関係しないと考えられるが、データなどは、エジプトの協力を得て適切に取得されていると言えよう。研究成果は、全体的に、乾燥地域の灌漑などで汎用性のあるものであり、国際的にもインパクトのあるものである。ただし、個々の地域の実情に応じて改良されるべき性質のものもある。

【その他の具体的成果物（提言書、論文、プログラム、試作品、マニュアル、データなど）】

研究及び政策に関する提言書を作成し、政府を含む関係先に提出された。また、日本側及びエジプト側研究者らの共同執筆により本研究課題の成果を含む書籍を出版する予定である。学会講演、論文などは多数発表されている。また、マニュアル類も ADCP に関するものや、フラックスステーション全体及び個々のトラブル対応マニュアルなど、本プロジェクト終了後の維持に関するものが作成されている。

【技術および人的ネットワークの構築（相手国を含む）】

当初、エジプト側の研究者のネットワークは弱かったが、この研究を通じて大学や研究機関が共同研究を行う体制が整えられた。ただし、プロジェクト終了後も継続的に発展する

かについては、組織的な運営がなされにくいこと、中心的な役割を担うリーダが特定されていないことなどのため、やや不明確であるといわざるを得ない。

４－４．プロジェクトの運営

【プロジェクト推進体制の構築（他のプロジェクト、機関などとの連携も含む）】

相手国の政府機関、大学など必要と思われる機関が参画しているが、エジプトの国民性もあり、チームのために働くという意識を持った研究者が少なく、かなりの苦労があったことが伺えるが、良くこれらを纏めて成果を出したと評価できる。また、本プロジェクトで研究成果を、現在エジプトで実施中の JICA プロジェクト（水管理改善プロジェクトなど）と共有するなどのシナジー効果もあった。

【プロジェクト管理および状況変化への対処（研究チームの体制・遂行状況や研究代表者のリーダーシップ】

相手国研究者の確執によるプロジェクト立ち上げ時の混乱、アラブの春などの政情不安により、研究の遅れがあり心配されたが、研究代表者の頑張りにより研究期間の１年延長で大きな成果を挙げるに至ったことは高く評価できる。また、研究を推進する過程で、バイオ燃料作物などの成果が期待し難いものについて課題を整理し、効果が大きな細溝灌漑や防風林の研究に注力するなど、的確にプロジェクトを運営したことが成功した大きな要因である。

【成果の活用に向けた活動】

その他の具体的成果物のところでも記述したが、提言書の作成、提出及び論文や書籍の発表が適切になされている。

一方、本プロジェクトで調査した圃場で実践された様々な農業生産における節水手法や水管理技術が、今後ナイル川デルタの農業用水管理にどのように展開されるかは、エジプト側の判断に依存するので、今後もエジプト側研究者及び農業研究機関との連携を継続し、この成果がエジプトとしての農業政策に反映されるように努める必要があろう。また、今回の研究では節水効果に関しての数値に関してまだ不確実な点が残っているので、この点に関するエジプト側研究者による継続した研究に関しても見守ることが必要である。

【情報発信（論文、講演、シンポジウム、セミナー、マスメディアなど）】

全体的に良くなされているが、マスメディアなどへの情報発信はもう少しあっても良かったのではないか。学術論文としては 10 編(うち 9 編が英文)発表されており、さらに 5 編が発表予定である。論文などはもっとインパクトのある雑誌に発表できるのではないかと思われるが一定の成果がでていると言えよう。また、プロジェクトのワークショップも頻繁に行われており、シンポジウムも必要に応じて開催されている。

【人材、機材、予算の活用（効率、効果)】

研究期間が延長された最終年度は、JST からの予算がないという状況になり、研究代表者に負担をかけたと思われる。一方、現地での機器の破壊などもあったとのことであるが、何とか対処したことは評価できる。また、多くの研究機材がエジプト側に供与されたが、この継続的な利用とその管理維持のための予算に関しては、今後エジプト側の努力に依存するところが大きい。資金的・技術的な持続性が何らかの形で確保されることを期待する。

４－５．今後の研究に向けての要改善点および要望事項

【要望事項】

① 節水技術及び政策に関する提言が実行されるよう引続き関係機関への働きかけを行って頂きたい。

② データの収集と技術評価の継続及び新しいアイデアの検証など今後なすべき課題も多いので何らかの形で体制（日本側及びエジプト側）を整え、連携を継続して頂きたい。

③ 観測やそれに必要な機材が確実に維持されるために、エジプト側の体制（特に人員配置など）を整備するように働きかけて頂きたい。

以上

JST成果目標シート

研究課題名	ナイル流域における食糧・燃料の持続的生産
研究代表者名 （所属機関）	佐藤政良　名誉教授 （筑波大学生命環境系）
研究期間	H20採択（平成21年4月1日～平成27年3月31日）
相手国名/主要研究機関	エジプト・アラブ共和国/カイロ大学

付随的成果

日本政府、社会、産業への貢献	・エジプトの水管理、農業に関する貢献で、日本のプレゼンスが向上 ・日本のコンサルタント会社、建設会社の活動機会の増大 ・JICAの他の水プロジェクトとのシナジー効果
科学技術の発展	・水管理技術、水政策（文理融合技術）の世界トップレベルへの発展
知財の獲得、国際標準化の推進、生物資源へのアクセス等	・FAO用水基準改善への貢献
世界で活躍できる日本人人材の育成	・ポスドク研究者の現地長期滞在による国際人材の育成（2名） ・学生による国際学会での発表（11件）、論文発表（2件）、関連分野企業への就職（3件）
技術及び人的ネットワークの構築	農業、水関係の研究ネットワークの構築（日本・エジプト間で初）
成果物（提言書、論文、プログラム、マニュアル、データなど	・灌漑方法と消費水量について掲載 ・デルタで推奨すべき節水栽培とその根拠について掲載 ・デルタ圃場における灌漑方法と用水の移動機構について掲載 ・水管理改善政策について政府に提言

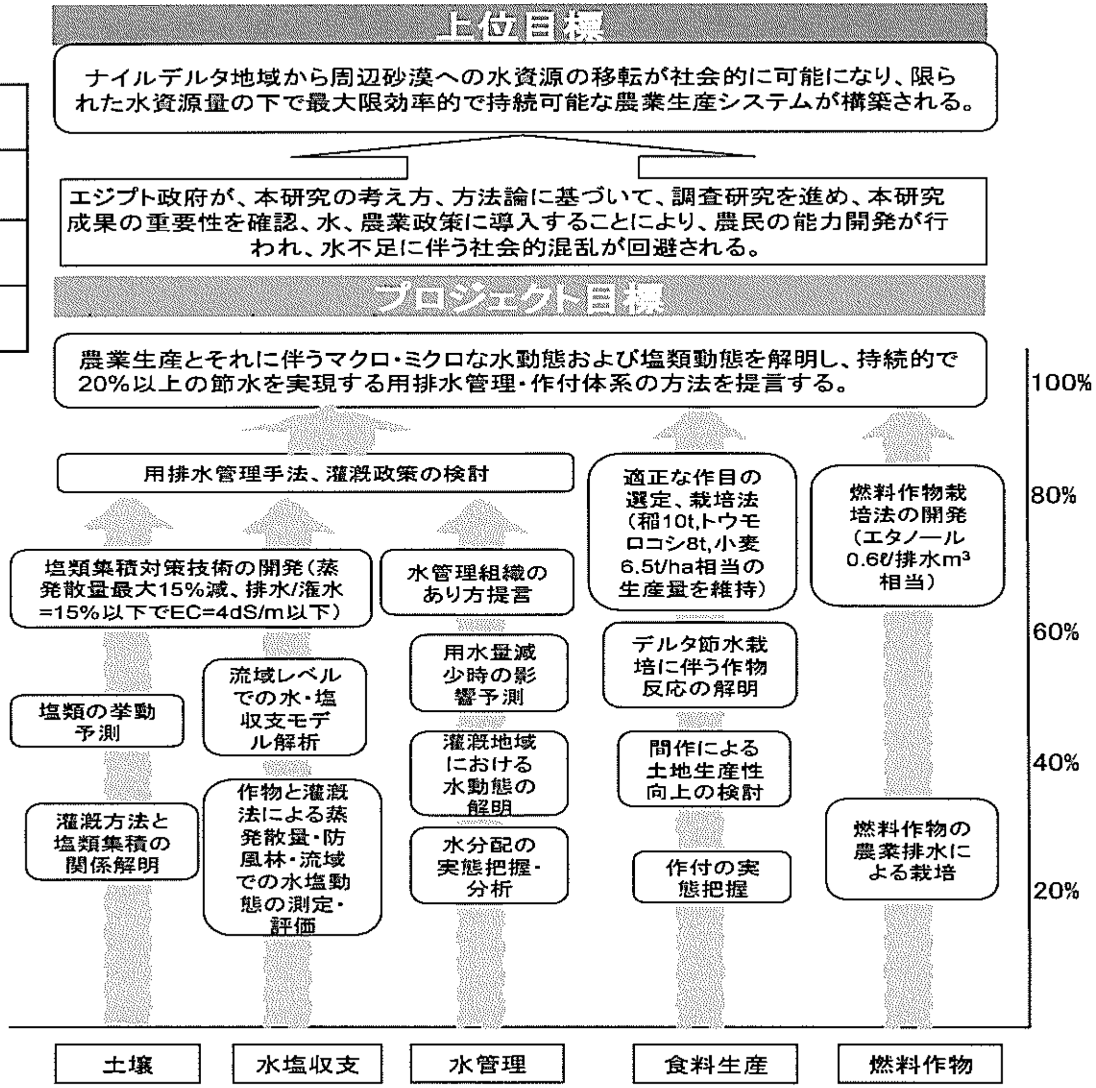

図１　成果目標シート及び達成状況（2015 年 3 月時点）

ジャイカ
JICA