


Capacity Building for the Efficient Utilization of Biomass for Bioenergy and Food Security in the Greater Mekong Subregion (TA7833-REG)

Technical Completion Report

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Landell Mills
DEVELOPMENT CONSULTANTS

Contents

Front cover photos (clockwise from top left): A farmer demonstration of biofertiliser in Takeo province, Cambodia; Selling Improved Cook Stoves in Viet Nam through a women's union; Drying of biofertiliser pellets in Cambodia; Testing of a kiln to produce biochar in Laos.

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**The final version of the report will also be submitted on a CD*

Quality Assurance Statement

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Prepared by:	Lindsay Saunders	Team Leader
Checked by:	Alex Warrington	Project Executive
	Simon Foxwell	Project Director

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Notes

In this report, "$" refers to US dollars.

Acronyms

ADB	Asian Development Bank
APMB	Agricultural Project Management Board
AROS	Asian Regional Organic Standard
ASEAN	Association of Southeast Asian Nations
BEFS	Bioenergy and Food Security
CASP	Core Agricultural Support Program
CDM	Clean Development Mechanism
CEDAC	Centre d'Etude et de Développement Agricole Cambodgien
CER	Certified emissions reduction
CFA	Climate-friendly agriculture
CLV	Cambodia, Lao PDR and Viet Nam
IFOAM	International Federation of Organic Agriculture Movements
DAHP	Department of Animal Health and Production, MAFF Cambodia
DARD	Department of Agriculture and Rural Development (MARD Viet Nam)
DCP	Department of Crop Production (MARD Viet Nam)
DMF	Design and Monitoring Framework
EA	Executing Agency
EOC	Environmental Operations Centre
EoI	Expression of interest
EU	European Union
FAO	Food & Agriculture Organization (United Nations)
GAP	Good Agricultural Practices
GBEP	Global Bioenergy Partnership
GHG	Greenhouse gas
GMS	Great Mekong Subregion
GOMA	Global Organic Market Access
GoV	Government of Viet Nam
IA	Implementing Agency
ICS	Improved cookstoves
ICT	Information and communication technologies
IFOAM	International Federation of Organic Agriculture Movements
LML	Landell Mills Limited
MAF	Ministry of Agriculture and Forestry (Lao PDR)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Cambodia)
MARD	Ministry of Agriculture and Rural Development (Viet Nam)
MEM	Ministry of Energy and Mines
MFI	Microfinance institutions
MIME	Ministry of Industry, Mines and Energy
MOE	Ministry of Education
MoF	Ministry of Finance
MoIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MoST	Ministry of Science & Technology
MPI	Ministry of Planning & Investment

NBP	National Biogas Program
NDF	Nordic Development Fund
NFP	National Focal Point (of the Implementing Agency)
NGO	Non-Governmental Organization
NPI	National Project Implementation
OVI	Objectively Verifiable Indicator
PDR	People's Democratic Republic
PGS	Participatory Guarantee Systems
PPP	Public-private partnerships
PPTA	Project Preparatory Technical Assistance
PSC	Project Steering committee
PSD	Private sector development
RETA	Regional Technical Assistance
RfP	Request for Proposals (RfP)
SME	Small and Medium Sized Enterprise
SNV	Netherlands Development Organisation
SOP	Standard operating procedures
SRI	System of Rice Intensification
TA	Technical Assistance
TFP	Technical Focal Point (of the Implementing Agency)
ToR	Terms of Reference
UK	United Kingdom
US$	United States Dollar
WB	World Bank
WGA	Working Group on Agriculture

Executive Summary

1. This report details the technical achievements under the 'Capacity Building for the Efficient Utilization of Biomass for Bioenergy and Food Security in the Greater Mekong Subregion' project (TA7833-REG). It lists lessons learned and recommendations for how the use of biomass for bioenergy and food security can be scaled-up in Cambodia, Lao PDR and Vietnam. For administrative and managerial aspects of the project, please refer to the associated draft final report.

2. The TA found significant gaps in the extent of readiness for up-scaling of certain technologies. For biochar kilns and bioslurry use the technology is still in the preliminary demonstration and proof of concept stage requiring field testing and demonstrations. As such the program implemented investment models for (i) upscaling of ICS using output based payment and incentives, and (ii) commune or village enterprises for the production and sale of compost and biofertilizers only. Biochar and bioslurry pilots were modified into demonstrations often linked to the use of biofertilizers that consist of biomass and bioslurry – these were then tested and demonstrated in farmer fields along with comparative plots using farmer practice and NPK fertilizers.

A. Lessons learned and recommendations from project work in Cambodia

3. While **standards for organic rice and biodigesters** have been prepared these have not yet been approved.

- Future donor projects should ensure that the institutional arrangements within which a specific standard will be applied are clarified and agreed. This agreement needs to precede the drafting of a standard and should clearly identify the agreed implementation arrangements.
- There needs to be greater clarity over the role of the standard and how this will be implemented needs to be agreed in advance
- Where public and private sector interests in the implementation of standards are ambiguous with respect to mandates, jurisdiction, authority and roles/responsibility the approval process will not be concluded.
- Prior to the development of future standards an institutional agreement on roles and responsibilities is required.

4. Women's groups are viable 'route to scale' for the sale of **improved cookstoves (ICS)**, provided the right incentive structure is agreed between ICS producers and such groups.

5. Further work is needed to test and demonstrate (proof of concept) the use of **bio-fertilisers (using biochar)** for farmers. It is therefore recommended to undertake further study to investigate spacial and temporal effects of such fertilizer formulas on soil qualities, crop yield, and crop quality, on a longer term basis. It is recommended that the ADB-funded Core Agricultural Support Program Phase II (CASP 2) develop long term sites that are used to demonstrate climate-friendly agriculture and nutrient-use efficiency (NUE) research and trials and that these sites be used for farmer field schools, coupled with field days. Such sites should be on both small and large farms to demonstrate replicability. As a whole each site needs to be evaluated in terms of technical achievement and also

in terms of influencing uptake of new technologies etc. The evaluation should inform policy dialogues as per the purpose of the ADB policy advisory TA 8163.

6. One constraint to the scale-up of biochar for biofertiisers is access to rice husk, due to competing uses.

B. Lessons learned and recommendations from project work in Lao PDR

7. The **Laos Organic Rice Standard (LORS)** has been approved and a guidebook for its implementation prepared.

- The LORS Books now need to be disseminated publicly prior to implementation. The Standards Division, Department of Agriculture should hold a dissemination forum with participants from private sector, producers and entrepreneurs, traders and partnership, millers, NGOs etc.
- In order to implement the LORS, MAF (possibly with ADB support through CASP2) should undertake capacity building programs in line with existing GOL Master Plan towards 2030 - prioritizing targeted groups/entrepreneurs, households, clusters, and zones. A planned approach should be undertaken including: (i) pilot farm demonstrations; (ii) replication of farm demonstrations across Lao PDR by 2030 to targeted households, areas; and (iii) upgrading the capacity of existing producers, entrepreneurs and traders leading to regional (ASEAN) cooperation.

8. Four **biochar-based organic fertiliser (BOF) formulations** were developed. Two standards have been approved by the government (F1 and F2).

9. Field trials of the **biochar-based organic fertiliser** formulations have been very successful. The yield of different types of vegetables has increased from 35-50%, and by 74% for rice, compared to farmer practice plots, and soil test results indicate soil properties (pH) and soil structure have improved. With increasing OM and soil carbon levels it is expected that in the future, plant available nutrients will also increase. However, nitrogen levels in vegetable demonstration plots remain low despite Organic Matter (OM) levels increasing. The option of adding reactive migro-organisms to F1 and F2 needs to be assessed.

10. Two private BOF enterprises have produced and processed biofertilizer (using either F1 or F2).

11. As a result of farm demonstrations, farmers' knowledge of improving soil health through use of Biochar and BOF whilst increasing yields is leading to increased adoption that is limited by availability of product. Pilot demonstration farms have, in some instances, expanded the area of vegetable production using Biochar and BOF significantly. In addition, neighbouring farmers have also reported adoption.

12. The lifecycle assessment of initial farmer biofertilizer strategies indicated a range of moderate gains in GHG emission reduction and the scale of gross margin benefits to those that use biofertilizer for vegetable and rice production. An extended assessment of the impact of biofertilizer use based on the national recommendation for organic matter soil amendments was conducted using the Roth C dynamic carbon model and then integrating this within a LCA assessment framework. The initial results clearly indicate substantial gains in the level of carbon sequestration

along with the reduced GHG emissions from avoided fertilizer use. A key recommendation is the need for long run soil carbon treatment trial sites that can be used to validate the model parameters such that potential GHG mitigation opportunities can be taken to the market.

13. To support further scale-up:

- DOA, DALAM and the private sector must ensure that the manufacture of BOF F1 and F2 achieves the registered standard and that quality control is maintained by ALaDC and local staff.
- Promotion of the use of BOF should be disseminated to farmers by DOA – including the use of BOF as a long-term soil amendment.[1] This should include the involvement of the two BOF enterprises as resources for the program. Additional demonstrations should be undertaken noting the following:
  - Demonstrations and trials should be more than one year e.g. results of soil amendments should be assessed and analyzed in a 4 – 5 year program.
  - BOF preparation and production demonstration are two separate phases. For preparation, sufficient time is needed for laboratory testing and analysis
  - Biochar and viochar-based organic fertilizers should be prepared in the dry season: raw materials dry faster and pyrolysis is easier.
- Local authorities, DOA and DALAM should help link the supply chain for BOF F1 and F2 to PGS (Participatory Guarantee Scheme) groups and the local market with an education campaign leading to awareness raising and increased trust. Such PGS groups could include the five supported under the project in Vientiane province; (ii) Boung Phao PGS groups supported by another ADB project (including CASP 2); (iii) Vientiane Organic Vegetables Association.
- As an incentive for using bio-fertilisers, efforts should be made to increase demand for organic produce.
- Agri-input distributors should be encouraged / incentivised to supply BOF as an agri-input – or purchasers who could supply such products in return for a guaranteed supply of certified organic produce through contract farming arrangements.
- BOF local enterprises need to obtain formal registrations and certification, which enable these enterprises to continue producing their products for demonstration and sale. The government should ensure that there are no hurdles to this process through efficient processing of necessary documents by DALAM/MAF, DAFO, PAFO, Department of Tax, and Department of Industry and Commerce. The status of business registration and business incentives for these enterprises needs to be assessed.

14. With secured suppliers and output-based incentives, the Laos Women's Union has been able to increase the uptake of **ICS** technology within households.

C. Lessons learned and recommendations from project work in Viet Nam

15. With regard to **standards**, no consensus was reached on what regulatory issues should be addressed by the project so activities were limited. This lack of consensus was partly due to

[1] *Farmers' preference is for higher yield within a short-term period as opposed to medium to longer term benefits to soil health.*

negative experience in setting up VietGAP which has failed to gain widespread adoption due to the lack of financial returns to producers that adopt VietGAP. After 7 years of implementation, including several multilateral donor project, bilateral technical support programs, and NGO programs only 500 certificated VietGAP producers had been established covering less than 0.1% of the cultivated area. Other stakeholders highlighted climate friendly agriculture standards as being important but most acknowledged that the concept of CFA was far too loose and broad for an effective standard to be developed and that implementation would be nearly impossible.

16. Furthermore, the project was implemented by the Agricultural Project Management Board (APMB) which was unable to mobilize a person to support national policy/regulation activities. If the project was embedded in a department, the results may have been different.

17. The main conclusion has been that Viet Nam has many standards with respect to food safety, VietGAP, biodigester technology etc but the effectiveness of these standards is low.

18. The application of VietGAP faces a number of difficulties and constraints including (i) lack of participation, (ii) high cost for certification for VietGAP standards, (iii) the perceived lack of practicality in the procedures, (iv) an inability to attain the specifications for some commodities. However the overarching weakness has been the lack of credibility of VietGAP labelled produce in the market place with limited consumer recognition and willingness to pay for the additional guarantee of VietGAP standards.

19. There is an urgent need to develop and resource an operational implementation framework for VietGAP. This framework needs to address the total value chain from fork to farm, ensuring compliance integrity, ensuring labelling and food safety integrity, and promoting the integrity to consumers. Further investment into standards as opposed to integrated quality control systems that address not only specifications, and their standardization but also how these are to be applied, maintained and promoted to protect consumers is required.

20. In order to set-up **ICS supply chains** it may be useful to consider the following issues:

- *Selection of ICS.* In order to identify suitable ICSs for up-scaling, the ICSs should be screened in two stages, (a) meeting expectations of households and (b) meeting expectations of sales enterprises in the district, as laboratory testing does not assess issues such as safety and durability.
- *Selection of unions.* Unions can play a key role of sale agency in ICS supply chains. Although only two unions were selected under the project pilot, it showed that women's union may be more successful with selling ICS to households than farmer unions. Farmer unions seems to be more interested in activities with larger investment than ICSs, and therefore selection of women's unions under ICS supply chains seems to be more appropriate. Ownership was a critical success factor - here the women's union performance far exceeded the farmers union, and has resulted in an ongoing business promoting the use of ICS to their members. The output based incentives while important for initial start-up were not considered to be important due to (i) the unions benefitting its members, and the use of the simple ICS technology included in the pilot.
- *ICS producers.* There was limited choice of ICSs that met the expectation of households. Selection of ICS producers for up-scaling is difficult. Producers are generally SMEs and concepts of business and marketing plans are not well developed and understood. Commercial contracts ensured commitment of stakeholders in writing and ensuring condition of supply relating to price, commission, quality, order quantity, and guarantee. The addition of penalty

clauses should be considered with respect to quality control, supply guarantee and theft. Artisanal production provides local employment but results in quality issues, supply issues and a higher cost of production per unit. Industrial production would lower costs and increase the probability of a sector funded quality control system being affordable.

- Donor programs providing subsidized cook stoves simply undermines the market and whilst enabling project targets to be achieved these targets never account for the loss of adoption and uptake due to undercutting prices and supply agreements.
- Price discounting by distributors that dump surplus product into the market is a potential constraint for sale by women's unions

21. The assessment of biogas programs highlighted the saturation of the sector for commercially based upscaling of biodigester use. However in promoting the use of biogas the significant impact of the biodigesters on the local environment through the release of digestate and bio-slurry, and the ignored decline in digester efficiency as digestate scum builds up in the digester were raised as priority areas for additional testing and demonstration. There is thus potential for using **bioslurry** as an ingredient in bio-fertilisers.

22. However, the pilot showed that the cost of moving bioslurry is significant (due to the distance between farm and household) in terms of labor cost for transportation, purchase of pumps and containers for transport. In addition, most households have only a small garden so that the garden is not big enough to absorb the nutrient from bioslurry that was estimated as 470 liters per day for a 10 cubic meter digester.

23. Most producers report favorable attitudes to the use of the compost that is enriched however most prefer to buy it given the labor required.

24. The composting cost produced by the community agriculture cooperative was also too high. It would be very hard to promote this product in the market. If possible, the compost should be produced at factory or workshop to reduce costs. However, the availability of biomass resources in some districts severely limits the scale of production.

25. The use of **biochar as a soil amendment** produced encouraging results.

- For rice cultivation, gross income from treatment with biochar plus 75%NPK or biochar plus 75%NPK in pelleted NPK-biochar fertilizer was 2,479- 3,379 thousand VND/ha more for rice cultivation in Hanoi, and 650- 1,700 thousand VND/ha more in An Giang than that in farmer practice.
- Application of biochar and biochar products for vegetables brought much higher gross income than farmer practice. An increase of 20,000- 25,333 thousand VND/ha in Hanoi and 4,200-6,686 thousand VND/ha in An Giang than that in farmer practice in each site.
- Application of biochar and NPK-biochar fertilizer was reduced 25%, even 34% of NPK in mineral fertilizers but gave equal or higher yield compared with farmer practice in some demonstrations.

26. However, there remain issues of using biochar as a soil amendment at scale. The assumption of rice husk availability was found to be over-estimated and poorly understood in the original concept paper for the Mekong delta. With the modernization of rice milling most husk is owned by the mill owner, and is being transformed into briquettes (e.g. for industrial heat production and for brick making) or flour for export to the plastics industry. The availability for biochar is limited to mostly disaggregated rice husk with commensurate high costs of freight.

27. The pilot was implemented in one season enabling the within season impact on crop yields to be observed. However the longer term impacts of organic matter and biochar on soil quality through future crop cycles needs to be tested.

28. Using life cycle analysis the GHG and nutrient emission of biomass use was estimated including for the production of commercial bio-fertilizers from peat. GHG emission savings were identified for the use of biofertilizers, however the peat based biofertilizers have significantly higher GHG emissions. Options for converting from peat to other biomass options are quantified in a life cycle assessment and indicate potential CDM and green fund investment options that should be explored under CASP2 – TA8163.

29. There were not significant different filtration effects between using biochar filters and animal waste sources for biogas.

I. Part One: Overview

A. Introduction

30. TA7833 is an ADB (NDF co-financed) regional capacity development technical assistance project. The impact of the project is: '*Improved use of biomass in Cambodia, the Lao PDR, and Viet Nam*'. The objective verifiable indicators (OVI) (performance targets & Indicators) for achievement of the impact are:

'*By 2020:*

- *5% increase in production of clean bioenergy from biomass*
- *5% increase in use of by-products of bioenergy systems (bio-slurry and biochar)*

31. The outcome of the project is: '*Efficiently operating pilot projects in biomass use*'. The objective verifiable indicators (performance targets & Indicators) for achievement of the outcome are:

'*By 2015 (originally 2014): at least:*

- *two investment modalities for biogas and bioslurry (Cambodia and the Lao PDR); three for biochar (Cambodia, the Lao PDR, and Viet Nam);*
- *two for improved cookstoves (the Lao PDR and Viet Nam); and three for inclusive supply chain of certified biofuel and organic crops in (Cambodia, the Lao PDR, and Viet Nam)*'

B. Outputs

32. The following section summarizes the outputs while parts 2, 3, and 4 presents the output achievements, lessons and recommendations for each of the three country programs in Cambodia, Lao PDR and Viet Nam respectively.

1. Output One: Enhanced regional cooperation on bioenergy development to foster and safeguard food security

33. The output will be achieved through a regional approach to climate-friendly agricultural development through sharing national experiences with institutional processes and mechanisms for introducing and operating regulatory and non-regulatory approaches for biomass related technologies while ensuring their compatibility with international trade obligations. The TA strategy for output 1 shifted during the extended inception phase away from a purely regional harmonization approach to one of building national level awareness, priorities and institutions that are being shared and discussed collectively through regional forums, study tours and sharing of outputs. The change responds to a common concern expressed by the government counterparts that harmonization from regional to national level was simply unacceptable and that the process needed to build a national position that could then be modified or adapted in response to regional benefits and opportunities.

34. The strategy for this output has therefore been modified which created greater ownership but significantly increases the complexity of what is being delivered through the TA due to the range of priorities and the potential scope for some of these i.e., climate friendly versus organic rice standards rice standards, as well as the vastly differing institutional contexts that the three countries are required to operate within and the limitations over the process for decision making. The TA provided technical input and the institutional knowledge of what is being developed regionally and internationally along with a process through which priorities are shaped and developed.

35. The overall output as stated has not changed in principle. However, the indicator targets of the output were modified in the interim report. Standards were drafted for organic agriculture and organic rice (Lao PDR and Cambodia), two biofertilizers in Lao PDR, and three biodigester standards in Cambodia. Lao PDR standards were completed whilst the Cambodian standards remain within the technical review process that was unable to complete the required review in the final three months.

36. Viet Nam was unable to agree or define its priorities for standards. Firstly, Viet Nam has a significant number of existing standards most of which are little more than technical specifications. Few if any are implemented for quality control, consumer or trade benefits. Experience to date with Viet GAP highlights the necessity of adopting quality control and market systems perspectives.

2. Output Two: Climate-friendly, gender-responsive biomass investment projects, pilot tested through implementation in Cambodia, Lao PDR, and Viet Nam

37. The technologies included in the TA Concept paper included biogas and bioslurry; improved cook stoves; biochar production and application, and; climate friendly agriculture value chains. Feasibility studies were used to define pilot projects based on technologies successfully tested on a smaller scale. In addition, business model case studies were to be completed for successful projects as a means of identifying potential upscaling modalities. The pilot projects were used to assess future investment options for upscaling in terms of technologies and business modalities if they are identified as being feasible and viable.

38. A significant constraint to the piloting of business models was the inability of ADB to use TA funds in a manner that is similar to their usual sovereign lending products and as such the provision of TA funds for government expenditures is simply not possible. Further, many business models require revolving funds or alternative credit systems that cannot be piloted over a 1 or 2 year TA program. The other challenge is to move away from a supply push for technology to one of demand creation for the use of technology outputs which fundamentally changes the manner in which upscaling is organized.

39. The TA adopted a preliminary step to assess the readiness of the proposed technology for commercial upscaling which was reported in the inception phase. The assessment found significant gaps in the extent of readiness and in some cases such as biochar kilns and bioslurry use the technology is still in the preliminary demonstration and proof of concept stage requiring field testing and demonstrations.

40. As such the envisaged program implemented investment models for (i) upscaling of ICS using output based payment and incentives, (ii) commune or village enterprises for the production and sale of compost and biofertilizers only.

41. Biochar and bioslurry pilots were modified into demonstrations often linked to the use of biofertilizers that consist of biomass and bioslurry – these were then tested and demonstrated in farmer fields along with comparative plots using farmer practice and NPK fertilizers. Technology and knowledge sharing events were held resulting in TULD kilns technology being transferred between Cambodia, Lao PDR and Viet Nam, a regional study tour and workshop on biochar and biofertilizers, whilst the importation of advanced kiln technology into the Soil Conservation Center of DALAM in Lao PDR was used to test the quality and cost of production of biochar commercially.

42. Biogas technology was only demonstrated in Lao PDR through the importation of two piece digesters from Viet Nam.

3. Output Three: Enhanced capacity for the efficient utilization of biomass

43. The output sought to raise awareness of the biomass resources and their potential uses amongst officials and policy makers as well as decentralized agencies and supporting civil society groups to enable investment options to be understood. Gender-sensitive capacity-building was provided to participating central and local governments, service providers, communities and women's groups with nearly 50% of training participants being female. A proposed distance learning program was discontinued due to approval delays and was replaced with four training videos being produced in local languages.

44. In total, the training delivered reached in excess of 5000 recipients of which 49% were female – see training program output tables in each country report and in the final report. These training figures do not however include the technical support and mentoring that was provide to build capability during implementation. For example the technical support provided in Lao PDR during the pilot implementation total nearly 1100 man days on inputs to address issues ranging from the use of biochar, making biofertilisers, compost making to small business development, planning of extensions services etc. Similar level of input were provided in Cambodia and to a slightly lesser degree in Viet Nam through technical focal points (TFPs) and subcontractors.

4. Output Four: Development and dissemination of knowledge products

45. Using output from the Global Bioenergy Partnership (GBEP), the TA developed a methodology for assessing the supply of biomass and prioritizing its use for enhancing energy and food security. Here the integration of resource assessment for crop and livestock wastes with lifecycle assessment, and least cost policy assessment were demonstrated and then used in training. TA 7833 produced a number of biobriefs that were widely distributed both electronically and through hard copy distribution systems, knowledge products of specific topics, technical reports of specific methods, technologies, feasibility assessments, occupational safety programs, and policies, and a series of training videos on biomass utilization.

II. Part Two: Cambodia Completion Report

46. The following provides a summary of the TA 7833 work program undertaken in Cambodia. The program is presented by output with key activities, output achievements, outcomes to date and lessons/messages from the implementation.

A. Output 1: Enhanced regional cooperation in bioenergy development to foster and safeguard food security

1. Outputs

47. Five draft standards with supporting documents were provided to MAFF including:

- Cambodian national standards for organic agriculture (part A) (1) and for organic rice (part B) (2).
- Cambodian national standard for biodigesters (3) and supporting standards for two specific biodigester technologies (4 and 5).

2. Activities

a) Organic agriculture (1) and organic rice standard (2) drafted

48. A draft standard was prepared using a consultative approach including two workshops (on 20-22 March 2014, Takeo province, and on 30 June 2014, Phnom Penh) to elicit technical and procedural input and feedback from stakeholders. The stakeholders included: MAFF, Cambodia Institute of Standards, MOIH, NGOs, and Cambodia Rice Federation. The technical and procedural comments were then integrated into a set of draft documentation for each standard that was to be used to obtain formal ratification of the standards. The two sets of draft standard documents were provided to the General Directorate of Agriculture (GDA) for comments that were then incorporated into the draft documents.

49. The final draft documentation for each standard was translated and provided to MAFF for the Government procedures for obtaining ratification and approvals. MAFF sought the required technical review of the draft standard from GDA and CARDI starting in August 2015. Comments were expected to be provided within one month, however by December 2015 no review was completed and TA7833 closure resulted in the withdrawal of its support for the completion of the standard. The planned public consultation and awareness raising workshops, the development of Trainer of Trainer curriculum and updating of existing trainers were therefore not undertaken.

50. Cambodia hosted a regional forum on standards and their implementation, on 5-6 February 2015 in Sihanuk Ville, Cambodia. A total of 33 participants (4 female) from Cambodia, Myanmar, Laos and Vietnam attended. The regional forum developed implementation road maps that the standards working groups presented at the final regional conference in Luang Prabang. The Cambodian working

group identified a number of steps for the implementation of the Organic Rice Standard which were used to plan the awareness raising and training program.

b) Three Cambodian national standards on biodigesters drafted

51. A sector meeting on 30 October 2014 involving 12 participants from MAFF, Cambodia Institute of Standard, MOIH, DAHP, NBP, and NGOs discussed the scope and purpose of the proposed biodigester standards. The development of the standard proceeded through a series of consultative meetings for drafting the required sections.

52. The initial draft standard was technology independent and applies to all small and medium sized biodigester technologies. The draft standard was presented to government and sector stakeholders at a workshop on 16 December 2014 in Kep province with 17 participants from MAFF, Cambodia Institute of Standard, MOIH, DAHP, NBP and NGOs. The workshop finalized the draft standard and discussed the initial implementation arrangements. The workshop concluded that additional input was required to finalize the scope and implementation arrangements (both the role of government, NBP and the private sector). The workshop output including the technical and procedural edits was presented to the regional standards forum in Sihanuk Ville in February 2015. No consensus was reached on the biodigester standard and a lack of consensus regarding the purpose and scope of the standard emerged.

53. The final draft of the Cambodian national biodigester standard was translated and submitted to MAFF. As part of the required technical review, MAFF sought comments from the Department of Animal Health and Production (DAHP). As of December 2015 no comments have been provided and MAFF are unable to process the standard.

54. Concurrently with the review of the national biodigester standard, TA7833 supported the drafting of two technology specific biodigester standards that were requested by the National Biodigester Program (NBP) of DAHP, MAFF. Standards were prepared for (i) Farmer Friendly Biodigesters and (ii) S1 Biodigesters. The two draft documents were translated and forwarded to MAFF who have sought comments from the NBP. As of December 2015 no comments were provided.

3. Outcomes

55. To date no outcome has been achieved due to an inability to obtain the consensus necessary for ratification.

4. Lessons

- Future donor projects should ensure that the institutional arrangements within which a specific standard will be applied are clarified and agreed. This agreement needs to precede the drafting of a standard and should clearly identify the agreed implementation arrangements.
- There needs to be greater clarity over the role of the standard and how this will be implemented needs to be agreed in advance
- Where public and private sector interests in the implementation of standards are ambiguous with respect to mandates, jurisdiction, authority and roles/responsibility the approval process will not be concluded.

- Prior to the development of future standards an institutional agreement on roles and responsibilities is required.

B. Output 2: Pilot tested climate-friendly biomass investment projects for wider implementation

56. Output 2 demonstrated biomass utilization technologies including:

- An output-based ICS adoption demonstrated
- Biofertilizers/biochar formulations tested
- Biofertilizer and biofertilizer / NPK blends demonstrated to farmers

57. Feasibility studies were conducted in order to prepare the pilot projects for implementation. These feasibility studies and the final reports for pilot implementation are available on request.

1. An output-based ICS adoption demonstrated

a) Activities

58. The focus of this pilot was to demonstrate how output incentives could be used to increase the use of existing ICS technology as opposed to the development and testing of technology.

59. A pilot program using an output-based program to increase the use of ICS was implemented in two communes in each of Kandal and Kampong Thom provinces. The pilot program was implemented through the village and commune women's representatives. For each commune, TA7833 signed an MOU with the women's groups to define the program, the roles and responsibilities. To support the increased demand a limited amount of resources were provided to the Improved Cook-stove Producer and Distributor Association of Cambodia (ICoProDAC).

60. The pilot provided funds to the ICoProDAC managed ICS producers support program. Through this support, ICoProDAC provides revolving funds to ICS producers to support further development of their production capability. Under TA7833 9 ICS producers received such support for the purchase of equipment necessary to increase the production for ICS. This funding was to be revolved back to ICoProDAC based on their existing operating procedures. As part of their access to the revolving funds the 9 ICS producers were required to enter into supply agreements with the pilot program women's groups.

61. The pilot also provided funds to the women's groups for purchasing their initial inventory that were then on-sold in their respective villages. GERES was contracted to provide training to the women's groups on the benefits, operation and maintenance of ICS. Each women's group agreed to an output-based incentive program where the group shared the profit from sales. The profit share agreement was:

- A profit margin of approximately USD 1 per stove sold by the women's group
- Based on the group agreement, the profits were divided as follows:
  - 50% is retained by the member that sells the ICS
  - 20% is retained by the group for administrative costs

- 20% is retained as capital by the women's group.
- 10% is contributed to the Commune/Sangkat Fund for support to elders or poor women in the village.

b) Output Achievement

62. The table below provides a summary of the ICS sales for Cambodia.

Table 1: Number of ICS sold by the four women group members

No.	ICS sale by commune in Dec 2014	Unit sold	Sale (US$)	Income (US$)	50% for seller (US$)	20% for Admin (US$)	20% for capital (US$)	10% for commune (US$)
1.	Prek Koy	40	30	36.60	9.90	4.60	2.64	1.98
2.	Kraing Yov	210	568	152.65	76.33	30.53	30.53	15.27
3.	Meanrith	213	483.75	100.58	50.29	20.12	20.12	10.06
4.	Tumring	115	445.75	76.18	38.10	15.23	15.23	7.62
	TOTAL	**578**	**1,527.50**	**366**	**174.60**	**70.50**	**68.50**	**34.92**

63. By December 2014 the revenue to the women's groups totalled to USD 545 with funds used to maintain their stove inventory.

c) Outcome

64. As of December 2015, all four women's groups continue to sell ICS and distribute the profit margins according to the agreed formula. It is recommended that ADB (CASP 8163) evaluate the progress of the four groups during 2016.

2. Biofertilizers/biochar formulations tested

65. The pilot sought to identify potential biofertilisers or soil amendment formulations that were tested in field trials in Takeo, Kampong Chhnang, and Battambang provinces. The company Mekong Carbon was contracted in collaboration with the Cambodia Agriculture Research and Development Institute (CARDI), COMPED, and Green Mountain Fertiliser Company (GF4) to produce biofertiliser, four formulas for vegetable and another four formulas for rice. COMPED supplied compost to GF4 to produce the 8 formulas of the biofertiliser. CARDI conducted field trials on vegetable using 4 biofertiliser formulas and rice using another 4 types of biofertiliser formulas in these 3 provinces.

a) Activities

66. **Fertilizer formulation**. A design group comprising experts in soil science, agronomy, fertilizer, biochar and soil amendment was used to develop (i) potential biofertilizer formulations for rice and vegetable crops based on local soil and crop types, (ii) define fertilizer trial treatments including biofertilizer/NPK blends, (iii) to specify application rates. Formulas developed for the vegetable crops did not include NPK fertilizers to replicate crops grown under organic fertility regimes.

67. **Rice experiment.** The fertilizer treatments for rice field trials were:

- T0. Control (Farmer Practice before trial)
- T1 (Formula 1). NPK (CARDI Prescribed Recommendation)
- T2 (Formula 2). Pellet (Biochar 20% + NPK + clay 25% + ash 5%)

- T3 (Formula 3). Mixed (Biochar 20% + NPK + Compost 1.5t/ha)
- T4 (Formula 4). Pellet (Biochar 20% + NPK + Poultry 1.0t/ha + clay 5% + ash 5%)

68. A randomized complete block design (RCBD) was used for the 5 treatments with 4 replications. Plot size was 5x5m (25m^2). Harvest area for grain yield was 3x3m (9m^2) in the center of each plot. The rice cultivar Phka Rumduol – a medium maturity, photoperiod sensitive was used.

Table 2: Amount of fertilizer and nutrient rates used for rice experiment. Nutrient rates are calculated based on chemical analysis of each fertilizer formula

Treatments	Fertilizer formulas	Fertilizer Rate	Nutrient rate based on chemical analysis (kg/ha)		
		kg/ha	N	P_2O_5	K_2O
Prateah Lang soil group					
T1	Urea+DAP+KCl	183	100	40	80
T2	Formula 2 +182 kg Urea	329	93	28	60
T3	Formula 3	2023	54	22	70
T4	Formula 4	1647	56	58	84
Prey Khmer soil group					
T1	Urea+DAP+KCl	140	80	40	60
T2	Formula 2 +137 kg Urea	279	64	29	51
T3	Formula 3	1975	51	19	59
T4	Formula 4	1561	35	65	74
Toul Samrong soil group					
T1	Urea+DAP+KCl	193	120	80	60
T2	Formula 2 +191 kg Urea	409	111	28	22
T3	Formula 3	2099	79	54	56
T4	Formula 4	1714	90	103	99

b) Outputs

69. **Results.** There were significant effects of combined inorganic and organic fertilizers application as formulas F2, F3, and F4. This resulted in additional increases in rice yields of 0.83 – 1.36 t/ha over the control untreated soils, on average of 5 trial sites. Pellet fertilizer formulas (F2, F4) performed much better than mixed non-pellet formula (F3). They increased rice grain yields by 1.25 – 1.36 t/ha over the control untreated soils, on average of 5 experimental sites.

70. Vegetables - Chinese kale responded strongly to application of fertilizers. The highest level of yield, 33.89 t/ha was achieved on more fertile Toul Samroung soil treated with poultry manure mixed with 20% RHB, in Battambang province. In this soil, addition of poultry manure alone produced 30.78 t/ha of vegetable fresh weight. By contrast, in another fertile Kein Svay soil (CARDI-V1), vegetable produced relatively lower yield with the same fertilizer formulas. On unfertile sandy Prey Khmer soil in Kampong Chhnang province, vegetable responded strongly to fertilizer application but the effects on yield were much smaller in comparison with more fertile soils.

71. Gross margin analysis (GMA) for rice crops suggests that levels of rice grain yield achieved with applied formulas F2, F3, and F4 were not profitable. The overall means of grain yield threshold for F2, F3 and F4 formulas ranged from 3.24 – 4.78 t/ha.

72. Gross margin analysis (GMA) for vegetable crop suggests that growing vegetable on rice-growing sandy soils of the lowland was not profitable unless fertilizers were applied. Applying poultry manure (2 t/ha) or poultry manure + 20% rice husk biochar was the most profitable treatment in all soil types used in the study. With fertilizer application, on fertile soils the GMA values were 4-4.5 times higher than that of infertile soils.

73. **Agronomy and crop yields.** The levels of rice grain yields produced under station conditions (BB-R1, BB-R2, KC-R2, and CARDI-R) remains modest even with fertilizer application, and they varied markedly across sites. The stations where experiments were conducted have no irrigation infrastructure, thus they are subject to rainfed conditions like most rainfed farmers' fields. In such conditions, there are so many factors affecting crop growth and yield such as intermittent drought, weeds, and differing soil fertility conditions especially pH and N and P availability.

74. The levels of vegetable yields (fresh weight) remain relatively low when vegetable was grown on rice-growing sandy soils in CARDI and in Kampong Chhnang province even with application of fertilizers with rates that would be equivalent to 120N, $45P_2O_5$ and $70K_2O$ (kg/ha), the rates considered to produce yield of about 20 t/ha. On more fertile soil in Battambang province, the levels of yield achieved were generally higher than the targeted yield (20 t/ha). The native soil fertility, soil conditions, fertilizer management technique, and agronomic practices could be attributed to achievable yields of vegetable.

75. **Effects on Soil properties**. Before the experiment, soils used were neutral to moderately alkaline in reaction (pH 1:5 soil/water ratio) with low to very low levels of organic C, and total N. Extractable P levels are low in all rice-growing soils, except for one site.

76. The Cation exchange capacity (CEC) was very low in 7 sites (<6 cmol/kg), low in 2 sites (6-12 cmol/kg), and moderate in BB-V3 site. After cropping, these soil parameters were not markedly different by the fertilizer treatments tested, and their responses to treatments were not consistent in all sites.

77. Spatial variations in soil sampling technique under field conditions, and then followed by laboratory procedures for chemical analysis may have contributed to inconsistent response to fertilizer treatments.

78. **Fertilizer formulation and production.** Making fertilizer pellets based on the developed formula, especially the former F2 (20% RHB+NPK (Urea, DAP, KCl) +5% clay+5% ash) was impossible to form fertilizer pellets (Kean Sophea, perscomm.). With 20% of RHB, the low percentage of clay and limited mixing compatibility of Urea + KCl could have caused the problem of not forming fertilizer pellets. Solution to this problem was to increase clay content to 25%, and removed Urea from mixing. The amount of removed urea was then used for top dressing at 30 days after transplanting, and panicle initiation (PI). Thus the modified Formula 2 is F2 (20% RHB+ NPK (DAP, KCl) +25% clay+5% ash).

79. Improved packaging of fertilizer products after mixing/pelletizing could help minimize the loss nutrients, especially mineral nitrogen from fertilizer products, and hence maintain its original quality during transport and storage.

c) Outcome

80. Results clearly highlight the need for ongoing research and replication of this research on a site over multiple crop seasons.

81. The biggest challenge is the cost of production for biofertilizers and this reflects the small scale operation and high transport and labor costs. The potential of reducing such costs through the commercial production of biofertilizer is recommended.

d) Lessons

82. The high cost of fertilizer production (Mixing and pelleting cost 0.47 USD/kg, Compost cost 150 USD/t, Poultry manure cost 300 USD/t) could not help compensate the saving of inorganic NPK fertilizer through improved organic formulas since the cost of materials used for formulation were also fairly high, and that the amount to be applied was also high (Compost 1500 kg/ha, poultry manure 1000 kg/ha).

83. Although results of the present study show that applying formulas F2, F3, and F4 to rice crop did not produce economic yield it was remarked that these fertilizer formulas could significantly reduce the amount of inorganic NPK fertilizers. These formulas have the potential to efficiently utilize agricultural biomass waste (crops and poultry) for soil fertility improvement.

84. It is therefore recommended to undertake further study to investigate spacial and temporal effects of such fertilizer formulas on soil qualities, crop yield, and crop quality, on a longer term basis. It is recommended that CASP 2 develop long term sites that are used to demonstrate CFA and nutrient-use efficiency (NUE) research and trials and that these sites be used for farmer field schools. As a whole each site needs to be evaluated in terms of technical achievement and also in terms of influencing uptake of new technologies etc. The evaluation should inform policy dialogues as per the purpose of the policy advisory TA 8163.

3. Farm Demonstration of biofertilizer

85. CelAgrid conducted farm demonstration of 4 biofertilizers or blend formulas for vegetable and 4 formula for rice. The farm demonstration on vegetable and rice was conducted in 2 communes in three provinces being Battambang, Takeo and Kampong Chhnang. In addition 13 rice husk kilns produced by the Department of Agriculture Engineering were provided to 13 farmer groups in Takeo province. The Department of Agriculture Engineering provided training on the advantage of the kiln and biochar and the use of the rice husk kiln to these 13 farmer groups.

a) Activities

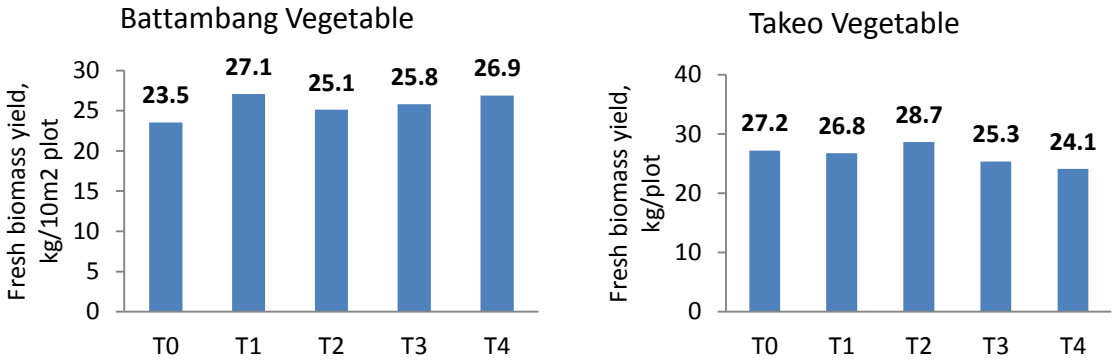
86. The program included the following activities (i) establishment of demonstrations sites for rice (24) and vegetable (47) production including field site manuals and monitoring systems, (ii) assistance with the production of biochar through the supply of lead farmer networks in 13 communes with TULD kiln technology and supporting training, (iii) crop monitoring and supervision integrated with local farmer field schools for demonstrating rice and vegetable production technologies and the effectiveness of biofertilizers using the demonstration sites within a commune, (iv) crop production records including gross margin analysis of each demonstration crop, (v) public awareness farm field days for building a wider knowledge and awareness amongst rural households, (vi) farm field schools for female vegetable producers in two communes on the use of biofertilizer and vegetable production.

b) Outputs

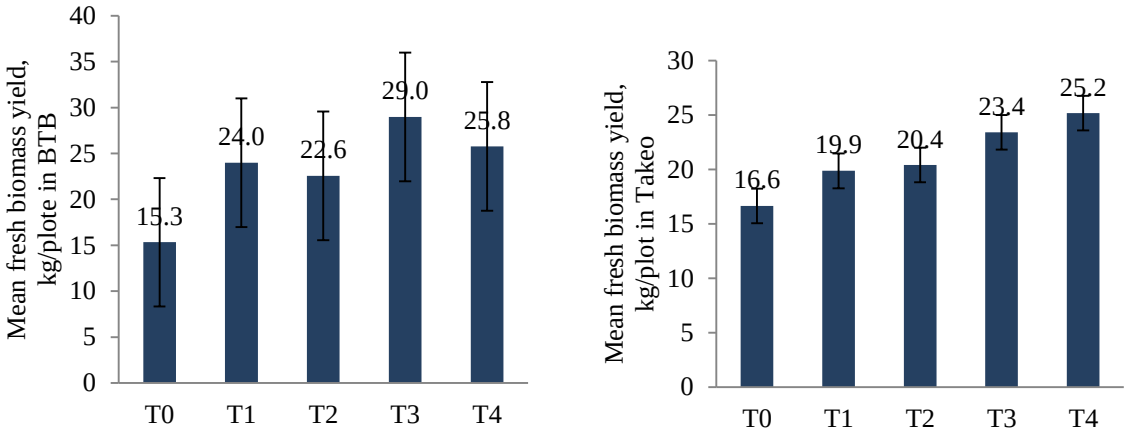
87. The demonstration provided detailed information on the alternative fertilizer treatment on crop performance in terms of yield and financial returns in the form of gross margins. The production

demonstration sites were used extensively in the raising of awareness and knowledge on the use of biofertilizer, production of biochar and crop production.

88. Crop production with blended NPK biofertilizer treatments has the potential to reduce NPK use, however longer term soil amendment benefits need to be researched further.



89. A second vegetable crop increased the use of biochar in the formulation. Within these trials the yield of vegetable responded to increasing levels. In this regard after discussion, we decided to increase biochar level to 5 tons per ha in Battambang and 10 tons per ha to T3 and T4 in Takeo resulting in higher yields. Further replication of these treatments is necessary.



90. It was planned that an average of 25 farmers would participate in each FFS – however few young farmers remain in most villages. The total of 271 farmers attended FFSs on vegetable (79% women) in Takeo, Battambang and Kampong Chhnang respectively and a total of 275 farmers (70.33 % women) attended the FFSs on rice in Kampong Chhnang, Battambang and Takeo. The repeat participation of farmers in FFSs on vegetable declined by 12% and 77% for rice as they moved into their rice harvest while others had migrated to work in Phnom Penh and other places.

91. Farmer feedback and evaluations were undertaken. The same questions were used for the pre and post tests and to help farmers, the drop box method was used. The results from pre and post tests showed that between 70-85% of participating farmers passed the pre-test on vegetable and all achieved excellence for the post test. Farmers got the scores between 67-75% for the pre-test on rice and the post-test score showed small improvement. At the end of the each FFS session, farmers were asked to evaluate the training session that included the participation, facilitation, topics, and practical work.

92. Given that the FFS participants are usually a small group of 25 – 30 farmers, the need to share with other members of the community arises. Demo farmers should take the leading roles to share and show other visiting farmers of their lessons of doing so. A total of 4 Farmer Field Days (FFD) were organized at the selected demo sites at harvest time and these occasions visiting farmers were given opportunity to interact with those who participated in the FFSs and especially the owners of the demo plots. During the FFD, the certificates of participation were awarded to participating farmers as the recognition to their knowledge improvement. A total of 153 participants of which 100 were women participated in the field days.

c) Outcomes

93. Farmer feedback was mostly positive, with many seeking access to the products for repeated use. Farmer preference was to purchase the biofertilizer rather than produce at the household level due to labor and raw material constraints.

94. The introduced fertilizer products have improved the yields of both vegetable and rice except in Kampong Chhnang with associated increased net profits. Labor cost is the most expensive part of the rice and vegetable production and the labor shortage for farming is an issue for future agriculture production. Here the availability of commercial nutrient sources in easy to use form is a critical factor in likely uptake.

95. The limit of only demonstrating one crop cycle means that technically it is still to provide firm conclusions to these demonstrations due to several factors such as the poor distribution of rain fall during the period of the demonstration, infection of disease in Battambang, and the delay in transplanting in Battambang and Takeo.

96. The cost of organic fertilizer including poultry manure and compost is expensive and the cost of inputs increased when fertilizer products were mixing with them. Sourcing sufficient quality compost for the trials/demonstration was difficult despite COMPED producing compost from vegetable waste at the market in Battambang but the capacity is still limited.

97. Although it is a time consuming training approach farmers learn best through exercises "SEEING IS BELIEVING" organized during the Farmer Field Schools. The greatest impact of the FFS is the knowledge sharing through group discussion during the sessions of FFS as well as during the Field Day. However to facilitate the sessions of the FFS, it is important to have technical people who beside their technical knowledge and experience have facilitating and communicating skills that could make the training events more enjoyable and productive.

d) Lessons

- Farmers achieved good sales with better prices for vegetable produced in the rainy season however it is important to have tools and technologies available to protect vegetable from rain including shelter and drainage.
- Farmer access to rice husk biochar is difficult as they do not own the rice husk and are increasingly having to compete with industrial users.
- Farmers in Battambang general own larger land as compare with those farmers in Kampong Chhnang and Takeo and therefore they want demonstration plots to be conducted on a larger area.
- Farmers Field Schools complementary with Field Days are excellent for demonstration and knowledge building regarding the transfer of technologies between technicians and farmers-to-farmers. Such systems need to be structured to crop growth cycles and require effective logistic support

4. Mobile Kiln for Biochar Production

98. The Department of Agricultural Engineering (DAEng) was supported to fabricate, test and field demonstrate a mobile kiln that could produce biochar in the rice field from husk straw and other biomass.

a) Activities

99. The Department of Agricultural Engineering, MAFF fabricated a biochar mobile kiln with 3 containers and 3 chimneys.

100. The biochar mobile kiln was tested at two farm sites around the Phnom Penh area - burning rice straw in two containers and rice husk in the third container. After testing, the kiln was modified and adjusted with the technical recommendations from the DAEng Engineer team, Technical Engineer from GIZ, and Professor Stephen Joseph, resource person TA7833.

101. The DAEng Engineer team conducted field demonstrations to farmer representatives and local authorities in 2 districts of Takeo province as part of the biochar lead farmer network program. Based on their feedback the DAEng Engineer team re-fabricated the second biochar mobile kiln. The DAEng then conducted three additional field demonstrations to some farmer representatives and local authorities in another 3 provinces, Prey Veng, Svay Rieng, and Kampong Chhnang.

b) Outputs

102. Initial findings from the mobile kiln operation are included in the following table.

Table 3: Mobile Kiln Operational performance

Loading capacity for each chamber	
- Rice husk (Kg)	61
- Rice straw(Kg)	28
Burning time (hr)	
- Rice husk	7-7:30
- Rice straw	1-1:30
Burning temperature (^{0}c)	
- Rice husk	380-400
- Rice straw	380-400
Biochar from	
- Rice husk %	38- 40
- Rice straw %	8 -12

c) Outcome

103. DAEng are continuing the development and production of the mobile kiln, with modifications to improve safety and efficiency of kin temperature control, and emission reductions.

C. Output 3: Enhanced Capacity for Efficient Use of Biomass

104. The detailed training and participation in workshops is presented in the tables below. In training a total of 915 trainee slots were delivered of which 682 (75%) were female trainees. For participation events such as study tours, workshops and regional events a total of 193 attendance slots were provided of which 26 were female (14%). Each course or event was assessed and these assessments are included below.

Table 4: Pilot Training Events

Pilot Project	Training events	Dates	Output (No. of Trainees by type (farmers, government or service providers) (and no. of women))	Outcome (Evaluation feedback)	Lesson
PP#1: Improved Cook Stove Up-scaling (Mekong TT)	ICS technical training for ICS enhancement (Coaching monthly quality control by GERES)	May – Sep 2014	18 ICS producers (Service providers) (9 women - wives)	SATISFY: 10% GOOD: 90%	
	ICS user training on different kinds of ICS and different biomass use (Contracted training by GERES)	04 15 August 2014	44 people (Women groups) (farmers) (all women)	SATISFY: 10% GOOD: 90%	
	Women Groups to open bank account (coaching)	Sep 2014	44 people (Women groups) (farmers) (all women)	SATISFY: 15% GOOD: 85%	
	Training on financial bookkeeping for women groups (coaching)	Sep 2014	44 people (Women groups) (farmers) (all women)	SATISFY: 56% GOOD: 44%	
PP#2: Farm Demonstration of Biofertilizers for Upscaling Investment (CelAgrid)	Orientation staff and training on farmer field school on methodologies andtechniques, facilitation and communication skills, vegetable and riceproduction, fertilization and fertilizer rates and biochar	19 – 23 May 2014	12 Farmers (4 women)	SATISFY: 27% GOOD: 73%	
	15 Farmer field school on vegetable in 15 villages.	2nd week of June 2014	271 Farmers (214 women)	Pretest: 23-59%of participants had good scores, 26-47%passed the test	

				and 15-30% failed the test Post-test: 100%of participants had good scores	
	13 Farmer field school on rice	1st week of September	275 farmers (193 women)	Pre-test: 40-100% of participants got good scores, 4-31% passed the test and 4-40% failed the test	
PP#3: Production and Testing of Biofertilizers (Mekong Carbon)	No training				
Under direct support from the TA 7833-CAM	Biochar Making and Application in Agricultural Crops (2 days training at DAE where participants can visitthe workshop where kilns are produced and 3 days practice in Samroung village – production of biochar.)	7 – 11 September 2013	30 mainly government although some farmers (2 women) (GDA Officers, DAEng, NEDO, ADB project staff, Farmers)	Pretest: 65%of participants had good scores, 35%passed the test. Post-test: 100%of participants had good scores. All the participants realize the important of biochar that can help to improve soil structure for crops growing.	
	Operation and maintenance of TLUD kilns for farmers'	2nd week of June	30 Farmers (11 women)	SATISFY: 9 participants	

	groups in Takeo province (3 days training of which participants had 1day visit to Samroung village that received 3 kilns already and 2 days theory plus practice			GOOD: 21 participants	
	Training on Veg & Nutrient Planning and Management for women were conducted in 2 sessions in 2 communes in Takeo province.	23-24 June and on 25-26 June 2014	60 participants (54 women)	SATISFY: 39 participants GOOD: 20 participants UNSATISFY: 0 participants	. Men were able better to understand and capture knowledge faster than women (these groups are mostly elder women), therefore only men can become the trainers. . After the training in each commune, participants in each commune were very enthusiastic to use biochar for their vegetable plantation. They understand and expect that biochar help to amend their soils, reduce acidity and improve their crop yield. . These villagers have got 1rice husk kiln per village for making biochar, all participants promise to make biochar using the kiln and apply on their vegetable land. . They also request for training on using biochar for rice field. The rice production technic using biochar will be delivered through the TA 7833 pilot project on biofertiliser for farmer demo. . The commune chief and the participants from both communes requested the trainers to provide more training to more women groups

	This training were also conducted in in 2 sessions in 2 communes in Battambang province.	2-3 July and 4-5 July 2014.	59 participants (56 women)	SATISFY: 39 participants GOOD: 21 participants UNSATISFY: 0 participants	from other villages in the neigbouring communes. . As the farmers become keen to use biochar, suddenly, some rice mills in the area start to increase the price of rice husk (i.e. the price was 1,000 Riels = 0.25$ per big bag, now the price increase to 2,000 Riels = 0.50$ per big bag). . Technical notification – when biofertiliser mixed with soil for vegetable plantation, there needs to keep the bed for 4-5 days for the reaction process of the fertiliser and the soil. Then the bed can be used to plant vegetables. . After the training in each commune, participants in each commune were very enthusiastic to use biochar for their vegetable plantation. They understand and expect that biochar help to amend their soils, reduce acidity and improve their crop yield. . In Battambang province, the TA 7833 did not distribute the rice husk kiln, as Battambang has piles of rice husk and biochar that are not used yet. But, both target communes where the training were conducted are a bit far from big rice mill, therefore, villager have to transport the rice husk or biochar to their field.

					. In Takriem commune, some farmer groups learned to use biochar as the soil amendment and regulate water for plants by an FAO project on Seed Production. This project trained these farmer groups to make cheap rice kiln made by a big biscuit can with a chimney. This kiln cost between 5$ – 15$ depending on what type of can they use. . Rice husk or biochar are free to take as much as people want. Moreover, the rice mill owner sometimes pay for trucks to carry the rice husk or biochar to through out to some places which create pollution in that area. . They also request for training on using biochar for rice field. The rice production technic using biochar will be delivered through the TA 7833 pilot project on biofertiliser for farmer demo. . Some village chiefs from both communes who participated in the training requested the trainers to provide more training to more women groups from other villages in the neigbouring communes. . Technical notification – when biofertiliser mixed with soil for vegetable plantation, there needs to keep the bed for 4-5 days for the

					reaction process of the fertiliser and the soil. Then the bed can be used to plant vegetables.
	Training on Life Cycle Analysis related to Climate Change policy analysis was conducted at Sunway hotel, Phnom Penh	27 October 2015	24 participants (7 women)	. There were: 2x poor; 5 OK; 7 good; 2 very good. . This training is very general. There needs develop a more specific training model with clear calculation to be added to the next training session. . This training is more focus on GHG emission from animal production, especially, the animal waste. It would be better to include model on crop production, especially, the GHG emission from rice production. The calculation should be on paddy rice, as well as other agriculture sub-sector, therefore the training session should be extended another half day.	

				. Need more time for group discussion. . This knowledge can be shared at the work place with other colleagues in the sector related to animal production.	
	DAEng staff participated in the 2nd International Training Course on Biochar Production testing and application in China	25 October to 1 November 2013	2 participants (men)	Participation in 2nd International Training Course on Biochar Production, Testing, and Application was usefully. It provided new knowledge and information about Biochar production and application on agricultural crop. Through this training course, many Biochar researches and case studies were presented by soil scientist and researchers. So from the knowledge of this training course, some the results of research studies and experiments, the participants can try to	

				apply in their own countries for reducing poverty and combating with climate change by using proper rate of Biochar product depend on soil types and crop. The research results confirmed that biochar can be used as soil amendment substance, enable plant to grow better (water and/or fertilizer absorption capacity of plants). Another advantage of the biochar is that biochar can be a good substance for cleaning any polluted environment.	
	DAEng staff participated in the Carbon Gold Kiln (imported from UK to Laos PDR) training in Vientiane, as the observers.	23-25 November 2015	2 participants (men)	The operation of kiln needs more wood chips to keep the fire for burning rice husk.	

Table 5: Other Events and Study Tours

	Event	Dates	Output (No. of participants by type (farmers, government or service providers) (and no. of women))	Outcome (Evaluation feedback)
Workshops	Regional workshop on efficient utilization of biomass for biochar production & application, in Siem Reap province, Cambodia.	4-8 March 2013	38 participants from CLV (4 women)	All participants, TA Team members and invited speakers were united in discussion and hard work together and provided valuable contributions of ideas and suggestions to address the key concerns and how to overcome these in each assigned topics. The participants also shared their existing capacity and on-the-ground experiences for future successful implementation of biochar activities for improving rural bioenergy and food security. Participants were thanked for their attendance and asked to evaluate and provide feedback on the workshop / training with a view to ensuring continuing improvement in individuals' and TA7833 future activities.
	National Forum on Policy and Standards of Cook Stoves, Household Biogas/Bioslurry and Climate-Friendly Agriculture at InterContinental hotel, in Phnom Penh, Cambodia.	30 May 2013	47 participants (7 women) from different ministries and government institutions, NGOs and some local communities (all women)	The National Forum provided a platform for the continued exchange of knowledge, experience, positions, concerns and perspectives on standards for household bioenergy technologies and climate-friendly agriculture systems, among the various government, NGO, and private sector stakeholders of TA7833. The key issues on standards and certification that were raised during the presentations, open forums, and in the break-out groups as noted in this report, will provide additional bases for the development of two (2) outputs to be presented by the IA at the Regional Forum later this year: the standards roadmap and the policy reform matrix. A Working Group or Task Force for Standards is envisioned to be formed, led by MAFF, explicitly to deliver these outputs. The Standards roadmap will entail an intensive process that includes prioritization of technologies, systems, or products within certain parameters, evaluation of options and policy instruments appropriate to these priorities,

				and putting together a capacity strengthening program. The Terms of Reference for the Working Group or Task Force for Standards will be developed and finalized in August. The process will start from September 2013 and expected to be concluded within twelve (12) weeks of the first meeting of the Working Group. The recommendations and implementation plan that will be developed will go through the government approval protocols, before the consolidated roadmap and policy matrix is presented during the 2013 Regional Forum.
	Regional Forum on different Standards and Roadmap for their Implementation in Sihanuk Ville, Cambodia.	5-6 February 2015	33 participants from CMLV (4 Women groups) (farmers) (all women)	Participants could have opportunity to share knowledge and experience related to biofertiliser productions and applications. The emergence of biofertilizer standardization is an important input to climate friendly agriculture, but still all the four countries are at the beginning of the learning curve. The WGA process seeks to utilize the countries joint knowledge and experience, to bridge the differences between countries whilst enabling each of country to respond to markets in a competitive manner. The forum is an example of how such interaction can contribute to the WGA goals.
	1st Consultation workshop on reviewing the draft organic agriculture and organic rice standards (OA & ORS), in Takeo province.	20-22 February 2014	13 participants (2 Women) of the policy working group on the (OA & ORS)	All participants were satisfied on the detailed discussion on the draft standards. They contribute comments to modify the draft standard that will lead to the final consultation workshop.
	2nd Consultation workshop on reviewing the draft organic agriculture and organic rice standards (OA & ORS), at Himawari hotel, Phnom Penh.	30 July 2014	30 participants (4 Women) of the policy working group on the (OA & ORS)	All participants were satisfied on the detailed discussion on the draft standards, contributing comments to modify and finalize the draft standard. Cambodia at this stage, there are some companies produce organic rice and other agriculture products for export using internal and external certification system based own established voluntary standards, e.g. CEDAC, COrAA, etc. The RGC needs to enforce this national organic rice standard to regulate these voluntary standards.
	1st Consultation meeting on Cambodian national standard on biodigester (BS)	30 October 2014	10 participants (1 Women) of the policy working group on the (BS)	All participants were satisfied on the detailed discussion on the draft standards. They contribute comments to modify the draft standard that will lead to the final consultation workshop.

	2nd Consultation meeting on Cambodian national standard on biodigester (BS)	15 – 16 December 2014	17 participants (3 Women) of the policy working group on the (BS)	The consultation meeting was enable participants to discuss, comment for finalizing the Cambodia national biodigester standard for the government approval process also able to discuss plan for further steps.
Study Tour	Study tour to the *Agriculture New Theory Komes Farm, Bo Kwang Chhor village, Bor Thong commune, Bo Kwang Thong district, Chunbori province, Thailand.*	6-8 November 2015	5 participants (1 woman) from DAEng, CelAgrid, TA 7833-CAM	All participants were able to obtain detailed knowledge of the reported technology and expected to adapt this knowledge through presentation by the owner of the farm (Mr. Pansak Komes) on the innovative ideas of the starting-up the biochar kiln construction. The team could see the actual two different biochar kilns and actual testing of both kilns at the farm. The team could also see some crops growing with the biochar application on the soil. Mr. Pansak using this experience in this farm as the change agent, i.e. his approach is to change attitudes and behavior of the farmers to produce foods that are safe for human health not simply to produce foods to meet the demands and preference of the people. He could share the knowledge and experience related to the production of biochar for soil amendment to enable crops growing organically for safety foods, and contribute to green environment to farmers. This new knowledge and technology is being embedded in the practical lessons within the Public Health Care Faculty of the Chonburi University. There are potential risks in the model being proposed for safe food. The use of urban or periurban farm biomass and waste being converted to biochar is that uninformed operators incorporate non biomass waste into the kiln as a means of disposal, leading to potential contamination of the resultant biochar. Moreover, the economic benefits are low to negative.

D. Output 4: Development and Dissemination of Knowledge Products

105. The final (administrative) report provides details on the knowledge products, bio-briefs and videos disseminated. In Cambodia these were translated into Khmer and distributed to different government ministries and departments, NGOs, CSOs, and the private sector. In addition, during the extension phase of the project (July to December 2015) a number of studies were undertaken as detailed below. Reports are available on request.

1. Surveys on Supply Side of Biofertiliser

106. **Chickens.** Total chicken manure produced, on average across all study sites, is estimated at 38,732 tons/year, which could be the important source for composting, or production of bio fertilizers. The chicken manure has been utilized for mango, pepper, vegetable, rice, and other cash crop production at a commercial level.

107. The transportation cost per 100 Km per ton is estimated to be US$ 15/ton/100 KM, while the average selling price of chicken manure at farm gate is estimated at US$ 37.50 to 50/ton. Moreover, the pepper planting in Kampong Cham suggests that the majority of farmers prefer to use organic fertilizer as the main source of fertilizing their crop, because their experience with synthetic fertilizer negatively impacted their soil and resultant crop production. Limited quantities of chicken manure from Phnom Penh's chicken farms are sold to bio fertilizer firms who used it as a raw material to produce bio/organic chicken manure. The firm purchased, on average, 50 tons of chicken manure per year to process bio fertilizer. In practice, they sold the bio fertilizer to different provinces through wholesale/retail market.

108. **Pigs.** The pig manure estimation across four study provinces is about 21,000 tons per year with most currently having no market value. Thus, based on the study reports the majority of pig manure (78%) from the farm is mainly becoming a waste product on the back yard of the farm (dig pit and dumping), only some other (7%) were dried and sold to farmers (Kandal and Battambang province), and 17% was used for biogas.

109. Pig manure is currently sold at an estimated average farm gate price is of US$0.025/Kg or US$ 25 per tonne. In this regards, this can create a potential for bio fertilizer development around the study site, especially around Kampong Speu, Kandal and Phnom Penh study site, which can contribute to a win-win solution for both pig farm owners and bio-fertilizer firm development.

110. **Rice husk.** Based on statistics from the Rice Federation of Cambodia and IFC (2015) total rice mills, including medium and large scale, in Cambodia are 125 officially registered firms. However, based on the interviews with the rice miller association and the provincial government officials, there around 20-30% of rice mills have been closed. Therefore, currently there are only 83 rice mills operating in the study provinces, which can produce rice husk around 348,460 tons per year, which will be potentially used as the raw materials for bio fertilizer, but this figure needs to exclude the existing utilization for other industries.

111. Currently, there is a high demand for export rice husk to Thailand as raw material. Besides, this rice husk is used locally for brick and tile manufacturing, briquettes, rice drying machine, bio fuel for gasifiers, steaming cement factory and used as a fuel for making cook stove. Some remaining rice husk is kept for selling by the rice millers with a high price at US$15 to US$20 per ton.

2. Surveys on Demand Side of Biofertiliser

112. The bio fertilizer product market in Cambodia is still in its infancy, although several importers/companies have introduced their products to the Cambodian market. Only a few wholesalers and retailers have sold bio products although this is still a small volume amount of products because farmers still have a reasonable choice to use the local available raw materials of organic fertilizer as a means for farm input. Therefore, strong marketing strategies and product development are of paramount importance for bio fertilizer firms to adopt and adapt in their business development.

113. The main source of purchasing synthetic fertilizers are from retail and wholesale places, especially for rice and vegetable farmers who purchased it and make homemade compost. However, the main sources for purchasing organic fertilizers are from farmers who have raised livestock. Only a few percent are from organic fertilizer companies. Equally important, the supply side study indicates there is sufficient raw material from the provincial study site which is potentially available for bio fertilizer establishment.

114. Commercial farming activity, including cash crop and organic farming production, has a high demand for organic fertilizer utilization.

III. Part Three: Lao PDR Completion Report

115. The following provides a summary of the TA 7833 work program undertaken in Lao PDR. The program is presented by output with key activities, output achievements, outcomes to date and lessons/messages from the implementation.

A. Output 1: Enhanced regional cooperation in bioenergy development to foster and safeguard food security

116. The Laos Government prioritized development of a Lao PDR organic rice standard and the standards for bio-organic fertilizer formulation.

1. Organic Rice Standard development

117. The **Lao Organic Rice Standard (LORS)** has been developed and approved.

118. Supporting this an LORS Field Implementation Guide Book has been prepared. 200 copies were produced and they are now available for dissemination and use. Preparation of the guidebook was done in a participatory way as follows:

- First Technical Meeting was held on 3 December 2015: 33 participants (13 women)
- Second Technical Meeting for refinement being held on 7 December 2015: 37 participants (15 women)
- Final round of Tech. Meeting for approval of the Guide Book by 9 December 2015: 35 participants (15 women) and then Publication of 2000 Guide Books
- Forum on Public Hearing and Dissemination of LORS and LORS Field Implementation Guide Book at VTE PLAZA on 18 December 2015: 63 participants (19 women)

119. Recommendations for follow-up are as follows:

- *Recommendation 1: the LORS Books need to be disseminated publicly prior to implementation*
- Recommendation 2 for Standard Division, Department of Agriculture: A dissemination forum should be convened wisely and publicly with anticipated participants from private sector, producers and entrepreneurs, traders and partnership, millers, NGOs etc.
- Recommendation 3 for MAF/ADB (CASP 2): in order to implement these LORS, more capacity building programs are required in line with existing GOL Master Plan towards 2030 - prioritized targeted groups/entrepreneurs, households, clusters, and zones. A planned approach including (i) Pilot Farm Demonstrations; (ii) Replication of Farm Demonstrations across Lao PDR by 2030 to targeted households, areas; and (iii) Upgrade capacity of existing producers, entrepreneurs and traders leading to regional (ASEAN) cooperation, including China, Japan and EU is required.

2. Biochar-based Organic Fertilizer (BOF) Standards formulation and development

a) Product Formulation and Testing:

120. Four formulations have been designed and developed (classified as F1, F2, F3 and F4)

121. Final results: through demonstration of 1 year, **F1** and **F2** have been accepted by farmers and users. Lab. Tests and Analysis have been completed. Both products achieved the required **Laos (DOA MAF) BOF Standards Indicators (21 in total).**

b) Commercial Production of Formulated Products

122. Two BOF Entrepreneurs have produced and processed biofertilizer. Initially four formulas for technology development and demonstration were used.

123. KONGKHAM BOF Enterprise has been **certified and registered as a F2 Producer**. F2 standard was developed, processed and product (10 tons, including 1 ton in pellet form – REAL PRODUCT, Premium Quality (N-P-K: 1.5 – 3.6 – 1.5) and well packaged[2].

124. MEKSAVAN BOF Enterprise has been **certified and registered as of F1 Producer**. This Enterprise has produced and processed F1 (10 tons, including 1 ton in pellet form – REAL PRODUCT, Premium Quality: (N-P-K: 1.5 – 3 – 1.5) with good packaging.

- *Recommendation 4 for the BOF supply chain: There is a need to undertake more awareness raising / education campaigns due to farmers' lack of awareness, knowledge and access to the BOF – including the use of BOF as a long-term soil amendment.[3] This should include the involvement of the two BOF Entrepreneurs as resources for the program.*
- *Recommendation 5 for DALAM, DOA: More demonstration, extension and promotion is required of the results/benefits from using F1 and F2 for promoting healthy soil and healthy people and food safety.*
- *Recommendation 6 for PAFO, DALAM, DOA: The supply of F1 and F2 should be linked to (i) 5 PGS groups supported by the Lao Pilot Project (ref. Lao Pilot Economic, Social and Environmental Survey) and within Vientiane province; (ii) Boung Phao PGS groups supported by another ADB project (including CASP 2) in Laos; (iii) Vientiane Organic Vegetables Association*.

c) Lessons - Key Messages

125. Institutional implementation arrangements should be set up properly with a bottom up approach: village and cluster level; district and provincial coordination; and central levels such as TFP and WG to function at initial stage.

126. Pilots should be implemented as follows:

- BOF preparation and product demonstration in different phases - the Lab test and analysis need more time
- project life should be more than one year e.g. results of soil amendments should be assessed and analyzed in a 4 – 5 year program.

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[2] *See Biochar and Biochar-based Organic Fertilizer Development Working Papers*
[3] *Farmers' preference is for higher yield within short-term period as opposed to medium to longer term benefits to soil health.*

127. DOA MAF rules and regulations are that two years (conversion period) of vegetable production experiments are needed, and under DALAM control, Organic Veggies Production Groups should be identified as PGS groups and it is proposed to DALAM to follow up the trial, record and analyze the results using first year project fund;

128. Implementation should start the before rainy season – before May;

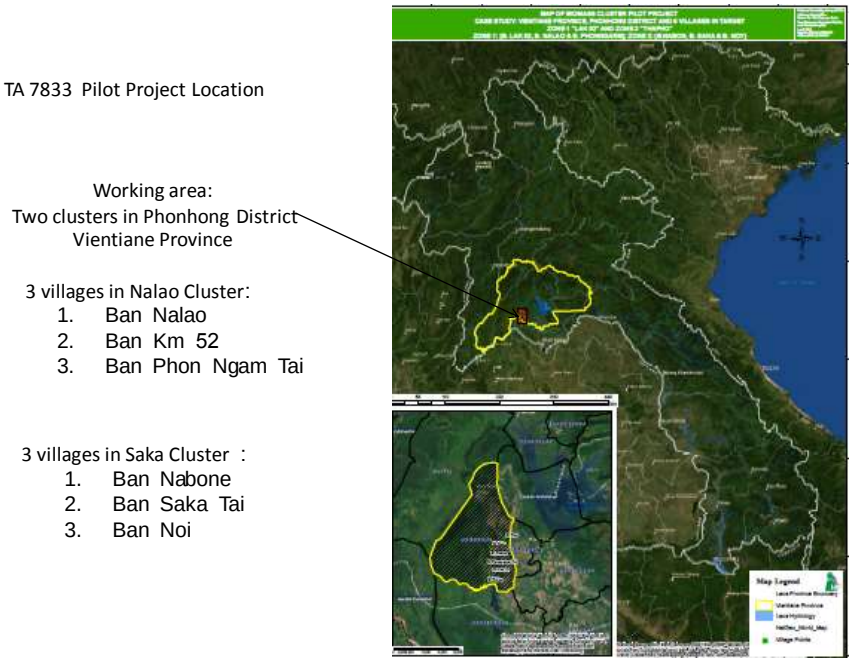
129. Biochar and Biochar-based organic fertilizers should be prepared in the dry season: raw materials dry faster, easier for pyrolysis.

B. Output 2: Pilot-tested climate-friendly biomass investment projects for wider implementation

130. A prefeasibility rapid appraisal mission was undertaken and two clusters identified in Phonhong district, Vientiane Province, with 3 villages targeted within each cluster. Within these voluntary farmers/families/households/LWU/private entrepreneurs were targeted.

131. Beneficiaries: Total number: 9542 (4725 women) of which:

- Cluster 1: 6056 (3025 women)
- Cluster 2: 3486 (1700 women)



1. Outputs

132. The Laos Pilot Project (LPP) has two outputs:

a) Output 1: Increase the use of ICS

133. Increasing the use of ICS is expected to use less biomass, decrease air pollution and women's labor. The LPP has promoted Laos Women's Union (LWU) to increase sales of ICS and enhance local producer capacity as per the following activities:

- Capacity building of women in the community:
  - Capacity building on ICS specifications to improve efficiency and reduce emissions/pollutants
  - Different promotional materials, resources (such as leaflets, public demonstrations, meetings and test results from different ICS technologies)
  - Train LWU on planning and ICS sales and marketing program
  - Encourage customers to use ICS by designing the ICS label and ICS shop plates, making a short movie to promote the use of ICS, and
  - The use of incentive payments to increase the sales
- Enhance ICS producers capacity to improve the production and the quality of the ICS in order to meet ICS market needs
  - Trained and provided support for a local producer of the Laos Superman ICS
  - Linked the ICS producer to the market
  - Entered into a supply agreement with SNV and ARMI for the supply of Superman ICS to the LWU with technical support

b) Output 2: Biochar and BOF Technology and product development and demonstration using biomass from agricultural residues

134. The program supported two private enterprises (Mr. Kongkham in Ban Km 52 and Mr. Meksavan Valintho in Ban Saka-Tai) to invest in production of agreed BOF formulations, to supply to farms in the district that agreed to demonstrate new BOF formulations on their vegetable plots (27 families) and rice fields (5 families) in the two development clusters.

135. The LPP has implemented the following activities:

- Develop BOF formulations with four formulas (standards) from which 3 formulas were selected for testing in rice and veggie demo plots
- Capacity Building on:
  - Equipment operation and maintenance for 2 enterprises and cluster staff
  - Improvement of the skills along the supply chain from BOF producer to BOF user
  - Additional technical training was provided to farmers and service providers in the clusters and to government staff
- Procure equipment for BOF production and supply of feedstock materials for the production of agreed formulations (including technical support)
- Prepare raw materials supply chain with 10 biochar kilns, 12 biogas Composite Digesters, animal manure / dung suppliers (cattle, pig, and poultry farm in the areas) and peat from the bottom lake and clay soil of termite mound
- Develop compost making in 2 enterprises
- Produce BOF in loose mixed and pellet form in 2 enterprises
- Built supply relationship between the farmers and the LPP
- Support for farm demonstration plots and field days in terms of technical assistance, materials and equipment while the farmers contributed labor and local materials

- The clusters and project staff have been supported regularly and they participate in farm training practices.

2. Results

a) LPP Output 1: Scaling-up ICS Program Using Output-Based Incentives

136. The pilot target was for ICS to be used by at least 40% of the total household number in target villages in 10 months. **Achieved** – after 8 months (April- October 2014) the ICS sale volume reached 737 and included 43% of the 1742 targeted households in the area.

137. Status at 10 months (Dec. 2015: expert and tech. staff inputs: 205 man/day): all 6 LWU shops remain selling ICS. Local producer is producing ICS - medium scale with capacity about 100 units per month to supply to LWU and other shops and restaurants.

b) LPP Output 2: The Demonstration of production and use of Soil Fertilizers and Amendments

138. **Production demonstrations.** To date a number of products[4] have been produced for farm demonstration. Two BOF enterprises have gained experience on tools and materials operation and maintenance (Biochar kilns, Biogas Composite Digesters, Crushers, BOF mixers, pellet machines), the BOF composting and packaging.

Table 6: Total Production of products (tonnes):

Product	During Demonstration	Post Demonstration to December 2015	Total Production
Biochar	6	12	18
Biochar-based Bio-fertilizers	14	20	34
Compost	7.2	12	19

139. **Demonstration of use**

- 27 households demonstrated the use of BOF on vegetable production for four cropping cycles (two in wet season, two in dry season)
- 5 households demonstrated the use of BOF for one rainy season rice crop
- Expert and tech. staff inputs: 1105 field days for local producers

140. Additional support included a study tour, trainings and hands-on mentoring on application of biochar and BOF in rice and vegetable plantation, including bio-fertilizers, botanic pesticide making and use, its record and management and producing compost.

141. **Application to vegetables.** The biochar and BOF application on 27 vegetable demonstration plots using different crop varieties were conducted over 4 cycles: 2 cycles in dry season and 2 cycles in rainy season. BOF lab test and its demonstration results have been submitted to DALAM/MAF periodically after each cropping cycle.

[4] *Ref. NCG spreadsheet Record of Production (provided on 23 June 2015): BOF & Compost & Biochar. The record figures up to Nov./Dec. 2014 only*

142. The demonstration consisted of 5 treatments (T1 to T5) and 3 replications. The subplots were:

- T1 (usual farmer practice used as a baseline to compare the effectiveness of BOF),
- T2 with Biochar (30% rice husk+30% manure + 30% clay soil+ 10% straw/bamboo/chicken dung via kiln pyrolysis process),
- T3 with BOF formula 1 (F1),
- T4 with BOF F2,
- T5 with BOF F3.

143. *Outcome:* The yield of different types of vegetables has increased from **35-50%** compared to farmer practice plots and soil test results indicate soil properties and soil structure have improved.

144. **Application to rice.** Four formulas (standards) of BOF were formulated through a design process involving experts in soils, fertilisers, agronomy, extension and biochar. The design team recommended 3 formulas for rice crop demonstration. The team designed the rice demo plots with 5 treatments and 3 replications. Each treatment subplot had 30 m2 and was marked by T (treatment) from T1 to T5 being:

- T1 used farmer practice as a baseline.
- T2 used only biochar produced by pyrolysis using a TULD kiln from a pre-mixed feedstock comprising pre-pyrolysis: 30% rice husk, 30% cattle manure, 30% clay soil (termite mound) and 10% rice straw, bamboo, cob corn, chicken dung.
- T3 used Biochar-based Organic Fertilizer formula 1 (BOF F1),
- T4 used BOF formula 2 and
- T5 used BOF formula 3. Making sure the result of BOF demonstration to be positive, there were three replications and marked: Replication 1 by 01, Replication 2 by 02 and Replication 3 by 03.

145. *Outcome:* The monitoring data indicates that all T2 to T5 has improved soil properties (soil structure and pH) and with an associated rice yield increase. The use of BOF in pellet or mixed form on 5 rice fields in the 2 clusters increased yield by **74%** compared with normal farmer practice.

c) Pilot Project Outcomes

(i) Scaling-up ICS Program Using Output-Based Incentives

146. With secured suppliers and output-based incentives, the LWU is able to increase the uptake of ICS technology within households.

(ii) The use of biochar and bio-fertilisers as a soil amendment

147. The organic contents of the soil in vegetable demonstration plots have significantly increased with each cycle. However, Nitrogen levels remain low despite Organic Matter (OM) levels increasing. The option of adding reactive migro-organisms to F1 and F2 needs to be assessed.

148. The repeated application of biochar and bio-fertilizers on vegetable production continues to increase OM levels with increases to yields and improved soil properties (soil structure, pH). With increasing OM and soil carbon levels it is expected that in the future, plant available nutrients will also increase.

149. The lifecycle assessment of initial farmer biofertilizer strategies indicated a range of moderate gains in GHG emission reduction and the scale of gross margin benefits to those that use biofertilizer for vegetable and rice production. An extended assessment of the impact of biofertilizer use based on

the national recommendation for organic matter soil amendments was conducted using the Roth C dynamic carbon model and then integrating this within a LCA assessment framework. The initial results clearly indicate substantial gains in the level of carbon sequestration along with the reduced GHG emissions from avoided fertilizer use. A key recommendation is the need for long run soil carbon treatment trial sites that can be used to validate the model parameters such that potential GHG mitigation opportunities can be taken to the market.

150. As a result of farm demonstrations, farmers' knowledge of improving soil health through use of Biochar and BOF whilst increasing yields is leading to increased adoption that is limited by availability of product. Pilot demonstration farms have, in some instances, expanded the area of vegetable production using Biochar and BOF significantly. In addition, neighbouring farmers have also reported adoption.

151. Under a single rice crop, yields have improved under T2 to T5. However, to amend soils will take several crop cycles.

152. Farmers and target beneficiaries with the support of central and local authorities continue practicing climate-friendly agriculture by using biomass for biochar and bio-fertilizers and soil amendments.

d) Recommendations

- *Recommendation 8* to DOA, DALAM and Private Sector: ensure the manufacture of BOF F1 and F2 achieve the registered standard and that quality control be maintained by ALaDC and local staff. Similarly, for PGS groups to achieve organic certification will require that the quality of BOF standards to be maintained.
- *Recommendation 9* to DOA: Promotion and marketing of BOF and soil health is a key point in this value chain – prior to the PGS groups to be certified as Organic Farming (2 year conversion period). This will require continued support from local authorities and the private sector. For example, there is an urgent need for a permanent site for the marketing of organic or safe food products and to supply the necessary inputs to. Further, the recent support provided by a private supermarket chain (seeds, shadow cover plastic sheets, protection nets to the PGS groups) should be extended to include other essential inputs such as BOF. In return, producers supply the supermarket with certified organic produce.
- *Recommendation 10* to Lao PDR Government: BOF local enterprises need to obtain formal registrations and certification, which enable these enterprises to continue producing their products for demonstration and sales. Applications of documents to DALAM/MAF, DAFO, PAFO, Department of Tax, and Department of Industry and Commerce need to be processed. The status of business registration and business incentives for these enterprises needs to be assessed.
- *Recommendation 11* to local authorities, DOA and DALAM: It is recommended the supply chain for BOF F1 and F2 should be linked to PGS groups and the local market with an education campaign leading to awareness raising and increased trust. Further replication and expansion of CFA practices using biochar and BOF should be promoted more widely.

C. Output 3: Enhanced capacity for efficient use of biomass

153. Capacity building was provided through a range of activities including conferences, meetings, workshops, trainings and study tours. In total the number of trainees and participants was 3123 of

which 1417 were women. A detailed listing of capacity building and events is provided in the table below.

Table 7: Training, Workshops and Study Tour Events undertaken

	Training	Dates	No. of Trainees by type (farmers, government or service providers) (and no. of women)	Evaluation feedback
Output#1 ICS program: scaling up ICS use in project clusters				
A#1.1 Scaling up ICS use and Education Campaign	Hands-on/OJT ICS production focus on Super Stoves and Work Bank Stoves Hands-on/OJT rice husks stove production and small wood residue Hands-on/OJT biomass stove production	July 2014	1 local producer and 4 labors, 0 women (Service providers) 1 local producer and 6 labors (Service providers) 1 local producer and 3 labor (Service providers)	Difficult to produce with high standards Price still high Price still high
A#1. 2 ICS use and education program	ICS demonstration and efficient use of biomass for bioenergy	July	18 people including 8 women (Service providers)	Agreed on 4 types of ICSs
A#1.3 ICS Business planning	ICS Sale projection and Incentive –Based Systems	July	7 women (LWU) (Service providers)	Business plan established
A#1.4 ICS Inventory	ICS Shop design and Promotion Campaign	July	7 women (LWU, service providers) and 3 ARMI/NCG staff	Good fashion, posters Good start, advertisement
A#1.5 Practical knowledge transfer	ICS practical training and marketing /after sale services	Aug	49 people, including 46 women (cost sharing workshop) (LWU) (service providers)	Sale techniques applied Education campaign
A#1.6 ICS sale recording	Monitoring and ICS users survey	Aug	7 women (LWU) (service providers)	Sale recording and monitoring Reports

A#1.7 Biomass stoves (metal)	Rice husks stoves and other biomass stoves promotion	Aug	1 local producer / inventor and 6 labors, 0 women (service providers)	Good quality Price still high
A#1.8 ICS Village Demonstration	Cluster Demonstration at KM 52 market places, trails and tests on efficiency	Sept	155 participants (55 women) Villagers/Users, Producers, Retailers, LUW, Tech. staff	Good ICS promotion campaign Feedback on 4 types of ICS: Prices, Quality, Likeability, Durability and Efficiency
A.1.9 ICS Exhibition at special events	2 Clusters and Phonhong District Government special events / meetings	Sept	250 participants (65 women) Gov. staff, officials, LWU, Producers, farmers/end-users	Good exhibition organized Increased sale promotion and demonstration at district and provincial level
A.1.10 Monitoring and evaluation	ICS use assessment within two clusters of Phonhonhg District	Nov	15 participants (8 women), LWU, Cluster staff, Village and district authorities	Spot checks/Interviews: sale evaluation, use assessment, SWOT analysis made Exit plan and strategy drafted
A.1.11 ICS program exit strategy	Stakeholders review meeting on exit strategy of Lao Pilot Program	Dec 2014	30 participants (20 women), LWU, Producers, Users, 6 village, Clusters and district authorities	Open discussions on outcomes made – opinions on ICS program Exit Strategy agreed upon LWU and producers are willing to continue business plans (PCR)
			Expert and tech. staff Inputs/field days of ICS pilot program: **205 man/day**	
Output#2: Biomass for bio- fertilizers and soil amendments				
A.2.A First National Forum on Policy and Standards	National Forum on Policy and Standards for Enhancing Bioenergy and Food Security: Biogas & Bioslurry, Biochar,	11 June 20113	Lao Plaza Hotel: 28 participants (7 women): public and private sector, entrepreneurs, NGOs, NPAs, Experts	Information sharing Awareness campaign Satisfaction

	Improved Cookstoves, Climate-Friendly Agriculture			Tech. Report available (1)
A.2.B Debriefing on RA Mission Findings	Technical review on rapid appraisal mission on Laos Pilot Biomass clusters	Oct. 2013	At central level: 12 key stakeholders, NFP, TFPs (4 women) At provincial, district, clusters, village levels: 55 participants (28 women)	Minutes (2) (including the Rapid Appraisal Report (3)) of the debriefing endorsed and submitted
A.2.C Laos Working Group Orientation	Technical Meeting on Working Group Approaches on priorities of development technology	Jan 2014	18 participants (6 women), NFP, TFP, WG members, experts	Approaches agreed upon WG action plan established
A.2.D First WG Meeting	1st WG Meeting on prioritizing technology to be developed under Output#1 and to be piloted and demo. under Output#2 of TA7833-REG	Jan 2014	16 participants (6 women), NFP, TFP, WG members, Centers of Excellence, Experts	2 priorities agreed upon Inputs for development process Minutes of the First Meeting: Next steps – Road to WGM 2: Laos Organic Rice Standard Biochar and Biochar-based Organic Standard
A.2.E 2nd WG Meeting on development of LORS and BOF design	WGM2 on Laos Organic Rice Standard and Biochar-based Organic Fertilizers	Feb 2014	14 participants (4 women), key staff of centers of excellence, TFP, WG members, experts	LORS draft starting point 4 Biochar-BOF designed and formulated at initial stage Next steps – to WG3 final round WGM2 Tech. Report (4)
A.2.F Inception phase at Provincial level	Lao Pilot Inception Meeting at Provincial Level	Feb 2014	18 participants (8 women), PAFO tech. staff, extension service center, provincial authority, LWU	Institutional arrangement Better informed staff Agreed on 2 clusters Staffing
A.2.G Inception phase at District, Clusters, Village Level	Lao Pilot Inception Meeting at District, Clusters, Village level	Feb 2014	65 participants (30 women), DAFO staff, cluster staff, LWU, Farmers Beneficiaries, Experts	Scope of works defined Activities indentified Better informed stakeholders Institutional arrangement setting up Lao Pilot Work Plan

A.2.H 3nd WG Meeting LORS and BOF final round	WGM3 on final round of LORS and BOF F1, F2, F3 and F4 development	Mar-Apr 2014	20 participants (3 women), TFP, NFP, Centers of Excellence, Experts, National Consulting Group	Initial first draft of LORS Agreed on F1, F2, F3, F4 to be tested at ALaDC and Lab. WGM3 Tech. Report (5)
A.2.I Lao Pilot Inception Workshop at Central Level	Inception Workshop on Lao Pilot project Implementation in 2 clusters of Phonhong district, VTE province	Mar 2014	At MAF: 28 participants (11 women), SNV, ARMI, District and Provincial staff, farmers, entrepreneurs, TFP, experts, NCG	Consensus made Better informed beneficiaries Institutional arrangement LPP Inception Report (6)
A#2.1 Biochar and Biochar Organic Fertilizers	How to make biochar and effective use for soil improvement Organic farming by using biomass for Biochar-based Organic Fertilizers	July-Aug 2014	19 people, including 3 women (farmers)	Learning by doing and practices applied Awareness raising on Biomass Utilization (NCG monthly Report)
A#2.2 Biomass feedstock and soil conditions	Biomass feedstock and soil samples collection and analysis - Healthy Soil Requirements	July-Aug	35 Veggies growers (farmers) (28 women) 7 rice farmers (4 women)	35 veggies plots/soil samples and 7 rice field plots tested and analyzed Test results have been used for baselines and BOF Formulations (NCG monthly Report)
A#2.3 Cross-study tour	GAP practices and Organic Vegetables and Market Places	Aug	20 veggies and rice farmers, including 12 women	Lessons learnt and applied and implied Want to be Organic Farmers
A2.4. BOF – Volunteer Soil Doctor	BOF/BCF and Use Theory on good soil and Biomass/BOF for healthy soil	Aug	22 farmers, including 10 women (plus two women trainers)	Learning by doing at farm levels Compost making and applied Field Manuals
A2.5 Biochar Organic Fertilizers	How to produce BOFs and Processing and Application	Aug	31 farmers, including 16 women	Want to applied Want to make compost by themselves
A#2.6 MEKSAVAN Enterprise	On the job-training /learning by doing: BOF Formulation 1	Aug	22 farmers (compost makers), including 15 women	Want to apply Standard registration required

A#2.7 KONGKHAM Enterprise	On the job-training/learning by doing – kilns and machines tested to produce BOF Formulations 2	Aug	14 farmers, including 7 women	Eager to use BOF Standardization process
A#2.8 Compost at fields	How to make compost in the fields / practices at KM 52	Aug	18 people (farmers), including 12 women	6 families applied 6 compost makers trained
A#2.9 Biogas composite digesters	Installation, Use, Operation and Maintenance	Aug	12 families 72 persons (farmers) (34 women)	Good performance Hans-on training on O&M made
A#2.10 Veggies demo	28 green houses installation	Aug	56 farmers, including 28 women and family members	Good performance with in-kind contribution and labor
A#2.11 Rice fields demo	7 plots preparedness	Aug	14 farmers, including 7 women and family members	Good performance with in-kind contribution and labor (NCG monthly Report)
A#2.12 Application and follow up	Routine and periodical learning by practicing / hands-on advice	Started from July 2014 onwards	75 farmers, including 40 women (44 locations) owners and their family members	Case-on-case basis applied Active participation Active local tech. staff (Monthly Monitoring Report)
A#2.13 TVD series review meeting	Disseminate and review TVD synopses Parts A, B, C and D at central level	3 July	14 government officials (4 women)	Consensus on proceedings Minutes of the meeting (7)
A#2.14 Hands-on Biogas Composite Digesters	OJT learning by doing with farmers participation and contribution – BCD O&M	26-28 July	72 farmers, including 34 women	Active participants Want to use biogas (NCG monthly Report)
A#2 15 TVD series review meeting	Disseminate and review contents of TVD series production at pilot clusters	22 Aug.	29 mainly farmers (14 women)	Understandings and consensus to proceed preparation and readiness Evaluation Report (8)
A2# 16 OJT Pest-Control Techniques	Organic / Botanical Pest-Control Approaches and Methodologies	4-7 Sept.	18 families in 3 villages of pilot cluster (mainly farmers: 18 women)	Learning by doing and applied
A#2 17 Mid-Term Performance Review	Lao Pilot Interim Performance Review Meeting	16 Sept.	33 persons (mixture – say 11 gov, 11 service providers and 11 farmers) (14 women)	Satisfaction LPP Interim Report endorsed (7)
A2#18 LPP Education/	Sale promotion and demonstration of ICS, with Organic Vegetables Produce and	Sept.	At clusters level: 21 persons (estimate at 7 government, 7 service	Good satisfaction Local government support

demonstration program	Sale, BOF use and replication / introduction		providers and 7 farmers) (20 women) At district level on spec. events: 250 farmers(165 women)	Market places need for organic food and vegetables Want to use BOF with registration and certification (NCG monitoring Report)
A2#19 OJT Soil Test	OJT on soil test (NPK and PH) after first cycle of veg. production	Sept.	At farm levels: 6 farmers, including 3 women and two local staff	Being applied at other farms (NCG monthly Report)
A#2.20 2nd cycle organic veg. Production	OJT 2nd cycle cropping of veggies production with more than 5 varieties	Oct	At farm level: 60 farmers (27 women) 60 families of beneficiaries	Replication of BOF Rotation Diversification Satisfaction Want to continue (Monthly monitoring report)
A#2.21 Sale promotion and exhibition	Sale promotion campaign and exhibition of Non-Chemical Vegetables, Biochar and Biofertilizer Utilization	Oct	At market place KM 52, Cultural Festival 450 participants (250 women) LWU, Users, Consumers, Service Providers (approximate at 50% farmers (225) and 50% service providers (225))	Good products Good prices Need more awareness raising program on Organic Farming (Monitoring report)
A#2.22 Spec. Review Workshop	First Laos Organic Rice Standard Tech. Review	Nov.	At central level: 31 persons (8 women) Tech. staff, services providers, traders (approximate at 50% government and 50% service providers)	Satisfaction Refined first draft in Lao and English Second draft of LORS
A#2.23 Biochar Training Course	Biochar and Bio-Fertilizers Production and Application	Nov	At Pilot Clusters Level: 24 persons (7 women). Famers	Satisfaction Application Adjustment needed (NCG monthly report)
A#2.24 Demonstration of Pellet machine use	Original pellet machine trial /use and maintenance training	Nov.	At Meksavan BOFE: 24 participants (7 women) Producers, Farmers, End-Users.	Satisfaction Operational Manual Safety first required

and maintenance			Assume 50% farmers (12) and 50% service providers (12)	
A#2.25 OJT compost making	Review compost making and adjustment	Nov.	At 6 villages: 60 farmers (20 women) 60 families members	Adjust ingredients/composition Adjust application ratio Want to produce more BOF
A#2.26 OJT veggies plantation techniques	OJT land preparing , BOF application Ratio adjustment, transplanting techniques with rotation / diversification	Nov.	At LPP plot areas: 170 participants (60 women) LWU, Farmers, Tech. Staff (assume 70% farmers (119) and 30% service providers (51))	Satisfaction Need more varieties Knowledge refreshed Want to sell veg. At good price / organic market
A#2.27 OJT veg. Harvest techniques	Routine and periodical learning by practicing / hands-on advice	Nov.	At LPP plot areas: 144 participants (54 women)LWU, Farmers, Traders, Consumers, Tech. Staff. Assume 70% farmers (101) and 30% service providers (43)	Follow up needed Data recorded Value added activities Packaging/transport for market
A#2.28 OJT veg. Germinating techniques	OJT vegetable effectively germinating round 3 (third cycle with more than 5 varieties by the project support and 5 varieties by farmers needs)	Nov.	At LPP plot areas: 57 participants (20 women) Farmers families, tech. staff	Reliable method of germination New varieties needed Market demand and supply chain
A#2.29 OJT organic rice harvest techniques	OJT harvest techniques, record, keep, storage (LORS approach)	Nov.	AT LPP plot areas: 26 participants (10 women) LWU, Farmers families, tech. staff .Assume 50% farmers (13) and 50% service providers (13)	Rice production evaluation Laos Organic Rice Standard approach tested
A#2.30 OJT New pellet machines use and maintenance	2 BOF Enterprises and workers/labors learning by doing	Nov.	At Meksavan and Konglham Enterprises: 11 participants (2 women). Service providers	Moisture contents to be kept at appropriate percentage Want to produce BOF in pellet forms (NCG Monthly Report)
A#2.31 Routine practices on vegetable	Hands-on practices of vegetable plantation round 3 / rotation / diversification techniques	Dec.	At LPP areas: 180 participants (80 women) LWU, Farmers families, tech. staff, surrounding villagers	Organic methods of pest control More varieties needed Satisfaction (M&E Report)

plantation round 3				Optimistic Adjust BOF application ratio
A#2.32 Routine practices of BOF production	Hands-on practices of BOF production and processing (crushing ,filtering, mixing , turning over ,pellet making)	Dec. 2014	At 2 BOF Enterprises: 60 participants (10 women) Farmers, Tech. Staff, Workers. Assume 50% farmers (30) and 50% service providers (30)	Quality of BOF Standardization Registration and Certification (Monitoring report)
A#2.33 2nd Tech. Meeting on LORS	2nd Tech. Review on LORS	30 Dec 2014	42 participants (9 women): tech. staff, experts, specialists	Agreed on LORS refinement Finalized LORS for approval Final version
A#2.34 Routine practices of round 4 vegetable production	Refresh-Hands- on practices learning by doing (germinate , BOF applying, transplanting) – new varieties/diversification	Jan. 2015	At LPP areas: 126 participants (45 women) Farmers, LWU, Tech. Staff, Surrounding villagers. Assume 50% farmers (63) and 50% service providers (63)	Satisfaction Expansion of land areas Adjust BOF application ratio More benefit (Monthly monitoring Report)
A#2.35 BOF improving meeting	Tech. Review Meeting on BOF standards, lab. Tests requirement - evaluation	Jan. 2015	At DALAM and Central Lab. Of NAFRI: 12 participants (3 women) Government staff	Better understanding Lessons learnt for improvement Heavy metal tests requirement (Test result report)
A#2.36 BOF meeting on feedbacks from tech. Review	Feedbacks meeting for farmers and BOF Entrepreneurs – quality control – standards F1 and F2 for production and processing	Jan. 2015	At LPP areas: 34 participants (10 women)LWU, Producers, Farmers, End-Users, Tech. Staff (Assume 50% farmers (32) and 50% service providers (32))	Standards F1 and F2 Quality Control Pelletizing Lab. Tests for heavy metal Test and Analysis Report
A#2.37 Cross study	Farmers to Farmers Visit and experience sharing	Jan. 2015	At LPP areas: 33 persons (10 women) LWU, Veg. growers, tech. staff.	Good lessons learnt from each other Market potential Price Quality products
A#2.38 Public Hearing on LORS	Public Hearing Workshop on LORS	12-13 Feb	26 participants (11 women): public and private sector, entrepreneurs, experts	Satisfaction LORS approved Wider dissemination needed Final version for publication

A#2.39 BOF F1 and F2 Tech. Review	Tech. Meeting on adoption of BOF F1 and F2 Standards	March	Participants 25 (5 women): experts, tech. staff	Accept BOF results Lab. Analysis on heavy metal Registration and certification proceeded
A#2.40 Use survey results meeting	Feedback BOF and End of LPP planning meeting	March	Vangxang Resort, VTE province 40 participants (15 women): District Governor, PAFO, DAFO, All beneficiaries	Agreed with last meeting and plan for project sustainability Exit strategy (Pilot Project Completion Report) (9) Market demand and supply chain at local level Private Sector – Super Market at VTE Capital Level
A#2.41 Joint Planning Meeting on Extension	Tech Joint Planning Meeting on prioritizing extension activities of TA7833	Aug	MAF 14 participants (4 women): NFP, TFP, Tech. staff, Experts	Activities prioritized and agreed for proceeding by end of Nov. Minutes of the Meeting (10)
A#2.42 BOF F1 & F2 OJT Standardization	BOF F1 and F2 development : OJT on standardization, quality control	Oct-Nov.	BOF Enterprises at pilot areas 60 participants (20 women): entrepreneurs, workers, local staff, farmers	Become producers Standardization Pellet form Quality control Tangible results: F1 and F2
A#2.43 LCA Workshop	Life Cycle Analysis Training Workshop	6 Nov.	VTE PLAZA 17 participants (5 women): tech. staff, experts	Awareness raising on GHG reduction LCA Module introduced Training Evaluation Report (11)
A#2 44 Kiln Training Program	Super Char 100 Mk II Training Program	23-27 Nov.	ALaDC 3 tech. staff of DALAM, 2 observers from Cambodia, PM staff, experts (total 12, incl. 1 woman)	3 Lao Tech. Staff can operate the kiln Training Evaluation Report (12)
A#2 45 LORS Field Guide Book Development	1st Tech. Meeting on LORS Field Implementation Guide Book	3 Dec	Veunkhan Clean Agriculture Development Centre 33 participants (13 women): tech. staff, specialists, experts	Review draft field guide book The Guide Book V1 to be refined
A#2 46 LORS Field Guide Book	2nd Tech. Review Meeting on the LORS Field Guide Book	7 Dec	At Central Level 37 participants (15 women): tech. staff, specialists,	Refined field guide book The Guide Book V2

Development			experts	
A#2 47 LORS Guide Book Final Refinement	Final Round Meeting on LORS Filed Implementation Guide Book	9 Dec	At Central Level 35 participants (15 women): specialists, experts, PM members	Refined field guide book The Finalized LORS Field Guide Book V3 for approval
A#2 48 BOF F1 and F2 Sale demo. education campaign	Organize Real Products of BOF F1 and F2 Sale Demo. Education Campaign and awareness raising at KONGKHAM and at MEKSAVAN Enterprises and at Local Market	12-16 Dec	At local KM 52 Market Place: visitors, farmers, end-users, tech. staff, experts: total number 219 (101 women) International Earth Day Hmong New Year Festival	Advertizing made Trust building and education needed Demand and supply chain to be created
A#2 49 Public Hearing on LORS and Guide Book	Public Hearing Workshop on Dissemination of Laos Organic Rice Standard and its Field Implementation Guide Book	18 Dec	At VTE PLAZA Central level 63 participants (19 women): public and private sector, NGOs, NPAs, Entrepreneurs, Experts, Press Agencies	LORS awareness raising LORS Field Guide Book awareness raising Satisfaction with two books in hard and soft copies
			Total number of participants: 3123 (1417 women)	
			Expert and tech. staff inputs/field days of farm demo pilot project: 1105 man/day	

D. Output 4: Development and Dissemination of Knowledge Products

154. The final (administrative) report provides details on the knowledge products, bio-briefs and videos disseminated. In Lao PDR these were translated distributed to different government ministries and departments, NGOs, CSOs, and the private sector. Reports are available on request. Specific reports applicable to Laos include the following:

- Report on the Rapid Appraisal for Lao Pilot Efficient Utilization of Biomass for Bioenergy and Food Security
- Final pilot project report
- Laos Organic Rice standard field implementation guide
- Life Cycle Analysis of GHG emissions from Pilot use of BOF
- Life cycle analysis of commercial biofertilizer production
- Life cycle analysis of recommended biofertilizer and organic matter treatments including the effects on Soil Carbon Sequestration
- Laos Case Study Report: BOF Inclusive Business Value Chain

IV. Part Four: Viet Nam Completion Report

A. Output 1: Mechanisms for enhancing regional cooperation and development of bioenergy and food security harmonized

1. Activities

a) National Policy and Standards forum

155. A National Policy and Standards Forum was held on the 4th June 2013 in Hanoi. During the forum a range of topics were discussed regarding the international and regional experience with standards and certification systems within the context of whole of Government, Viet Nam experience to date with standards and their implementation, and an attempt to define future TA7833 input to the development of standards.

b) Regional Road map for standards and certification

156. The Viet Nam NFP and TFPs participated in a regional workshop in Sihanouk Ville Cambodia. The workshop shared the experience of developing standards and certification systems within the work plan of TA7833 – especially from Cambodia and Lao PDR, and then used working groups to (i) review draft standards, (ii) identify potential implementation arrangements, and (iii) define a roadmap for advancing the standards prepared during TA7833 implementation.

2. Results

a) National forums

157. For the joint national policy and standard forum, 40 participants attended (40% female). The forum highlighted a number of significant issues in Viet Nam and the introduction of standards. The over-riding view of the forum participants was that while Viet Nam had standards, most of these standards were not effectively applied or implemented. Wide ranging discussion on the efficient and sustainable use of biomass for bioenergy and climate-friendly agriculture and the need for standards and or certification failed to clarify future priorities. In particular, the negative experience of producers that implemented VietGAP at considerable cost with little or no additional return was a recurring theme. Some participants highlighted climate friendly agriculture standards as being important. Most however acknowledged that the concept of CFA was far too loose and broad for an effective standard to be developed and that implementation would be nearly impossible. The purpose of a CFA standard was discussed but failed to find any degree of consensus.

158. The forum attempted to define a road map for moving forward on standards and certification, with follow on meetings. However, no consensus or demand for additional input emerged. Key aspects of the forum outcome were (i) the lack of operational institutional systems for the implementation of

public sector standards, (ii) limited interest in the public sector in moving to private sector based standards and certification systems, (iii) a lack of vision with respect to certification, certification bodies, and (iv) a seemingly negative response for the public sector to promote PGS systems that are operated by communities or the private sector.

b) Regional forum

159. During the workshop the Viet Nam participants recognized the benefits of supporting the application of quality controls and standards and despite experiences in Viet Nam recognized that an opportunity had been missed through not addressing the constraints faced in implementing standards in Viet Nam.

160. The outcome of the workshop was for each country to prepare presentations for the final international workshop in Luang Prabang. Viet Nam's presentation focused on the VietGAP experience and how this had failed to bring about widespread adoption on VietGAP due to the lack of financial returns to producers that adopt VietGAP.

3. Lessons

161. Vietnam has many standards with respect to food safety, VietGAP, biodigester technology etc. The effectiveness of these standards is low as demonstrated that after 7 years of implementation, including several multilateral donor project, bilateral technical support prograsm, and NGO programs only 500 certificated VietGAP producers had been established covering less than 0.1% of the cultivated area.

162. The application of VietGAP faces a number of difficulties and constraints including (i) lack of participation, (ii) high cost for certification for VietGAP standards, (iii) the perceived lack of practicality in the procedures, (iv) an inability to attain the specifications for some commodities. However the overarching weakness has been the lack of credibility of VietGAP labelled produce in the market place with limited consumer recognition and willingness to pay for the additional guarantee of VietGAP standards.

163. There is an urgent need to develop and resource an operational implementation framework for VietGAP. This framework needs to address the total value chain from fork to farm, ensuring compliance integrity, ensuring labelling and food safety integrity, and promoting the integrity to consumers. Further investment into standards as opposed to integrated quality control systems that address not only specifications, and their standardization but also how these are to be applied, maintained and promoted to protect consumers is required.

164. The RETA 7833 had been implemented by APMB - this is second level of MARD which was unable to mobilize a person to develop the national policy/regulation.

B. Output 2: Mechanisms for scaling-up biomass investment projects for bioenergy and food security demonstrated through pilot projects

165. The DMF output indicators for output 2 were attempting to promote upscaling through demonstrations. The expectation being that demonstrations would lead to upscaling. However, the TA

undertook a technology readiness assessment by country and found that apart from ICS (in Cambodia) and biodigesters /biogas (in Viet Nam) other technologies identified in the DMF were not ready for commercialization. The DMF targets (across all 3 countries) were:

- At least 500 bio-digesters,
- 600 biochar kilns,
- 75,000 improved cookstoves (ICS); and
- introduction of at least 300 farmers to sustainable certification standards.

1. Improved Cook Stoves

a) Activity

166. **Demonstrate and test output based ICS supply chain.** The pilot program for ICS was designed through a feasibility study conducted by a national firm to assess options for upscaling the use of ICS. The scope of the pilot was designed not to include “technology development”. Rather it sought to increase the number of households using available ICS.

167. A national consultancy firm EPRO was contracted to implement the proposed use of output based incentives for the upscaling of ICS use in two districts. The program offered support to the Women's Union Ha Hoa District and the farmers Union of Ung Hoa districts to demonstrate, promote and prove accessibility to ICS.

168. Introductory meetings were conducted at Ung Hoa farmer union and Ha Hoa woman union with representatives of district and pilot commune unions. At the end of the kick-off meetings, 5 contracts were signed among three parties (ICS producer, union and consultant firm).

169. **Stove producer support.** Laboratory tests were conducted for a range of available ICS technologies available in the pilot districts. The test results showed advantages of ICSs in comparison with traditional cook stoves with the same use of local fuels and in the same cooking conditions. These tests were shared with the two unions and also used to develop ICS user documentation for each of the proposed technologies.

170. User manuals were developed with illustrating photos. During pilot implementation each union provided feedback to ICS suppliers on quality issues.

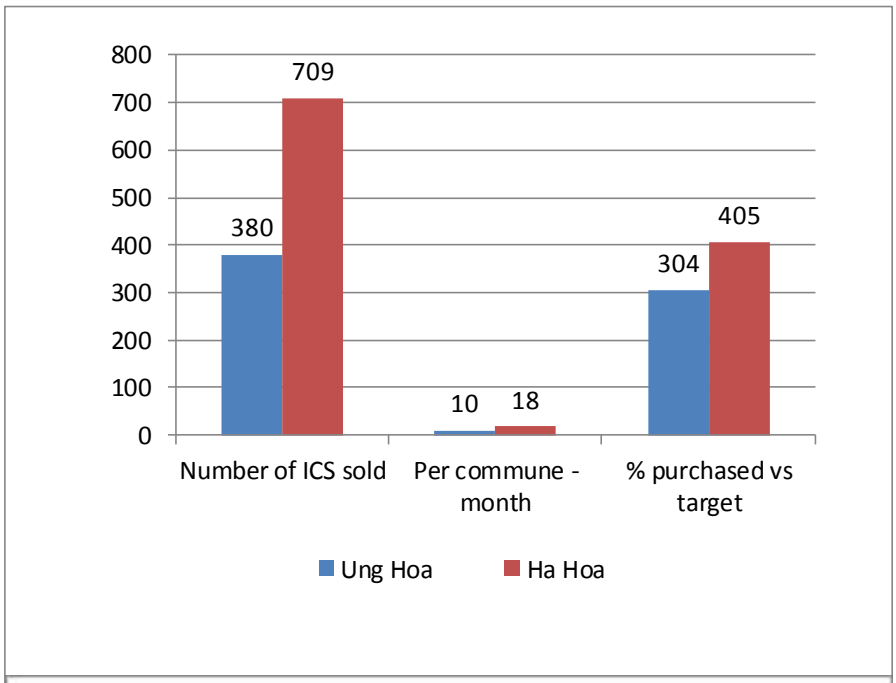
171. In total 12 showrooms were established to promote and demonstrate the technologies. These were located in the offices and shops of the commune woman unions in Ha Hoa and in shops and houses of farmer union representatives in Ung Hoa.

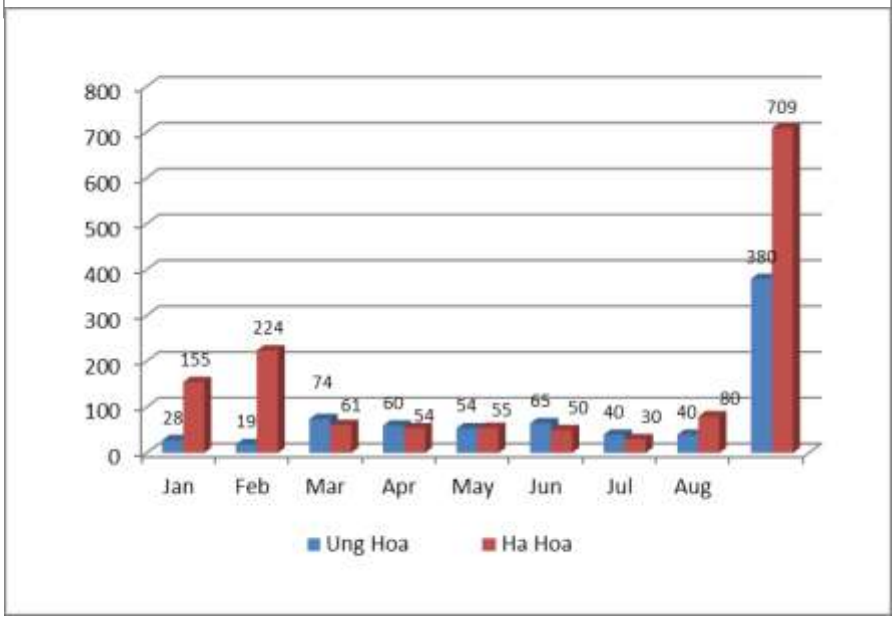
172. **Communication, awareness and demand aggregation.** Unions, as non-commercial units, were supported with training in marketing, communication skills and efficient biomass use for further activities. The unions also received support in development and implementation of a communication strategy, and the use of a voucher system towards ICS producers, and of monthly sale campaigns within the pilot period.

b) Results

- 5 commercial contracts for the pilot period were signed between producers, district unions and TA7833 within the first quarter of the pilot - 83% of the contract target.

- At completion of the pilot one commercial contract between producers and the women's union was continued and additional technologies were being demonstrated.
- All stove producers provided a quality control - warrantee scheme for consumers and developed an ICS user manual within the first quarter of pilot.
- One producer was successful with the development of a marketing and business plan.
- The number of pilot supported ICS within the pilot districts increased by 363%. 1,089 stoves were sold to 587 households that started the pilot with traditional cook stoves.





c) Lessons

173. In order to set up a supply chain from producers to unions, it may be useful to consider the following issues:

174. **Selection of ICS.** In order to identify suitable ICSs for up-scaling, the ICSs should be screened in two stages, (a) meeting expectations of households and (b) meeting expectations of sales enterprises in the district, as laboratory testing does not assess issues such as safety and durability.

175. **Selection of unions.** Unions can play a role of sale agency in ICS supply chains. Although only two unions were selected under the pilot, it showed that women's union may be more successful with selling ICS to households than farmer unions. Farmer unions seems to be more interested in activities with larger investment than ICSs, and therefore selection of women's unions under ICS supply chains seems to be more appropriate.

176. **Selection of ICS producers.** There was limited choice of ICSs that met the expectation of households. Selection of ICS producers for up-scaling is difficult. Close monitoring on the business behaviour of ICS producers is important to secure the success of the program.

177. **Doing business.** All producers were SME enterprises and for many the concept of business and marketing plans were not well developed and understood by producers. Commercial contracts ensured commitment of stakeholders in writing and ensuring condition of supply relating to price, commission, quality, order quantity, and guarantee. The addition of penalty clauses should be considered with respect to quality control, supply guarantee and theft.

178. **Other lessons:**

- Ownership was a critical success factor - here the women's union performance far exceeded the farmers union, and has resulted in an ongoing business promoting the use of ICS to their members. The output based incentives while important for initial start up were not considered to be important due to (i) the unions benefitting its members, and the use of the simple ICS technology included in the pilot.
- Donor programs providing subsidized cook stoves simply undermines the market and whilst enabling project targets to be achieved these targets never account for the loss of adoption and uptake due to undercutting prices and supply agreements.
- Price discounting by distributors that dump surplus product into the market is a potential constraint for sale by women's unions
- Artisanal production provides local employment but results in quality issues, supply issues and a higher cost of production per unit. Industrial production would lower costs and increase the probability of a sector funded quality control system being affordable.

2. Bioslurry management

179. The assessment of biogas programs highlighted the saturation of the sector for commercially based upscaling of biodigester use. However in promoting the use of biogas the significant impact of the biodigesters on the local environment through the release of digestate and slurry, and the ignored decline in digester efficiency as digestate scum builds up in the digester were raised as priority areas for additional testing and demonstration.

a) Activities

- Conduct an overview on the availability of current policy and standards of the Viet Nam's Government on bioslurry and organic fertilizer, organic composting fertilizer and test samples of slurry and slurry treatments

- Provide technical and equipment support to establish and operate a composting enterprise that uses bioslurry to increase compost nutrients enterprise.
- Support for 25 selected households to use bioslurry enriched compost for maize (one season) and vegetable (two seasons). The maize and vegetable demonstrations included three different treatments being: (i) chemical fertilizer only - farmer practice; (ii) Using a mix of 50% bioslurry and 50% composting; (iii) using a compound mixture including 25% bioslurry + 25% chemical fertilizer + 50% composting.
- Capacity building and training for enhanced knowledge and technology development and transfer systems.

b) Results

- Biogas households collected 12 tons of agricultural waste, and 11m^3 liquid slurry. At the end of composting process, 5 tons of composting fertilizer were produced. Production cost of 1 ton is 99.4 USD.
- For green mustard: T3 created the biggest revenue, e.i. 4,187.2 USD/ha, 20.4% higher in comparison to T1.
- For maize: Maize cobs of T2 and T3 were greener, better looking, be able to sell at higher price and having sweeter taste. Households communicated that the maize trees of T2 and T3 had taller stem, higher number of big ear, greener ear, easier to sell in the local market in comparison to cobs of T1 but the revenue for T3 was lower than T2 and T1 because the investment cost of T3 was higher than T1 and T2.
- The cost of production for the bioslurry enriched compost was US $110 to 120 per tonne of which nearly 50 to 60% was due to labor costs.

c) Lessons

180. **Location.** Tam Xa is suburban and an agricultural commune with a big proportion of households having animal and crop production. The commune is challenged as are many in North Viet Nam by the large distances between homes (and therefore digesters) and their fields. The cost of moving bioslurry is significant in terms of labor cost for transportation, purchase of pumps and containers for transport. In addition, most households have only a small garden so that the garden is not big enough to absorb the nutrient from bioslurry that was estimated as 470 liters per day for a 10 cubic meter digester.

181. **Scale of production.** The composting cost produced by the community agriculture cooperative was too high. It was very hard to promote this product in the market. If possible, the compost should be produced at factory or workshop; it will reduce labor cost and lending land. A 5,000 to 10,000 tonne commercial production enterprise produces similar product for a cost of production of US$ 60 per tonne.

182. **Labor costs.** Labor availability and costs are increasingly prohibitive for handling biomass at a small scale or through the use of labor intensive techniques. Most producers report favorable attitudes to the use of the compost that is enriched however most prefer to buy it given the labor required. Further in Tam Xa the availability of biomass resources severely limits the scale of production.

3. Biochar

183. The TA concept paper defined the excess of biomass including a concern about the extent of rice husk that was disposed of into the environment. It was proposed to convert such biomass into

biochar as a soil amendment. An initial feasibility study concluded that the concept of applying 10t per ha of rice husk char was simply not feasible due to the extent of feedstock required – 30t per ha and due to the costs of applying such application rates. However more recent international literature had found potential of biochar to carry nutrients in a soil fertility treatment at low application rates. The pilot sought to test a soil nutrient application of biochar.

a) Activity

- TA 7833 reviewed existing kilns in use, mostly TULD kilns, and recommended modifications including the development of a large scale fixed kiln in An Giang Province
- For two sites in Hanoi province and An Giang province a fertiliser formulation exercise that includes biochar, biochar –biofertilsier and biochar –NPK pellet form were defined and then formulated for use on rice, vegetables and maize.
- Produce rice husk biochar and link to biochar product formulations and demonstrations
- Designed a pilot based on a replicated treatment block design for vegetable and rice product field trial that includes biochar, biochar-biofertiliser pellets, biochar –NPK pellets and controls
- A total of 20 farm demonstration plots with vegetables and rice were used to demonstrate to farmers the use of biochar based soil amendments and bio-fertilizers
- The nutrient loading capability of biochar could see it being used as a water filter material. One option identified was to use biochar to minimize the risk to the environment by absorbing nitrogen and phosphate from bioslurry.
- Implement farmer field days for building capacity

b) Results

- For rice cultivation, gross income from treatment with biochar plus 75%NPK or biochar plus 75%NPK in pelleted NPK-biochar fertilizer was 2,479- 3,379 thousand VND/ha more for rice cultivation in Hanoi, and 650- 1,700 thousand VND/ha more in An Giang than that in farmer practice.
- Application of biochar and biochar products for vegetables brought much higher gross income than farmer practice. An increae of 20,000- 25,333 thousand VND/ha in Hanoi and 4,200-6,686 thousand VND/ha in An Giang than that in farmer practice in each site.
- Application of biochar and NPK-biochar fertilizer was reduced 25%, even 34% of NPK in mineral fertilizers but gave equal or higher yield compared with farmer practice in some demonstrations.
- There were not significant different filtration effects between biochar filters and animal waste sources for biogas.
- Using life cycle analysis the GHG and nutrient emission of biomass use was estimated including for the production of commercial bio-fertilizers from peat. GHG emission savings were identified for the use of biofertilizers, however the peat based biofertilizers have significantly higher GHG emissions. Options for converting from peat to other biomass options are quantified in a life cycle assessment and indicate potential CDM and green fund investment options that should be explored under CASP2 – TA8163.

c) Lessons

184. **Assumed Biomass Availability.** The assumption of rice husk availability was found to be over-estimated and poorly understood in the original concept paper for the Mekong delta. With the modernization of rice milling most husk is owned by the mill owner, and is being transformed into

briquettes or flour for export to the plastics industry. The availability for biochar is limited to mostly disaggregated rice husk with commensurate high costs of freight.

185. For example, Chau Phu District, An Giang Province faced a high demand for rice husk briquettes for industrial heat production and for brick making. As households do not own the rice husk they have no ability to compete for the husk resource.

186. **Implementation time.** The pilot was implemented in one season enabling the within season impact on crop yields to be observed. However the longer term impacts of organic matter and biochar on soil quality through future crop cycles needs to be tested.

C. Output 3: Strengthened capacity of project stakeholders for the efficient use of biomass

187. The training and capacity building activities are presented in the table below. The total number of trainees at officials level was 451 trainees with a further 828 trainee slots for farmers and producers conducted as part of the pilot and demonstration programs. Trainee evaluation of events is provided in the tables below.

Table 8: Stand-alone training events and study-tours

Event	Location	Dates	No. of Trainees by type (farmers, government or service providers) (and no. of women)	Evaluation feedback
Awareness-raising activities were initiated through inception workshops (Cambodia and Lao PDR) and a stakeholder meeting in Viet Nam.	CLV	February 2012	Government and service providers (not disaggregated - approximately 50:50) 121 total (39 women) • 60 government • 61 service providers	Report available
1st regional conference on Efficient Utilization of Biomass for Bioenergy & Food Security in the Greater Mekong Subregion. Copies of presentations are available at: https://drive.google.com/folderview?id=0B1wKP1C0cX-jLWJTNU54SXFKbUk&usp=sharing	Hanoi, Vietnam	16th-18th Dec 2013	Government and service providers (approximately 50:50) 122 total (34 women) • 61 government • 61 service providers	Report available
Training session on the application of the FAO's Bioenergy and Food Security (BEFS) Analytical Framework and Tool Box[5]. Held at the regional conference	Hanoi, Vietnam	18th Dec 2013	Government and service providers (approximately 50:50) 27 total (5 women) • 13 government • 14 service providers	Not available
Biochar training in Vietnam	Hanoi	December 16-18, 2014	25 total (8 women) • 17 government officers • 8 service providers	• SATISFIED: 22 participants • GOOD: 3 participants • UNSATISFIED: 0 participants
Field day in Takeo	Takeo, Cambodia	December 26, 2014	55 total (36 women) • 50 farmers • 1 government staff • 4 service providers	
2nd regional conference on Efficient Utilization of Biomass for Bioenergy & Food Security in the Greater Mekong Subregion	Luang Prabang, Lao PDR	5th-6th March, 2015	Government and service providers (approximately 60:40) 76 total (15 women) • 46 government	Report available

[5] *www.fao.org/bioenergy/foodsecurity/befs*

			• 30 service providers	
LCA training in Viet Nam	Hanoi	23 October 2015	25 total All government officials (50% female)	• SATISFIED: 15 participants • GOOD: 10 participants • UNSATISFIED: 0 participants

Table 9: Pilot Training Events

Pilot Project	Training	Dates	No. of Trainees by type (farmers, government or service providers) (and no. of women)	Evaluation feedback
PP#1: Improved Cook Stove Use (EPRO)	Training in marketing, communication skills and efficient biomass use for union reps, showrooms and stove producers	February 2014	28 service providers (including 15 women)	- SATISFIED: 25 participants - GOOD: 1 participant - UNSATISFIED: 0
PP#2: Bioslurry Management (CARES)	2 Training courses on biogas technology and its benefits	March 2014	30 people/each (8 women) i.e. 60 farmers (16 women)	- SATISFIED: 48 participants - GOOD: 12 participants - UNSATISFIED: 0
	2 Training courses O&M biogas digester	June 2014	30 people/each (8 women) i.e. 60 farmers (16 women)	- SATISFIED: 50 participants - GOOD: 10 participants - UNSATISFIED: 0
	2 Training courses on Bioslurry utilization	August and September 2014	30 people/each (7 women) i.e. 60 farmers (14 women)	- SATISFIED: 46 participants - GOOD: 14 participants - UNSATISFIED: 0

	2 Training courses on composting and business skills	July and August 2014	31 people/each (7 women) i.e. 62 farmers (14 women)	- SATISFIED: 54 participants - GOOD: 8 participants - UNSATISFIED: 0
PP#3: Biochar based soil amendments (COTDEP)	4 TOT on kiln design (DK-TR1) and operation to produce biochar	May and June 2014	200 Farmers (50 person/each and totally 107 women)	- SATISFIED: 148 participants - GOOD: 52 participants - UNSATISFIED: 0
	4 Training courses on operation of biochar kiln and application in An Giang	July 2014	37 Farmers (5 women) 34 Farmers (2 women) 47 Farmers (5 women) 40 Farmers (4 women)	- SATISFIED: 102 participants - GOOD: 56 participants - UNSATISFIED: 0
	4 Training courses on operation of biochar kiln and application in Hanoi	August 2014	200 Farmers (50 person/each and totally 107 women)	- SATISFIED: 130 participants - GOOD: 70 participants - UNSATISFIED: 0

D. Output 4: Knowledge products developed and disseminated

188. The final (administrative) report provides details on the knowledge products, bio-briefs and videos disseminated. In Vietnam these were translated distributed to different government ministries and departments, NGOs, CSOs, and the private sector. Reports are available on request. Specific reports applicable to Laos include the following:

- Pilot feasibility reports
- Final pilot project reports
- Biochar based fertilizer in Viet Nam – Demonstration Results
- Bioslurry Management – lessons and experience
- Biochar filters for Bioslurry management
- Lifecycle analysis of Bioslurry Management
- Lifecycle analysis of Commercial Biofertilizer production
- Market demand and raw material supply for the commercial production of Biofertilizer in Phu Tho Province

Appendix 1: Design And Monitoring Framework (DMF)

Design Summary	Performance Targets & Indicators with Baselines	Data Sources & Reporting Mechanisms	Assumptions and Risks
Impact Improved use of biomass in Cambodia, the Lao PDR, and Viet Nam	By 2020: 5% increase in production of clean bioenergy from biomass (2011 baseline: 0.1%) 5% increase in use of by-products of bioenergy systems (bio-slurry and biochar) (2011 baseline: 0%)	Project baseline and benchmark surveys Periodic surveys and annual reports of agriculture and energy ministries of Cambodia, the Lao PDR, and Viet Nam6	**Assumptions** The governments of Cambodia, the Lao PDR, and Viet Nam remain committed to regional cooperation in clean bioenergy and food security. **Risk** Private sector investment is constrained by over-regulation.
Outcome Efficiently operating pilot projects in biomass use	By 2014: At least two investment modalities for biogas and bioslurry (Cambodia and the Lao PDR); three for biochar (Cambodia, the Lao PDR, and Viet Nam); two for improved cookstoves (the Lao PDR and Viet Nam); and three for inclusive supply chain of certified biofuel and organic crops in (Cambodia, the Lao PDR, and Viet Nam)	Project completion report Annual reports from agriculture ministries of Cambodia, the Lao PDR, and Viet Nam	**Assumptions** The central and provincial governments remain committed to working with the poor in remote areas. **Risk** Pilot projects are not successfully implemented.

[6] *a Ministry of Agriculture, Forestry and Fisheries (Cambodia); Ministry of Agriculture and Forestry (Lao PDR); and Ministry of Agriculture and Rural Development (Viet Nam)*

Outputs *1. Enhanced regional cooperation in bioenergy development to foster and safeguard food security* *2. Pilot-tested climate-friendly biomass investment projects for wider implementation* *3. Enhanced capacity for efficient use of biomass* *4. Development and dissemination of knowledge products*	By 2014: Mechanism tested for harmonizing at least three bioenergy standards7 and certification systems, and a common method of assessing greenhouse gases Construction of at least 500 bio-digesters, 600 biochar kilns, 75,000 improved cookstoves; and introduction of at least 300 farmers to sustainable certification standards Increased capacity for gender-sensitive investment among at least 500 government officials, 400 service providers, and 3,000 lead farmers (i.e., at least 55% of those to be trained will be women and at least 70% of those trained will have increased capacity) Methodology for assessing and prioritizing the use of biomass for bioenergy and food security Compendium of good practices in biomass use Booklets on different models of improved cookstove, biochar kiln, and biodigesters	Consultants' reports and document records of agriculture ministries of Cambodia, the Lao PDR, and Viet Nam Agricultural household survey reports of Cambodia, the Lao PDR, and Viet Nam Benefit and impact monitoring reports Project review missions	**Assumptions** The consulting team is given timely access to records, information, personnel, and relevant geographic sites. Local officials, technicians, and lead farmers are available to participate in training Development partners and the private sector are keen to participate in the TA activities. **Risks** Cambodia, the Lao PDR, and Viet Nam cannot agree on harmonized standards and certification systems

[7] *b Including standards set by such organizations as the Global Alliance on Clean Cookstoves and the Roundtable on Sustainable Biofuels, along with quality assurance from regional quality assurance centers to be established for biogas, improved cookstoves, bio-char, etc.*

Activities with Milestones	Input
1.0 Holding of regional forums to facilitate high-level dialogue within the region on bioenergy and food-security policy issues, by 2011 1.1 Testing of mechanisms to facilitate adoption of common sets of sustainable indicators, bioenergy and trade standards, certification systems, and eco-labeling systems, by 2012 1.2 Holding of annual international workshop on household bioenergy and food security to foster exchange of information, particularly between more advanced Greater Mekong Subregion countries and Cambodia, the Lao PDR, and Viet Nam 2.0 Conduct of biomass assessment and development of criteria for the selection of pilot project areas, by early 2012 2.1 Implementation of pilot projects in lower-cost biogas technologies as investment project with a component involving the use of bio-slurry for high-value crop production, by 2012 2.2 Conduct of reviews to identify appropriate biochar, improved cookstove, and biofuel investment modalities, and implementation of pilot project, by 2013 3.0 Development of gender-sensitive training programs, including distant learning modalities, and use of these programs in the training of central and local government officials, farmers' organizations, women's groups, and service providers (of which at least 30% are women), by 2012 3.1 Conduct of training in the implementation of the investment project, by 2013 3.2 Conduct of training in the use of biomass to enhance food security and soil carbon sequestration, by 2013 4.0 Development of methodology for assessing and prioritizing the use of biomass for energy and food security, by 2011, and dissemination of the methodology through regional forums, training, and capacity building by 2012 4.1. Establishment of baseline information and monitoring and evaluation system for pilot projects, by 2012; 4.2 Conduct of key studies, such as studies on life-cycle assessments, least-cost options, and eco-labeling, by 2013 4.3 Publication of compendium of good practices in biomass use and booklets containing information on different models of improved cookstoves, biochar kilns, and bio-digesters, by 2014 4.4 Analysis of potential climate change scenarios and their likely impact on the availability of different types of biomass, and assessment of need for the development of alternative biomass sources, by 2013	Total cost: $4.6 million equivalent

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Appendix 2: Summary of Progress against the DMF

Intervention Logic	Progress
Impact	
Improved use of biomass in Cambodia, Lao PDR and Vietnam By 2020: - 5% increase in production of clean bioenergy from biomass (2011 baseline: 0.1%) - 5% increase in use of by-products of bioenergy systems (bio-slurry and biochar) (2011 baseline: 0%)	Achievement of the impact (and measuring of performance) is outside the scope of the project. However, it is clear that the impact is still relevant and that the project outcome and outputs have contributed to the impact, particularly increase in the use of by-products of bioenergy systems (bio-slurry and biochar).
Outcome	
Efficiently operating pilot projects in biomass use By 2014: At least two investment modalities for biogas and bioslurry (Cambodia and the Lao PDR); three for biochar (Cambodia, the Lao PDR, and Viet Nam); two for improved cookstoves (the Lao PDR and Viet Nam); and three for inclusive supply chain of certified biofuel and organic crops in (Cambodia, the Lao PDR, and Viet Nam)	**Achieved** All pilot projects are completed and have been assessed and used as a basis for preparing proposals for future investment modalities (to be funded through a future ADB loan or other potential investors). Early discussions with the government and ADB however resulted in the project dropping research into investment modalities for certified biofuel. Pilots, for which investment modalities have been prepared, cover the following: • Biogas and bioslurry (OVI – two in Cambodia and Lao PDR; Pilot Projects – two in Laos PDR and Vietnam) • Biochar (OVI – three in Cambodia, Lao PDR, and Viet Nam; Pilot Projects - three in Cambodia, Lao PDR, and Viet Nam) • Improved cookstoves (OVI – two in Lao PDR and Vietnam; Pilot Projects – three in Laos, Cambodia and Vietnam) • Organic crops (OVI – three in Cambodia, Lao PDR, and Viet Nam; Pilot Projects – four in Cambodia, Laos PDR and Vietnam)

Output 1	
Enhanced regional cooperation in bioenergy development to foster and safeguard food security Mechanism tested for harmonizing at least three bioenergy standards[8] and certification systems, and a common method of assessing greenhouse gases	**Partially achieved** See below. Three standards prepared. Work not undertaken on a common method for assessing greenhouse gases as methodologies are already present and it depends on the technology used. Plus there is no regional laboratory that can do the analysis. However, carbon pathways were examined through life cycle analysis work.
1.0 Holding of regional forums to facilitate high-level dialogue within the region on bioenergy and food-security policy issues	**Achieved** Harmonization Roadmap devised and agreed at 1st GMS Forum in Nanning, China, in July 2012, as initial mechanism for facilitating dialogue and ultimate adoption of common standards. See p12 of 'Report on Proceedings'. While benefits of harmonization agreed, priority set on developing national level regulatory framework. 3 National policy forums (May 2013) - one in each country, which involved a more intensive mechanism for national-level dialogue for wider harmonization. The forums provided a venue for policymakers and public officials to discuss policies and opportunities relevant to their country, and engage with other stakeholders and experts. Reports on the 3 national policy forums submitted. Following these forums, TORs prepared and agreed for policy working groups in each country to prepare policy road maps for standards, certification and labeling for biomass related technologies and climate friendly agriculture based on the national forums. WGs formed. WG meetings held in Laos and Cambodia. See 1.1. The following priorities were identified in the first WGs on a demand-led basis: • Cambodia – standards for organic rice and biodigesters; • Laos PDR – standards for organic rice and biofertilizer; Work in Vietnam stopped due to lack of agreement on achievable activities and the progression of an existing draft biofertilizer standard through the existing Government process. In Cambodia a standard for organic rice and biodigesters was developed, plus an organic rice standard and standards for biofertiliser formulations in Laos. A regional workshop (forum) was organised between NPIs/TFPs/NFPs from each country on 5th-6th February 2015 in Cambodia (and planning meetings before then in Cambodia and Laos) in order to discuss standard development progress in each country, prepare a roadmap for the roll-out of each standard (certification, labelling, traceability, inspection), and

[8] *Including standards set by such organizations as the Global Alliance on Clean Cookstoves and the Roundtable on Sustainable Biofuels, along with quality assurance from regional quality assurance centers to be established for biogas, improved cookstoves, bio-char, etc.*

	discuss possibilities for harmonization. The country roadmaps were presented at the final conference in Laos in March. 2015 Government staff from Myanmar attended as observers. Working groups in Laos and Cambodia were then convened to present priorities for support through to December 2015 based on the roadmaps developed in the regional forum. In Cambodia, little additional work stemming from the roadmap could be undertaken however since, as of December 2015, the standards had not been approved by government. In Laos, the outcome was more successful. The Laos Organic Rice Standard was approved by government and a guidebook was prepared to help with adoption of the standard.
1.1 Testing of mechanisms to facilitate adoption of common set of sustainable indicators, bioenergy and trade standards, certification systems an eco-labeling	**Partially achieved** See above for details on standards prepared. The organic rice standards in Laos and Cambodia have been developed in parallel with joint discussions such that they are very similar, which will improve cross-border trade.
1.2 Holding of annual international workshop on household bioenergy and food security to foster exchange of information, particularly between more advanced Greater Mekong Subregion countries and Cambodia, the Lao PDR, and Viet Nam	**Achieved** Regional conference held in Hanoi in December 2013. Regional conference held in Luang Prabang, Laos PDR in March 2015
Output 2	

Pilot tested climate friendly biomass investment projects for wider implementation Construction of at least 500 bio-digesters, 600 biochar kilns, 75,000 improved cookstoves; and introduction of at least 300 farmers to sustainable certification standards	**Achieved** While climate-friendly biomass investment projects were pilot-tested for wider implementation, the OVIs were not achieved as stated. This is because the project aimed to test business models for future scale-up, not to construct a specific number of bio-digesters, biochar kilns, or improved cookstoves, or to test these particular technologies. Thus the indicators were not realistic, or in line with what the project was trying to achieve. Additional remarks on these indicators is as follows: <u>Bio-digesters:</u> 500 biodigesters was optimistic given that the ADB had existing lending products in place for biodigesters in Viet Nam and the assessment of biodigesters in Cambodia and Laos was negative <u>Biochar</u> Biochar and bioslurry technologies were assessed to be too immature and as such the targets for their adoption in the DMF are considered too optimistic. Pilot projects focused on demonstrating production and management of the more immature technologies and how these products can be integrated into greener value chains. i.e. there is a need for both biochar and bioslurry to shift the focus from 'which technology' to product development and formulation linked to fertilizer supply chains. 600 biochar kilns was simply unsupportable – there is no local production of kilns that has a commercial basis. Kiln technology and feed stocks are not well known and the benefits of biochar may not warrant the investment of resources. Further, the international experience with biochar has been to move away from high volume soil amendments to incorporation of biochar into nutrient products where the biochar changes the characteristics of the biochar through reduced volatilization and provides potential water and nutrient release benefits lowering overall demand for nutrients. The preference for household-level technology, while appropriate for ICS, may be inappropriate for biochar and to a lesser extent bioslurry. The financial viability of such technologies will determine the extent of their adoption. However TA findings and expert opinion suggested that the viability of small-scale technology that has adequate safeguards may be insufficient to generate viability and attract investment and adoption. Experience in Thailand and China suggest that the biochar and bioslurry sectors emerge from a demand for biofertilizer from specialist agents that collect from product catchment areas. The focus should maybe move away from technology of production to how to build supply chains – a key finding from the assessment of climate friendly value chains in GMS. <u>ICS</u> A program target to upscale 75,000 cook stoves in the three countries far exceeds both the resources available and the likely uptake rate – further it would exceed the ICS stove producer capacity. The ICS sector has a range of players many of whom offer subsidies and grants for the adoption of ICS technologies. The continued investment from the WB, EU and other ADB TAs that offer more concessional investment makes a purely commercial value chain less likely. The TA focused its ICS pilots on stove producer risk reduction through skill development, and demand aggregation through women's unions. ICS technology in GMS is highly visible, however the gains from the technology are relatively small and with most improved stoves failing to address the durability of stoves it is questionable if significant gains are being achieved.

	The target of introducing at least 300 farmers to sustainable certification standards is unrealistic since the process of agreeing and ratifying a standard and then setting up the certification systems to support this is beyond the timescale of the TA. Instead the TA developed standards and then a roadmap for their uptake. See output 1 above.
2.0 Conduct biomass assessment and development of criteria for selection of pilot project areas by 2012	**Achieved** Regional biomass resource assessment submitted. Options for integrating this within a multi-criteria decision support tool linked to life cycle analysis have been developed and are being reviewed.
2.1 Implementation of pilot projects in lower cost biogas technologies as investment options involving use bioslurry for high vale crop production	**Achieved** • Priority topics by country agreed • Terms of reference for feasibility studies prepared and approved by ADB and IAs. • Expression of interest for feasibility studies in Viet Nam and Cambodia received and evaluated. Laos PDR had no national EOI despite a second round of advertisement although an EOI was received from a Viet Namese contractor for Bioslurry and Biochar work but was not approved by government • WB, AUSAID and GERES/EU have completed reviews of ICS sector for the purpose of undertaking pilot upscaling investments – raises the need for FS and or pilot in ICS for Laos • FS in Cambodia and Viet Nam contracted and final reports accepted • Rapid appraisal of options undertaken in Laos • Value chain business models for potential upscaling case studies identified • Procurement using a shopping and RFP modality approved by ADB • TORs approved for proposed pilots • All pilot projects contracted and implemented • Baseline data collected • Pilot project final reports approved • Lessons learned fed into final TA7833 reports Additional activities undertaken during the extension period from July to December 2015: • A commercial mobile medium scale biochar kiln with low to moderate temperature was introduced to Laos with technical assistance and testing provided • Further testing and development of biochar filters to extract nutrients from bioslurry undertaken • A feasibility study in each country undertaken for the use of medium scale commercial biofertilizer production and costs of production including labor costs assessed

2.2 Conduct of reviews to identify appropriate biochar, ICS and biofuel investment modalities by 2012 and implementation of pilot project by 2014	**Achieved** • Summary reviews of ICS, Biochar, the private sector, financing modalities, and the institutional frameworks in CLV completed. • Technology commercialization status assessment based on NASA's Technology Readiness Levels (TRL) completed and included in inception report – highlighting the immature nature of biochar and bioslurry technologies for widespread up-scaling. • Biofuel technology dropped based on TA team findings and CLV Government skepticism. • Biochar testing and analysis report (including risk analysis) submitted • Further dialogue on the design of rice straw kilns for turning surplus straw to biochar in the field immediately after harvesting has proposed alternate designs for inclusion in pilot program • Recommendations for future investment scale-up included in final reports
Output 3	
Enhanced capacity for efficient use of biomass Increased capacity for gender-sensitive investment among at least 500 government officials, 400 service providers, and 3,000 lead farmers (i.e., at least 55% of those to be trained will be women and at least 70% of those trained will have increased capacity)	**Achieved** To date, training initiatives have increased the capacity of 5292 trainees (136% of target) including 512 government officials (102% of target), 980 service providers (245% of target), and 3800 lead farmers (127% of target). Of the trainees 2591 have been women (49% which is just below the target of 55%). Evaluation sheets show that the majority have been satisfied with the training received and expect it to increase their capacity.
3.0 Development of gender-sensitive training programs including distant learning activities, use of these for training local and central govt officials, farmers organization and women's groups (30% women by 2013)	**Achieved** • Gender-sensitive training programs undertaken • Biobriefs and DVD disseminated
3.1 Conduct training in the implementation of the investment project by 2014	**Not achieved** Undertaken instead as part of TA8897

3.2 Conduct of training in the use of biomass to enhance food security and soil carbon sequestration by 2014	**Achieved** Training programs undertaken.
Output 4	
Development and dissemination of knowledge products Methodology for assessing and prioritizing the use of biomass for bioenergy and food security Compendium of good practices in biomass use Booklets on different models of improved cookstove, biochar kiln, and biodigesters	**Achieved** See below
4.0 Development of methodology for assessing and prioritizing the use of biomass for energy and food security by 2012 and dissemination of the methodology through regional forums, training, and capacity building by 2014	**Achieved** A biomass resource availability report (including methodology) was prepared. Lifecycle models and methodology, to assist policy makers in prioritising the most appropriate use of biomass, prepared, with a training course undertaken and report (and biobriefs) disseminated
4.1 Establishment of baseline information and monitoring and evaluation system for pilot projects by 2012	**Achieved** • Baseline requirements specified in the pilot feasibility study ToR • Baseline and on-going monitoring requirements specified in pilot project TORs • Baseline data collected
4.2 Conduct key studies such as life cycle assessments, least cost options, and eco-labeling by 2013	**Achieved** • Lifecycle analysis and least cost assessments undertaken • Lifecycle models developed and reported in biobrief and knowledge products

4.3 Publication of compendium of good practices in biomass use and booklets containing information on different models of ICS biochar kilns and bio-digesters by 2014	**Achieved** A number of knowledge products (KPs) were produced and disseminated as follows <u>The Context</u> • Agriculture, Food Security and CC in GMS • Agricultural Biomass Resource Assessment in CAM, LAO and VIE <u>Biochar</u> • Soils and Biomass Amendments • Biochar • Biochar testing and analysis report (including risk analysis) • Relevant Pilot Feasibility Study Reports • Relevant Pilot Final Reports • Biofertilisers in Cambodia, Laos and Vietnam <u>Biogas and bioslurry</u> • Relevant Pilot Feasibility Study Reports • Relevant Pilot Final Reports • Biochar filters for biodigesters <u>ICS</u> • Relevant Pilot Feasibility Study Reports • Relevant Pilot Final Reports <u>The Regulatory and Enabling Framework</u> • An overview of international standards and certification systems on bioenergy and climate-friendly agriculture (see output 1) <u>Scaling-Up</u> • Business Models for the Scaling-Up of CFA VCs in GMS • Lifecycle analysis and least cost assessment report series (LCA report; commercial biofertilisers; carbon sequestration (incl. soil/carbon modelling) • See above on ‘Biofertilisers in Cambodia, Laos and Vietnam‘ • Final Technical Report

	We propose that the above KPs are included (together with the bio-briefs) on the WGA site
4.4 Analysis of potential climate change scenarios and their likely impact on the availability of different type of biomass and assessment of need for the development of alternative biomass sources by 2013	**Not achieved** Biomass availability report undertaken. It was felt that there was no need for further work to identify the impact of CC on biomass availability as this was too theoretical and would not be of use for present purposes