THEME [KBBE.2011.2.5-02]
[Reducing post-harvest losses for increased food security — SICA]

Grant agreement for: Collaborative project*

Annex I - "Description of Work"

Project acronym: Gratitude

Project full title: " Gains from Losses of Root and Tuber Crops "

Grant agreement no: 289843

Version date: 2011-11-15

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Part A

Workplan Tables

A1:
Project summary

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per project

General information			
Project title [3]	Gains from Losses of Root and Tuber Crops		
Starting date [4]	The first day of the month after the signature by the Commission		
Duration in months [5]	36		
Call (part) identifier [6]	FP7-KBBE-2011-5		
Activity code(s) most relevant to your topic [7]	KBBE.2011.2.5-02: Reducing post-harvest losses for increased food security — SICA		
Free keywords [8]		cassava, yam, post harvest losses, waste, added value, food security, food chain, processing, fresh product, Africa, Asia, Nigeria, Ghana, Vietnam, Thailand	

Abstract [9]

Cassava and yam are important food security crops for approximately 700 million people. Post-harvest losses are significant and come in the three forms: (a) physical; (b) economic through discounting or processing into low value products and (c) from bio-wastes. This project aims to reduce these losses to enhance the role that these crops play in food and income security.

Post-harvest physical losses are exceptionally high (ca. 30% in cassava and 60% in yam) and occur throughout the food chain. Losses in economic value are also high (e.g. cassava prices discounted by up to 85% within a couple of days of harvest). Wastes come in various forms e.g. peeling losses can be 15-20%. Waste often has no economic value which can make processing a marginal business proposition.

South-south learning is a feature of the project – with partners in sub-Saharan Africa and Asia. Cassava and yam are contrasting in terms of their use and these differences will contribute to developing a comprehensive approach to reducing losses. Technologies and systems will be developed, validated, demonstrated and disseminated that focus benefits on small-holder households whilst offering increased income earning opportunities through SME development and links to large scale industry. These contribute to the comprehensiveness of the approach, and provide diverse learning opportunities and allow examination of losses in a wider food security context.

There are 3 impact pathways:

1. reduction of physical losses – focussing on fresh yams storage
2. value added processing reducing physical and economic losses in yam and cassava.
3. improved utilisation of wastes (peels, liquid waste, spent brewery waste) producing products for human consumption including snack foods, mushrooms and animal feed.

Cross-cutting are issues of food safety, enterprise development and practical demonstration.

It is aimed to validate technologies capable of reducing losses by an equivalent of at least 50%

A2:
List of Beneficiaries

Project Number [1]	289843	Project Acronym [2]	Gratitude

List of Beneficiaries

No	Name	Short name	Country	Project entry month[10]	Project exit month
1	UNIVERSITY OF GREENWICH	UoG-NRI	United Kingdom	1	36
2	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Wageningen Universit	Netherlands	1	36
3	UNIVERSIDADE CATOLICA PORTUGUESA	ESB	Portugal	1	36
4	ACCORD ASSOCIATES LLP	Accord Associates	United Kingdom	1	36
5	SABMILLER PLC	SABmiller	United Kingdom	1	36
6	UNIVERSITY OF AGRICULTURE ABEOKUTA	UNAAB	Nigeria	1	36
7	COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH	FRI	Ghana	1	36
8	FEDERAL MINISTRY OF SCIENCE AND TECHNOLOGY	FIIRO	Nigeria	1	36
9	NATIONAL SCIENCE AND TECHNOLOGY DEVELOPMENT AGENCY	NSTDA	Thailand	1	36
10	ST. BAASA GHANA LIMITED	St. Baasah Ghana Lim	Ghana	1	36
11	CALTECH VENTURES LTD	Caltech Ventures	Ghana	1	36
12	VIEN CONG NGHE SINH HOC VA THUC PHAM	SBFT	Viet Nam	1	36
13	PEAK PRECISION PRODUCTS NIGERIA LIMITED	Peak	Nigeria	1	36
14	NOBEX TECHNICAL COMPANY LIMITED	Nobex	Nigeria	1	36
15	SOCIAL DEVELOPMENT AND IMPROVEMENT AGENCY LBG	Sodia	Ghana	1	36
16	NORTHEASTERN STARCH (1987) CO LTD.	Northeastern Starch	Thailand	1	36

A3:
Budget Breakdown

Project Number [1]	289843	Project Acronym [2]	Gratitude

One Form per Project

Participant number in this project [11]	Participant short name	Fund. % [12]	Ind. costs [13]	Estimated eligible costs (whole duration of the project)					Total receipts	Requested EU contribution
				RTD / Innovation (A)	Demonstration (B)	Management (C)	Other (D)	Total A+B+C+D		
1	UoG-NRI	75.0	T	546,600.00	56,588.80	208,070.80	117,316.80	928,576.40	0.00	763,630.00
2	Wageningen Universit	75.0	A	303,859.00	0.00	0.00	35,480.00	339,339.00	0.00	263,374.00
3	ESB	75.0	T	238,363.20	0.00	0.00	39,747.20	278,110.40	0.00	218,519.00
4	Accord Associates	75.0	T	77,600.00	0.00	0.00	33,600.00	111,200.00	0.00	91,800.00
5	SABmiller	50.0	F	124,999.20	0.00	0.00	0.00	124,999.20	0.00	62,499.00
6	UNAAB	75.0	T	360,000.00	56,000.00	2,700.00	85,600.00	504,300.00	0.00	386,300.00
7	FRI	75.0	T	295,000.00	84,000.00	0.00	87,600.00	466,600.00	0.00	350,850.00
8	FIIRO	75.0	T	72,000.00	24,000.00	0.00	8,800.00	104,800.00	0.00	74,800.00
9	NSTDA	75.0	A	238,756.00	45,178.00	0.00	32,091.00	316,025.00	0.00	233,747.00
10	St. Baasah Ghana Lim	75.0	T	10,000.00	32,000.00	0.00	11,360.00	53,360.00	0.00	34,860.00
11	Caltech Ventures	75.0	T	10,000.00	32,000.00	0.00	11,360.00	53,360.00	0.00	34,860.00
12	SBFT	75.0	F	212,160.00	35,520.00	0.00	42,360.00	290,040.00	0.00	219,240.00
13	Peak	50.0	F	7,500.00	24,000.00	0.00	8,520.00	40,020.00	0.00	24,270.00
14	Nobex	75.0	T	8,800.00	28,800.00	0.00	11,360.00	48,960.00	0.00	32,360.00
15	Sodia	50.0	F	7,500.00	24,000.00	0.00	8,520.00	40,020.00	0.00	24,270.00
16	Northeastern Starch	75.0	A	9,960.00	31,808.00	0.00	11,660.00	53,428.00	0.00	35,034.00
Total				2,523,097.40	473,894.80	210,770.80	545,375.00	3,753,138.00	0.00	2,850,413.00

Note that the budget mentioned in this table is the total budget requested by the Beneficiary and associated Third Parties.

*** The following funding schemes are distinguished**

Collaborative Project (if a distinction is made in the call please state which type of Collaborative project is referred to: (i) Small of medium-scale focused research project, (ii) Large-scale integrating project, (iii) Project targeted to special groups such as SMEs and other smaller actors), Network of Excellence, Coordination Action, Support Action.

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project, and it cannot be changed. The project number **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

2. Project acronym

Use the project acronym as indicated in the submitted proposal. It cannot be changed, unless agreed during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry info force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a detailed justification on a separate note.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Activity code

Select the activity code from the drop-down menu.

8. Free keywords

Use the free keywords from your original proposal; changes and additions are possible.

9. Abstract

10. The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

11. The number allocated by the Consortium to the participant for this project.

12. Include the funding % for RTD/Innovation – either 50% or 75%

13. Indirect cost model

A: Actual Costs
S: Actual Costs Simplified Method
T: Transitional Flat rate
F :Flat Rate

Workplan Tables

Project number

289843

Project title

Gratitude—Gains from Losses of Root and Tuber Crops

Call (part) identifier

FP7-KBBE-2011-5

Funding scheme

Collaborative project

WT1
List of work packages

Project Number [1]	289843	Project Acronym [2]	Gratitude

LIST OF WORK PACKAGES (WP)

WP Number [53]	WP Title	Type of activity [54]	Lead beneficiary number [55]	Person-months [56]	Start month [57]	End month [58]
WP 1	Value Chain Assessment and Management	RTD	1	42.00	2	35
WP 2	Reduced Post-Harvest Losses of Fresh Produce	RTD	7	71.00	2	35
WP 3	Alternative Market Development to Reduce Post-Harvest Losses	RTD	12	140.50	2	35
WP 4	Adding Value to Waste Products	RTD	2	171.00	4	35
WP 5	Food Safety, Quality and Compliance	RTD	3	43.00	6	35
WP 6	Demonstration of Technologies with Beneficiaries	DEM	6	102.00	6	35
WP 7	Dissemination and Support to Replication	OTHER	1	47.00	1	36
WP 8	Management and Monitoring and Evaluation	MGT	1	16.00	1	36
			Total	632.50		

WT2:
List of Deliverables

Project Number [1]	289843	Project Acronym [2]	Gratitude

List of Deliverables - to be submitted for review to EC

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D1.1	Value chains and levels/causes of post-harvest losses for cassava and yam	1	1	8.00	R	PU	12
D1.2	Market potential for the range of potential waste product solutions	1	1	7.00	R	PU	12
D1.3	Development and validation of approaches to support household decision	1	6	12.00	R	PU	20
D1.4	Analysis of the impact of availability on price and competitiveness	1	7	8.00	R	PU	34
D1.5	Benchmarking of approaches to reducing post-harvest losses and value addition to wastes	1	1	7.00	R	PU	35
D2.1	Identification of key yam species/varieties and levels of loss on farm within target region	2	6	12.00	R	PU	9
D2.2	Definition of post-harvest characteristics of key yam species/varieties	2	1	16.00	R	PU	12
D2.3	Optimal on-farm strategies for curing, sprout control	2	7	43.00	R	PU	20

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
	and storage identified						
D3.1	Development of methods for making yam flour & assess the nutritional composition	3	7	40.00	R	PU	18
D3.2	Development and validation of improved drying systems for high quality cassava products	3	6	11.50	R	PU	23
D3.3	Development and validation of other high value uses of processed cassava	3	9	27.00	R	PP	24
D3.4	Assessment of the storage and packaging characteristics for high quality yam flour	3	6	20.00	R	PU	25
D3.5	Potential to use feed High Quality Cassava Flour into the brewing industry assessed	3	5	42.00	R	PP	30
D4.1	Development of methods for growing mushrooms from the waste cassava & yam peel	4	2	45.00	R	PU	18
D4.2	Development and validation of methods for turning peel into animal feed suitable (goats)	4	6	22.00	R	PU	20
D4.3	Development of methods for extracting starch and other	4	9	24.00	R	PU	24

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
	nutrients from cassava peel						
D4.4	Development of methods for producing snack foods ingredients from waste from brewing cassava beer	4	5	14.50	R	RE	24
D4.5	Development of methods for scaling up mushroom production as commercial enterprises	4	2	23.00	R	PU	30
D4.6	Development of methods for turning waste from cassava beer production into snack food ingredients	4	5	16.50	R	RE	30
D4.7	Development of methods for scaling up production as commercial enterprises	4	4	16.00	R	PU	34
D4.8	Development and validation of methods for scaling up animal feed production (commercially viable)	4	6	10.00	R	PU	34
D5.1	Food safety baseline assessment	5	3	10.50	R	PU	8
D5.2	Develop HACCP based systems	5	3	20.00	R	PU	24
D5.3	Follow up surveillance of the quality management systems (safety, quality and	5	3	12.50	R	PU	30

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
	economic factors)						
D6.1	Web-based platform for South-South interactions	6	6	3.00	O	PP	6
D6.2	Selection of products and enterprises chosen for the study	6	6	18.50	R	PU	15
D6.3	Demonstration of new products from WP2, WP3 and WP4	6	6	80.50	R	PU	33
D7.1	Web site, video, interactive media on project achievements and results	7	1	5.50	R	PU	5
D7.2	Initial project publicity information produced – press releases, briefs and handouts	7	1	6.00	R	PU	6
D7.3	Development of a communication, dissemination and training strategy	7	1	5.50	R	PU	9
D7.4	Communication, dissemination and training strategy- Mid term update	7	1	3.50	R	PU	18
D7.5	Training materials and guidelines designed and produced	7	1	18.00	R	PU	36
D7.6	Communication, dissemination and training strategy- Final Stage	7	1	3.00	R	PU	36

WT2:
List of Deliverables

Delive-rable Number [61]	Deliverable Title	WP number [53]	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D7.7	Dissemination workshop with major stakeholders and publication of the proceedings	7	1	5.50	R	PU	36
D8.1	Kick-Off Meeting	8	1	3.00	R	PU	3
D8.2	Project Management Committee	8	1	4.00	R	PU	5
D8.3	Project Management Committee meeting	8	1	9.00	R	PU	36
			Total	632.50			

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP1	Type of activity [54]	RTD
Work package title	Value Chain Assessment and Management		
Start month	2		
End month	35		
Lead beneficiary number [55]	1		

Objectives

The overall objective of this WP is to ensure that technologies developed by Gratitude concerning waste products and ways of reducing losses are commercially viable for key actors in the value chain for yam and cassava products. This will be achieved with the use of value chain analysis applied prior to interventions and subsequently during the process of testing the various loss reduction and waste management technologies.

The specific objectives are:
1. to understand the existing value chains for cassava and yams in selected target areas
2. to understand the levels and causes of post-harvest losses
3. to identify options for reducing losses providing key information for other WPs
4. to document levels of waste generated and examine alternative value chains/markets for products from waste.
5. to provide baseline information to enable benchmarking of different approaches to post-harvest loss reduction and use monitoring data to undertake these benchmarking exercises
6. to understand household decision making with respect to the options for reducing post-harvest losses including the options of processing for value addition.
7. to model the impacts of developing strategies for reducing losses and adding value to waste to gain a comprehensive understanding of the impacts on the value chains for yam and cassava and their contributions to food security.

Description of work and role of partners

The objectives will be achieved by conducting value chain analysis and market research in the target countries. This work will be led by UoG-NRI working in collaboration with UNAAB in Nigeria, FRI in Ghana, NSTD in Thailand and SBFT in Vietnam.

Task 1.1 Select target areas in each country. Selection will be done of the basis of the importance of the crops and to maximise opportunities for lesson learning across the project (e.g. different agro-ecologies). (U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Task 1.2 Evaluate the existing value chains for cassava and yam in the target countries building up existing work carried out for example by the C:AVA project in Ghana and Nigeria. The roles and levels of participation of men and women at different points of the cassava and yam value chains will be analysed. Assess the current levels of post-harvest losses and their causes at specific selected locations to provide baseline information.(U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Task 1.3 Identify options for reducing losses. This task will be based on the outcomes from Task 1.2 and will be conducted in collaboration with partners in WPs2 and WP3.(U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Task 1.4 Assess levels of waste generated (focussing on peels, liquid waste and where use of cassava in brewing is an invested option (Vietnam) the use of spent brewery wastes and examine the size and profitability of various alternative market outlets for value added products developed in WP4.(U0G-NRI, SBFT)

Task 1.5 Understand household decision making with respect to reducing post-harvest losses and value addition to these commodities. This includes gender dimensions of decision making and allocation of these

responsibilities and work loads within the household. Examine how decisions to use, sell, store or process are taken in the context of the risks and benefits to food security and how these decision making processes might be improved and how household members could be best supported in their decision making. Some of these approaches will be evaluated alongside the technical interventions.(U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Task 1.6. Benchmark the different options for reducing post-harvest losses and model the likely impacts of implementation of the proposed interventions. There will an analysis of the wider impact within the context of the contrasting situations in Africa (where basic food availability and quality are key issues combined with the impact that the crops can have on income generation which itself contributes to food security); whereas in Asia the context will be the context of diverse uses of cassava including use as a biofuel (which could compromise food security) and as a substitute for other major food staples in processed foods as well as the impact on small-holder incomes (and hence food security).(U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Task 1.7 - Analyse the impact of greater cassava and yam availability on price and competitiveness through a number of case studies and value chain scenarios.(U0G-NRI, UNAAB, FRI, NSTD, SBFT)

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	11.00
6	UNAAB	8.00
7	FRI	11.00
9	NSTDA	6.00
12	SBFT	6.00
	Total	42.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D1.1	Value chains and levels/causes of post-harvest losses for cassava and yam	1	8.00	R	PU	12
D1.2	Market potential for the range of potential waste product solutions	1	7.00	R	PU	12
D1.3	Development and validation of approaches to support household decision	6	12.00	R	PU	20
D1.4	Analysis of the impact of availability on price and competitiveness	7	8.00	R	PU	34
D1.5	Benchmarking of approaches to reducing post-harvest losses and value addition to wastes	1	7.00	R	PU	35
		Total	42.00			

Description of deliverables

WT3:
Work package description

D1.1) Value chains and levels/causes of post-harvest losses for cassava and yam: The objectives will be achieved by conducting value chain analysis and market research in the target countries. This work will be led by UoG-NRI working in collaboration with UNAAB in Nigeria, FRI in Ghana, NSTD in Thailand and SBFT in Vietnam. This will involve selecting target areas in each country. Selection will be done of the basis of the importance of the crops and to maximise opportunities for lesson learning across the project (e.g. different agro-ecologies). Following this, the team will evaluate the existing value chains for cassava and yam in the target countries building up existing work carried out for example by the C:AVA project in Ghana and Nigeria. The roles and levels of participation of men and women at different points of the cassava and yam value chains will be analysed. Assess the current levels of post-harvest losses and their causes at specific selected locations to provide baseline information. [month 12]

D1.2) Market potential for the range of potential waste product solutions: Evaluate the existing value chains for cassava and yam in the target countries building up existing work carried out for example by the C:AVA project in Ghana and Nigeria. The roles and levels of participation of men and women at different points of the cassava and yam value chains will be analysed. Assess the current levels of post-harvest losses and their causes at specific selected locations to provide baseline information. [month 12]

D1.3) Development and validation of approaches to support household decision: Understand household decision making with respect to reducing post-harvest losses and value addition to these commodities. This includes gender dimensions of decision making and allocation of these responsibilities and work loads within the household. Examine how decisions to use, sell, store or process are taken in the context of the risks and benefits to food security and how these decision making processes might be improved and how householdershousehold members could be best supported in their decision making. Some of these approaches will be evaluated alongside the technical interventions. [month 20]

D1.4) Analysis of the impact of availability on price and competitiveness: An analysis of the impact of greater yam and cassava availability on price and competitiveness will be assessed through a number of case studies and value chain scenarios in Ghana, Nigeria Thailand and Vietnam specifically within the context of food security. [month 34]

D1.5) Benchmarking of approaches to reducing post-harvest losses and value addition to wastes: Benchmark the different options for reducing post-harvest losses and model the likely impacts of implementation of the proposed interventions. There will an analysis of the wider impact within the context of the contrasting situations in Africa (where basic food availability and quality are key issues combined with the impact that the crops can have on income generation which itself contributes to food security); whereas in Asia the context will be the context of diverse uses of cassava including use as a biofuel (which could compromise food security) and as a substitute for other major food staples in processed foods as well as the impact on small-holder incomes (and hence food security). [month 35]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Communication, dissemination and training strategy defined	1	9	Means of verification: D7.1
MS4	Value chain assessments completed	1	12	Survey complete and data quality validated. Means of verification: D1.1 and 1.2; 2.1
MS5	Procedure for SME production of high quality yam flour defined for Ghana and Nigeria.	7	14	Means of verification: D3.1
MS6	Options for mushroom production understood and economic viability as a business enterprise defined	2	18	Means of verification: D4.1, 4.2

WT3:
Work package description

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS7	Options for use of root crop peels for animal feed. determined	6	18	Means of verification: D4.4, 4.5
MS10	Options for development of other higher value products from wastes defined	5	24	Means of verification: D4.7 and 4.9
MS12	Commercial opportunities for cassava and yam defined	4	24	Means of verification: Annual progress reports towards deliverables 3.5 and 3.6
MS14	Dissemination of best strategies for reducing losses in fresh yam in Ghana and Nigeria identified	7	30	Means of verification: D2.6
MS15	Demonstration of production of yam flour in Ghana and Nigeria completed	7	30	Means of verification: Deliverables associated with WP6
MS17	Demonstration of processing options and waste product strategies completed	6	33	Means of verification: D6.3
MS18	Demonstration of selected waste production strategies with SMEs	6	33	Means of verification: D6.4

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP2	Type of activity [54]	RTD
Work package title	Reduced Post-Harvest Losses of Fresh Produce		
Start month	2		
End month	35		
Lead beneficiary number [55]	7		

Objectives

The objective of this WP is to reduce losses in the fresh yam value chain and hence improve food security and increase incomes with a focus on small-holder farmers. In parts of West Africa 10-50% of tubers are lost during on-farm storage (Amusa et al., 2003) and a further 10-40% during transport due to damage and rots (Rees and Bancroft, 2003). Technologies for the reduction of post-harvest losses of fresh yam will be developed and validated. This will focus on practices to control tuber sprouting, water loss and rotting which are major causes of loss.Losses on-farm could be reduced by improved storage structures and post-harvest practices to reduce sprouting and improve wound-healing. This would also provide tubers of better quality to withstand damage during transport.

The specific objectives are:
• Develop and validate strategies to improve curing of yam tubers.
• Develop and validate strategies for yam tuber sprout control.
• Identify appropriate storage structures to optimise tuber quality/storage.
Best strategies identified will be demonstrated in WP6 and information more widely dissemination to reduce yam tuber losses in WP7.

Description of work and role of partners

The objectives will be achieved by a combination of technology expertise (research institutes), in-country application and assessment of these technologies with partners

Task 2.1.Conduct surveys in target regions (FRI, UNAAB and UOG-NRI).
These surveys will be integrated and coordinated with the studies mentioned in task 1.2, but will go into more detail in terms of identifying key yam varieties/species utilized, the ideal on-farm storage duration required, sprout removal strategies presently used and confirm current levels of tuber loss in Ghana and Nigeria.

Task 2.2. Determine the wound healing efficiency and dormancy period for key yam species/varieties used (UoG-NRI).
For the varieties/species identified above, using controlled conditions (on-station in the UK) to determine wound-healing efficiency and dormancy period. Define optimum conditions for curing and subsequent storage of tubers (in terms of temperature and humidity).

Task 2.3. Develop strategies to optimise curing of yam tubers on farm (FRI, UNAAB and UoG-NRI)
Working with farmers identify appropriate strategies/storage structure for curing yams that achieve the environmental conditions identified in Task 2.2.

Task 2.4. Assess strategies for sprout control on farm (FRI, UNAAB and UoG-NRI)
Working with farmers test and compare the most common strategies for sprout removal, and identify/test appropriate sprout suppressant technologies (FRI, UNAAB and UoG-NRI)

Task 2.5. Test storage structures for yam on farm (FRI, UNAAB and UoG-NRI)
Working with farmers, this task will identify and test storage structures consistent with the findings of Tasks 2.3 and 2.4

Task 2.6. Test the best options identified in Tasks 2.3 to 2.5 (FRI, UNAAB and UoG-NRI)

The partners will work with men and women farmers and extension agents to test the improved technologies at the grass roots level. This will be undertaken in at least two different agro-ecological zones in Ghana and Nigeria. Testing will also indentify the factors affecting the adoption of yam storage techniques and would also be investigated and mitigating measures identified and tested.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	24.00
6	UNAAB	18.00
7	FRI	29.00
	Total	71.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D2.1	Identification of key yam species/varieties and levels of loss on farm within target region	6	12.00	R	PU	9
D2.2	Definition of post-harvest characteristics of key yam species/varieties	1	16.00	R	PU	12
D2.3	Optimal on-farm strategies for curing, sprout control and storage identified	7	43.00	R	PU	20
		Total	71.00			

Description of deliverables

D2.1) Identification of key yam species/varieties and levels of loss on farm within target region: Results of the surveys conducted in target regions and described in Task 2.1 will be reported. It will include identification of key yam varieties/species utilized, the ideal on-farm storage duration required, and sprout removal strategies presently used and confirm current levels of tuber loss in Ghana and Nigeria. [month 9]

D2.2) Definition of post-harvest characteristics of key yam species/varieties: Wound healing efficiency, dormancy period, optimum conditions for curing and subsequent storage of tubers for key yam species/varieties will have been identified. This will be based on using controlled conditions (on-station in the UK). [month 12]

D2.3) Optimal on-farm strategies for curing, sprout control and storage identified: Report on suitable strategies/storage structures for yam that achieve the environmental conditions found to promote efficient curing and long-term storage in Task 2.2. It will include an assessment of the most common strategies for sprout removal, and other appropriate sprout suppressant technologies, optimum strategies of sprout control. [month 20]

WT3:
Work package description

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS4	Value chain assessments completed	1	12	Survey complete and data quality validated. Means of verification: D1.1 and 1.2; 2.1
MS5	Procedure for SME production of high quality yam flour defined for Ghana and Nigeria.	7	14	Means of verification: D3.1
MS8	Post-harvest characteristics of key yam varieties	1	20	Means of verification is Deliverable 2.2
MS13	Package of best strategies for on-farm yam storage defined for intervention	7	28	Means of Verification: Annual progress reports leading to deliverables 2.3, 2.4 and 2.5

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP3	Type of activity [54]	RTD
Work package title	Alternative Market Development to Reduce Post-Harvest Losses		
Start month	2		
End month	35		
Lead beneficiary number [55]	12		

Objectives

The overall objective of this WP is to explore the development of new products from the fresh produce so that physical and economic losses in the value chain are reduced and value is added.

The specific objectives are:
1. To develop and validate technologies and systems that allow production of high quality yam flour of acceptable quality providing a new market outlet for yam produced by small-holder households.
2. To improve the systems for drying of cassava, increasing the potential to produce higher quality products, with lower levels of loss and more efficient use of fuel.
3. To develop new novel market outlets for high quality cassava flour as a versatile raw material for diverse markets.

Description of work and role of partners

Alternative novel markets for processed cassava and yam products will be developed and validated that reduce levels post-harvest loss and provide increased incomes for small-holder farmers and so contribute to food security. The key issue in this WP will be the development of viable new processed products for yam and cassava that provide options of households to sell their produce for reasonable prices and result in reduced physical or economic losses. This may be that less fresh produce is sold or stored and lower amounts of lower value products are processed. There will be an important balance to strike between products prepared and stored for household use and the generation of income – with the income contributing to food security.

The C:AVA project has already had success with producing high quality flour from cassava at the household level as well as at the SME level. The technology should be easily adaptable to yams of which 60% of fresh yams are currently considered to be a loss. Although there is some yam flour on the market in West Africa, there are issues in quality and the production at the SME level is limited. Urbanisation in West Africa is a driver of changing food habits and is therefore likely to offer an opportunity for composite flours or more convenient forms of traditional products. Therefore by converting some of this 60% loss into high quality yam flour should present value addition opportunities. This will be in collaboration with WP2 to ensure the approaches are economically viable and that markets exist and with WP5 to ensure that they are safe. As appropriate technologies will be demonstrated in collaboration with SMEs.

The C:AVA project is not a research project and the impact that this project has could be enhanced by researching new market outlets for High Quality Cassava Flour. The C:AVA project also provides a mechanism for the dissemination of the activities of this research.

Task 3.1 Develop methods for high quality yam flour production at a pilot-scale levels examining processing options suitable for use by SMEs. (UNAAB, FRI, UoG-NRI, Nobex, PP)

Sub-task 3.1.1. Assess the rheological properties of cassava flour (UNAAB/FRI/UoG-NRI)
This task will assess the potential for making high quality yam flour. This will include assessing the rheological characteristics of starch pasted made from the flour and its storage characteristics.

Sub-task 3.1.2 Assess the nutritional composition of the high quality yam flour (UNAAB/FRI)
This will be compared with cassava flour. This will include carbohydrate, protein, fat, dietary fibre and key minerals and vitamins.

Sub-task 3.1.3 Assess the storage and packaging characteristics (UNAAB, FRI, Nobex, PP)
Various drying methods would be investigated at different combinations of time and temperature for drying yams for flour production that have been subjected to specified pre-treatments. The various flours produced would be subjected to physico-chemical, nutritional and sensory analysis in order to establish the pre-treatments, drying methods and conditions that produce the best quality flour for up-scaling and promotion. The ideal conditions established would be used to produce yam flour for the storage and packaging trials. The yam flour would be stored under different conditions of temperature and humidity in a variety of packaging materials. Product quality during storage would be assessed and related to storage time, and packaging material in order to establish the most appropriate packaging requirement and shelf life of the product.

Task 3.2 - develop methods for scaling up yam flour production (UNAAB, FRI and AA).
This will take into account the following: Process conditions and operations; as well as storage/packaging problems within the context of a viable business plan.

Subtask 3.2.1 – Determine process conditions and operations. (UNAAB and FRI)
Pilot facilities at the UNAAB and FRI will be used to validate and optimise the stages involved in the processing of yam flour. The optimised processes and operations will then be trial-run at three participating SMEs to study the potential for scaling up.

Subtask 3.2.2 – Assess different storage and packaging modes for high quality yam flour (UNAAB, FRI & UoG-NRI)
Traditional yam flour packaging and storage techniques will be compared with innovative techniques developed in this project. These will be done both at pilot and SME levels.

Task 3.3 Optimisation of existing dryers (UNAAB and FRI, Peak, Nobex, CV, St. Baasah Ghana Lim).
Current designs of bin (Ghana) and flash dryers (Nigeria) are known to operate with low efficiency and that fuel is a major component of costs of cassava flour (50% of post-harvest costs). Dryer designs will be optimised in collaboration with SME partners . These modifications will be assessed over an 18 month period such that best bet technologies can be made available.

Task 3.4 Assessment of new dryer technologies (UNAAB, FRI, NSTDA, SBFT)
New approaches are required for drying that made the optimum use of the energy put into the processing system. New processing technologies have been developed in South American that uses ventilation rather than heated air to dry chips, alternative technologies exist in Thailand, and other technologies have not been evaluated for HQCF including various designs of fluidised bed. These will be evaluated on a small pilot scale and scaled up in collaboration with SME partners as promising results are obtained. South-south research collaboration will be an important part of this task.

Task 3.5. Developing new markets for High Quality Cassava Flour (NSTDA, SBTF, UNAAB, UoG-NRI, FRI, AA, CV, SBGL, PP, NF, SAB, NS)
NSTDA, SBTF, UNAAB, UoG-NRI, FRI will be involved in the technical aspects of this research, AA in the business planning and SME (CV. SBGL, PP, NF) and industry partners (SAB and NS) in validation of the new markets. C:AVA activities in Nigeria have indicated that the successful development of new products can contribute to new and high value markets for HQCF and this requires more systematic investigation.

Task 3.6 Functional properties of HQCF established (UoG-NRI, UNAAB, FRI, SBTF, NSTDA)
Technical information to support expanded uses of the commodity will be developed. This will include physical (flour yield, bulk density, and tri-stimulus color characteristics (L*, a*, b*, Chroma and Hue)), chemical (moisture, protein, ash, starch, sugar, TTA, pH, and amylose contents), functional (water and oil absorption capacities, water solubility, swelling power, least gelation capacity, diastatic activity, percent damaged starch), and pasting properties.

Task 3.7 New uses of HQCF examined at the laboratory scale/pilot scale in each country as a diverse set of different markets for the product.(UoG-NRI, UNAAB, FRI, SBTF, NSTDA)
Products produced at the laboratory and pilot scale will be tested for their acceptability in a variety of end use markets. Assuming economic viability of the product which may include a business plan, this will include consumer acceptance and market testing.

Task 3.8 Market potential for innovations evaluated. (NSTDA, SBTF, UNAAB, UoG-NRI, FRI, AA, CV, SBGL, PP, NF, SAB, NS),

As early as possible in the project, in each focus country partners will include an assessment of the potential of the industries to use the products in collaboration with WP1.

Task 3.9 Pilot level value chains established to validate the innovative new products. (NSTDA, SBTF, UNAAB, UoG-NRI, FRI, AA, CV, SBGL, PP, NF, SAB, NS),
This will enable the new products to be tested with end use industry partners that have already been identified.

Task 3.10. Specific innovation for the use of high quality cassava flour in the production of a fermented beverage (beer) (SBTF, UoG-NRI, AA,SAB),
The use of hqcf in beer production has the potential of saving on the use of imported raw materials or more commonly eaten raw materials. This will be specifically investigated in Vietnam where SAB has a specific interest. SAB will take responsibility for developing the product, but some of the key issues will be developed of the value chain to support such an industry. The use of cassava rather than grains in beer production will be explored and in Mozambique has been suggested as a way of improving household incomes for example (http://allafrica.com/stories/201009070937.html). Market and value chain work and the impacts of these innovations are measured in WP1.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	8.50
4	Accord Associates	3.00
5	SABmiller	8.00
6	UNAAB	16.00
7	FRI	26.00
9	NSTDA	14.00
10	St. Baasah Ghana Lim	6.00
11	Caltech Ventures	6.00
12	SBFT	25.00
13	Peak	6.00
14	Nobex	6.00
15	Sodia	6.00
16	Northeastern Starch	10.00
	Total	140.50

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D3.1	Development of methods for making yam flour & assess the nutritional composition	7	40.00	R	PU	18
D3.2	Development and validation of improved drying systems for high quality cassava products	6	11.50	R	PU	23

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D3.3	Development and validation of other high value uses of processed cassava	9	27.00	R	PP	24
D3.4	Assessment of the storage and packaging characteristics for high quality yam flour	6	20.00	R	PU	25
D3.5	Potential to use feed High Quality Cassava Flour into the brewing industry assessed	5	42.00	R	PP	30
		Total	140.50			

Description of deliverables

D3.1) Development of methods for making yam flour & assess the nutritional composition: This will be based on the assessment the potential for making high quality yam flour. This will include assessing the rheological characteristics of starch pasted made from the flour and its storage characteristics [month 18]

D3.2) Development and validation of improved drying systems for high quality cassava products: Current designs of bin (Ghana) and flash dryers (Nigeria) are known to operate with low efficiency and that fuel is a major component of costs of cassava flour (50% of post-harvest costs). Dryer designs will be optimised in collaboration with SME partners . These modifications will be assessed over an 18 month period such that a best bet technologies can be made available. [month 23]

D3.3) Development and validation of other high value uses of processed cassava: Functional properties of HQCF will be established so technical information to support expanded uses of the commodity is available. New uses of HQCF will be examined at the laboratory scale/pilot scale in each country as a diverse set of different markets for the product. Products will be tested for their acceptability in a variety of end use markets (including Uganda). Market potential for innovations will be evaluated as early as possible in each focus country all five African countries, including an assessment of the potential of the industries to use the products in collaboration with WP1. Pilot level value chains will be established to validate the innovative new products enabling them to be tested with end use industry partners that have already been identified. [month 24]

D3.4) Assessment of the storage and packaging characteristics for high quality yam flour: Various drying methods would be investigated at different combinations of time and temperature for drying yams for flour production that have been subjected to specified pre-treatments. The various flours produced would be subjected to physico-chemical, nutritional and sensory analysis in order to establish the pre-treatments, drying methods and conditions that produce the best quality flour for up-scaling and promotion. The ideal conditions established would be used to produce yam flour for the storage and packaging trials. The yam flour would be stored under different conditions of temperature and humidity in a variety of packaging materials. Product quality during storage would be assessed and related to storage time, and packaging material in order to establish the most appropriate packaging requirement and shelf life of the product. [month 25]

D3.5) Potential to use feed High Quality Cassava Flour into the brewing industry assessed: A specific innovation will be the use of high quality cassava flour in the production of a fermented beverage (beer) saving on the use of imported raw materials or more commonly eaten raw materials. This will be specifically investigated in Vietnam where SAB has a specific interest. SAB will take responsibility for developing the product, but some of the key issues will be developed of the value chain to support such an industry. The use of cassava rather than grains in beer production will be explored and in Mozambique has been suggested as a way of improving household incomes for example (http://allafrica.com/stories/201009070937.html). [month 30]

WT3:
Work package description

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Communication, dissemination and training strategy defined	1	9	Means of verification: D7.1
MS4	Value chain assessments completed	1	12	Survey complete and data quality validated. Means of verification: D1.1 and 1.2; 2.1
MS5	Procedure for SME production of high quality yam flour defined for Ghana and Nigeria.	7	14	Means of verification: D3.1
MS9	Innovations in cassava (yam) drying defined.	6	20	Means o Verification: Deliverable 3.4
MS11	Food safety strategies defined	3	24	Annual Progress Report
MS12	Commercial opportunities for cassava and yam defined	4	24	Means of verification: Annual progress reports towards deliverables 3.5 and 3.6
MS15	Demonstration of production of yam flour in Ghana and Nigeria completed	7	30	Means of verification: Deliverables associated with WP6
MS17	Demonstration of processing options and waste product strategies completed	6	33	Means of verification: D6.3
MS19	Dissemination of technologies capable of reducing post-harvest losses to SME's completed	1	34	Means of verification: Final Project Report

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP4	Type of activity [54]	RTD
Work package title	Adding Value to Waste Products		
Start month	4		
End month	35		
Lead beneficiary number [55]	2		

Objectives

The overall objective of this work package is to generate value added products from the waste products arising from cassava and yam value chains in order to increase food security at the low level of technology and at a higher level, increase business opportunities and reduce the damage done to the environment by providing new solutions to use the wastes.. These wastes can result either from the fresh roots due to their perishable nature or from the processing of cassava and yam (e.g. peels, waste water, waste from brewing etc.). This will lead to expanded/open new market opportunities for new products and added valued products generated from the waste of cassava and yam.

The specific objectives are:
1. To develop technologies for making food products from waste which is either in the form of food products, animal feeds or mushrooms made from composting waste. This will be in collaboration with WP5 to ensure that they are safe.
2. To assess the technologies at the household food security level
3. To assess the technologies at the pilot scale level
4. To assess the potential for enterprise development based on these technologies.

Description of work and role of partners

WP4 seeks to develop new technologies, systems and products to add value to the waste products from processing (mainly from cassava and to a lesser extent from yam). The specific wastes selected in part from the work detailed in WP3, but are also produced from the traditional processing systems and from current industries. This means that losses associated with wastes happen now and are not a consequence of WP3.

There will only be work on added value products that will feed into the human food supply chains, e.g. mushroom production using peels as substrate; use of peels as a raw material for animal feed and using peels as a raw material for added value products, such as sugars and other raw materials for the food industry. There may be the option to work on brewing waste if brewing is one of the options developed using high quality cassava flour as a raw material (WP3).

The objectives will be achieved by a combination of technology expertise (research institutes), in-country application and assessment of these technologies with partner firms and organisations. Value chains for the products developed from waste are assessed in WP1.

Task 4.1 Develop and validate improved utilisation of peels for mushroom production (PRI-WAG, FRI, UNAAB)) Develop methods (at the laboratory scale) for making food products from waste which is either in the form of food products, animal feeds or mushrooms made from composting waste.

Sub-task 4.1.1 Develop methods for growing mushrooms from the waste from cassava peel (with or without added waste water. Use of waste water would be a means of disposing of this processing waste) (PRI, FRI, UNAAB)
Spawn and fermentation technology used in the mushroom industry will be used to optimize the conversion of cassava peel into feed for edible mushrooms. A range of fugal strains will be tested. In addition, the above ground plant wastes will also be tested.

Sub-task 4.1.2 Develop method for growing mushroom from the waste from yam peel (PRI, FRI, UNAAB)

Spawn and fermentation technology used in the mushroom industry will be used to optimize the conversion of yam peel into feed for edible mushrooms. A range of fugal strains will be tested. In addition, the above ground plant wastes will also be tested.

Sub-task 4.1.3 Develop methods for producing mushrooms at the household level and also for scaling up production for SME's. (PRI, FRI, UNAAB, AA)
Implementation of spawn technology and fermentation technology needed for the treatment of cassava and yam waste will be undertaken at the household level to encourage food security and also on a large scales, suitable for SME's and hence develop new food chains. This will take into account Process conditions and operations, Processing, preservation and storage/packaging problems mad Assess within the context of a viable business plan.

Task 4. 2 Develop and validate methods for improved utilisation of peels for animal feed (UNAAB, PRI-WAG, AA)
Cassava and yam peels have the potential for use as animal feed. Staple and commercially viable animal feed supplements from cassava and yam wastes will be developed that can facilitate rapid weight gain in ruminant animal nutrition

Sub-task 4.2.1 Develop and validate methods for turning cassava and yam peel (with or without waste water) and plant waste materials into animal feed suitable (goats); this includes the pre-treatment of waste with fungi to increase the digestibility by goats (PRI-WAG, UNAAB)
Methodologies will be based on fermentation and pre-treatments with fungi to increase the digestibility. To validate the technologies, a replicated (3) digestibility trial over three rearing seasons for newly weaned West African Dwarf (WAD) goats with 4 treatments will be set-up. The treatments are: dry peels supplement, fungi treated peels supplement, untreated wet peels supplements and no supplements. Data will also be obtained of weight gain, growth rate (days to maturity) and other growth and development parameters. These data will be subjected to ANOVA to understand the influence of the different cassava peels supplement on feed digestibility and growth of the goats.

Sub-task 4.2.2 Develop and validate methods for scaling up animal feed production as commercial enterprises. (UNAAB, AA, PRI)
This will take into account the following: the sources and sourcing of waste products of cassava and yam processing, costs associated with handling (collection, aggregation, transportation) of waste products, sourcing and costs of additional raw materials and other inputs required in the composition of suitable feed for goats, distribution pathway for and profitability from commercial animal feed as well as the perception of selected goat keepers of the nutrition value and performance of goats fed with the feed.

Task 4.3 Develop and validate methods for improved utilisation of peels for value added products for the food industry (including starch and sugar syrups) Methods for starch and sugar syrup production (NSTDA, AA, NS)
The best feeding supplements from subtasks 4.2.1 and 4.2.2 will be evaluated for economic feasibility at pilot levels. Selected goat farms will then be provided technically suitable and economically feasible supplements to feed to selected weaner WAD goats over a six month period. Data will be collected on the performance and growth parameters of each goats. The data will then be analysed to determine economic viability of adopting each recommended feed supplement

Sub-task 4.3.1 Develop methods for extracting starch and other nutrients from cassava peel (with or without waste water) (NSTDA, NS)
Peels contain mainly starch and cellulosic fibres. The purified starch and cellulosic fibre are more value added as being most efficiently used based on their individual functionality. By using suitable enzyme cocktails, the starch can be either directly extracted as granular starch or indirectly as sugar syrup. The destarched fibrous residues have the potential to be also used to produce cellulosic-based materials or chemically and physically treated to produce microcrystalline cellulose or cellulose nanocrystal for the application in food (such as fat replacers, texturing agents, dietary fibre supplement).

Sub-task 4.3.2 Develop methods for scaling up production as commercial enterprises (NSTDA, AA, NS, UoG-NRI)). This will take into account
Process conditions and operations. nutritional properties, sensory parameters, rheological properties, processing, preservation and storage/packaging problems and assess within the context of a viable business plan.

Task 4.4. Methods for producing snack foods ingredients from waste from brewing cassava beer (SBFT, AA, UOG-NRI, SAB)
The waste from cassava beer production is likely to be low in carbohydrate but will otherwise have a high nutrient composition. Similar products commercially sold include 'yeast extract', 'vegimite' and 'marmite'. These are sold as meat free products with high nutritional value. The high glutamic acid content may give the product a umami sensory characteristic (similar to mono-sodium glutamate)

Sub-task 4.4.1 Develop methods for turning the waste from cassava beer production into nutritious ingredients that can be incorporated into snack foods (SBFT, SAB)

Sub-task 4.4.2 Assess the consumer acceptance of the snack food based products (SBFT, UoG-NRI, ESB-UCP, SAB)
Sensory and consumer testing of the products will be undertaken to access the market potential. This will be subject to food safety and ethical clearance.

Task 4.5. – Assess the enterprise potential snack food production from cassava beer waste(AA, SBFT, SAB)
The enterprise potential will be assessed within the context of a business plan

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	6.00
2	Wageningen Universit	29.00
3	ESB	10.00
4	Accord Associates	3.00
5	SABmiller	3.00
6	UNAAB	18.00
7	FRI	20.00
8	FIIRO	11.00
9	NSTDA	16.00
10	St. Baasah Ghana Lim	6.00
11	Caltech Ventures	6.00
12	SBFT	15.00
13	Peak	6.00
14	Nobex	6.00
15	Sodia	6.00
16	Northeastern Starch	10.00
	Total	171.00

WT3:
Work package description

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D4.1	Development of methods for growing mushrooms from the waste cassava & yam peel	2	45.00	R	PU	18
D4.2	Development and validation of methods for turning peel into animal feed suitable (goats)	6	22.00	R	PU	20
D4.3	Development of methods for extracting starch and other nutrients from cassava peel	9	24.00	R	PU	24
D4.4	Development of methods for producing snack foods ingredients from waste from brewing cassava beer	5	14.50	R	RE	24
D4.5	Development of methods for scaling up mushroom production as commercial enterprises	2	23.00	R	PU	30
D4.6	Development of methods for turning waste from cassava beer production into snack food ingredients	5	16.50	R	RE	30
D4.7	Development of methods for scaling up production as commercial enterprises	4	16.00	R	PU	34
D4.8	Development and validation of methods for scaling up animal feed production (commercially viable)	6	10.00	R	PU	34
		Total	171.00			

Description of deliverables

D4.1) Development of methods for growing mushrooms from the waste cassava & yam peel: Methods at the laboratory scale for making food products from waste which is either in the form of food products, animal feeds or mushrooms made from composting waste developed. Methods for growing mushrooms from the waste from cassava peel (with or without added waste water developed, optimized and tested. [month 18]

D4.2) Development and validation of methods for turning peel into animal feed suitable (goats): Methods for turning cassava peel (with or without waste water) developed and various treatment tested based on the approach in sub-tast 4.2.1. [month 20]

D4.3) Development of methods for extracting starch and other nutrients from cassava peel: Methods based on the application of a suitable mixture of enzyme cocktails developed to produce granular starch or sugar syrup. Processes to produce cellulosic-based materials such as microcrystalline cellulose or cellulose nanocrystal for the application in food. [month 24]

D4.4) Development of methods for producing snack foods ingredients from waste from brewing cassava beer: Products produced from the waste from beer that have a high nutrient composition developed. Testing of these ingredients as snack foods and sensory and consumer testing undertaken. [month 24]

D4.5) Development of methods for scaling up mushroom production as commercial enterprises: Methods developed for scaling up and evaluated for suitability at both the household level and at large scales, suitable for SME's and hence develop new food chains. Business plan developed [month 30]

D4.6) Development of methods for turning waste from cassava beer production into snack food ingredients: Products produced from the waste from beer that have a high nutrient composition developed. Testing of these ingredients as snack foods and sensory and consumer testing undertaken. [month 30]

D4.7) Development of methods for scaling up production as commercial enterprises: Scaled up methods based on the process conditions and operations, nutritional properties, sensory parameters, rheological properties, processing, preservation and storage/packaging problems developed and assessed within the context of a viable business plana viable business plan. [month 34]

D4.8) Development and validation of methods for scaling up animal feed production (commercially viable): Best bet feeding supplements from subtasks 4.2.1 and 4.2.2 identified and evaluated for economic feasibility at pilot levels. Goat farms provided with feasible supplements to feed to selected weaner WAD goats over a six month period and data on the performance and growth parameters of each goats assessed. Economically viable recommended made. [month 34]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS2	Communication, dissemination and training strategy defined	1	9	Means of verification: D7.1
MS4	Value chain assessments completed	1	12	Survey complete and data quality validated. Means of verification: D1.1 and 1.2; 2.1
MS6	Options for mushroom production understood and economic viability as a business enterprise defined	2	18	Means of verification: D4.1, 4.2
MS7	Options for use of root crop peels for animal feed. determined	6	18	Means of verification: D4.4, 4.5
MS10	Options for development of other higher value products from wastes defined	5	24	Means of verification: D4.7 and 4.9
MS11	Food safety strategies defined	3	24	Annual Progress Report
MS18	Demonstration of selected waste production strategies with SMEs	6	33	Means of verification: D6.4
MS19	Dissemination of technologies capable of reducing post-harvest losses to SME's completed	1	34	Means of verification: Final Project Report

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP5	Type of activity [54]	RTD
Work package title	Food Safety, Quality and Compliance		
Start month	6		
End month	35		
Lead beneficiary number [55]	3		

Objectives

The overall objective of this work package is develop appropriate food safety and quality management systems for processing at the household and SME levels. This is important to ensure products comply with food safety criteria and meet appropriate food laws and regulations.

The specific objectives are:
1. Undertake baseline assessments for food safety.
2. Evaluate the prerequisite for food safety
3. Develop food safety management systems based on HACCP suitable for the household level
4. Develop food safety management systems based on HACCP suitable for the SME and larger scale level
5. Undertake follow up surveillance of the food safety management systems in terms of safety and economic factors

Description of work and role of partners

WP5 will ensure that the new higher value products from waste are safe and that appropriate food safety and quality management systems are in place. It will also ensure the safety and quality of products from WP3. The success of the project will depend on the development of viable enterprises (from household level, to SME and possibly larger) to market the value added products developed in WPs 3 and 4.

Different approaches to ensuring the quality of high quality cassava and yam flour in the value chain will be evaluated that can be carried out at the field level. Specific emphasis in the case of cassava will be placed on cyanogens content, but this one technique needs to form part of a package of measures that meet end users specifications as well as national and international standards where they exist.

The food safety approach will differ according to the scale of the enterprise because the capacity and capability will vary. At the household level of production capital investment will be minimal and the householders, particularly women, may have minimal levels of education. This requires tailored approaches to information sharing. SMEs, will have a larger scale of operation and access to more resources. Large scale enterprises will be expected to have their own HACCP teams in place already and hence not require support from this project.

Task 5.1. Undertake baseline assessment of perquisites for food safety for selected household and SME enterprises (ESB, UNAAB, FRI, SBFT)
A baseline assessment will be made of the production and processing system for a selection of households and SME's for each products from WP2, WP3 and WP4. This will be from harvesting of raw materials, handling and preparation for processing, processing, packaging, storage and marketing. This will identify stages in the chain that need to be managed in order to produce a safe product at a specified quality. Products will be assessed by using prerequisites and risk analysis tools.

Task 5.2. Develop food safety management systems appropriate to the household level (ESB, UNAAB, FRI, UoG-NRI)
Appropriate food safety management systems will be developed that are suitable for the household level. This will involve the pre-requisites from

Task 5.1 and application of a simplified HACCP plan based on that previously developed for street food vendors in Africa and Asia (ESP, UoG-NRI, FRI, UNAAB).

These will be based upon the requirements for general hygiene and Hazard Analysis and Critical Control Points principles (HACCP) described by CODEX but will not involve the requirement of expensive equipment to monitor the process.

Task 5.3. Develop food safety management systems appropriate to the SME level (ESB, UNAAB, FRI, SBFT)
Appropriate food safety management systems will be developed that are suitable for SME's. This will involve the pre-requisites and application of a simplified HACCP plan based on that previously developed for street food vendors in Africa and Asia or where . These will be based upon the requirements for general hygiene and Hazard Analysis and Critical Control Points principles (HACCP) described by CODEX.

Task 5.4. Develop food safety management systems appropriate to large scale enterprises (ESB, UNAAB, FRI, SBFT)
Appropriate food safety management systems will be recommended to any large scale business adopting these products. However, these organisations will already have a well established HACCP team and expected resources to monitor the processes. Therefore, the activities will be minor and advisory only. These will be based upon the requirements for general hygiene and Hazard Analysis and Critical Control Points principles (HACCP) described by CODEX. Food safety and quality requirements at this level will however implications for food safety and quality management at the household and SME levels.

Task 5.5 Undertake follow up surveillance of the appropriate quality management systems in terms of safety, quality and economic factors (ESB, UNAAB, FRI, SBFT)
Using the outcome of Tasks 5.2 and 5.3, the product production system will be monitored to measure improvement in identified areas of safety and quality.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	1.00
3	ESB	29.00
6	UNAAB	4.00
7	FRI	6.00
12	SBFT	3.00
	Total	43.00

List of deliverables

Deliverable Number [61]	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature [62]	Dissemination level [63]	Delivery date [64]
D5.1	Food safety baseline assessment	3	10.50	R	PU	8
D5.2	Develop HACCP based systems	3	20.00	R	PU	24
D5.3	Follow up surveillance of the quality management systems (safety, quality and economic factors)	3	12.50	R	PU	30
		Total	43.00			

Description of deliverables

D5.1) Food safety baseline assessment: Baseline assessment of the production and processing system for a selection of households and SME's for each products from WP2, WP3 and WP4 developed. Stages indentified in

the chain that need to be managed in order to produce a safe product at a specified quality. Products assessed by prerequisites and risk analysis tools. [month 8]

D5.2) Develop HACCP based systems: Appropriate food safety management systems developed that are suitable for the household level. Monitoring systems developed. [month 24]

D5.3) Follow up surveillance of the quality management systems (safety, quality and economic factors): Product production system monitored to measure improvements in identified areas of safety and quality. [month 30]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS5	Procedure for SME production of high quality yam flour defined for Ghana and Nigeria.	7	14	Means of verification: D3.1
MS6	Options for mushroom production understood and economic viability as a business enterprise defined	2	18	Means of verification: D4.1, 4.2
MS7	Options for use of root crop peels for animal feed. determined	6	18	Means of verification: D4.4, 4.5
MS10	Options for development of other higher value products from wastes defined	5	24	Means of verification: D4.7 and 4.9
MS11	Food safety strategies defined	3	24	Annual Progress Report

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP6	Type of activity [54]	DEM
Work package title	Demonstration of Technologies with Beneficiaries		
Start month	6		
End month	35		
Lead beneficiary number [55]	6		

Objectives

The overall objective of this WP is to support the demonstration of results and outcomes developed under the WP6 will in either rural settings (for example for improved storage technologies in collaboration with extension services) or in collaboration with SMEs. Lessons from these demonstration activities will serve to support wider dissemination of the technologies developed.
The specific objectives are
1. To demonstrate technologies suited to the household level to support improved food security e.g. improved yam storage.
2. To demonstrate technologies suited to SMEs to support income generation and strengthen the food chain specifically in the context of reduced post-harvest losses.
3. To demonstration technologies suited to larger enterprises to support income generation at the farm level and strengthen the food chain specifically in the context of reduced post-harvest losses.

Description of work and role of partners

From the results obtained in WP3 and WP4 on products developed, a minimum of three 'best bet' products will selected for further dissemination.

Task 6.1. Platform for South-South interaction and engagement
A web-based platform for south-south interaction and engagement between the project partners and other potential parties will be developed. This platform will be led by UNAAB. To promote this dialogue and interaction, the project will set up a Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free source e-learning software platform. An advantage for this project is that Moodle is free to use and hence can be cost-effective as a business model and will be sustainable beyond the duration of this project. The Moodle will be set up in association with the planned GRATITUDE web site.

Task 6.2. Selection of 'best bet' products (new and high value waste) (UOG-NRI, PRI-WAG, ESB-UCP, AA, SAB, UNAAB, FRI, FIIRO, NSTDA, SBGL, CV, SBFT, PP, NF, NS and SODIA)
The selection will be made according to the following criteria:
1. It must include at least one product from each category being a) a new product (WP3) and at least two higher value products derived from WP4 (mushrooms, animal feed, starches, syrups, snack foods)
2. The product is safe
3. The product is acceptable to consumers
4. It will be economically viable The selection will be taken at a workshop or if this is not possible, the PMC will take this decision

Task 6.3 Demonstration of improved storage technologies for yam from WP2 (UNAAB, FRI and SODIA).
The demonstration activities will be led by the beneficiaries of the potential new products because they will be in the best position to exploit them. They will be guided and advised by UNAAB or FRI under the overall leadership of UNAAB who have an excellent track record in demonstration activities from the C:AVA project and elsewhere.

Task 6.4. Demonstration of new products from WP3 (UNAAB, FRI, SBGL, CV, PP, NF, NS and SODIA; SAB, SBFT)
The demonstration activities will be led by the beneficiaries of the potential new products because they will be in the best position to exploit them. They will be guided by the national lead institutions (UNAAB, FRI, NSTDA

and SBFT) under the overall leadership of UNAAB who have an excellent track record in demonstration activities from the C:AVA project and elsewhere.

Task 6.5. Demonstration of new higher value products from waste derived in WP4 (UNAAB, SBGL, CV, PP, NF, NS and SODIA)
The demonstration activities will be led by the beneficiaries of the potential new products because they will be in the best position to exploit them. They will be guided by the national lead institutions (UNAAB, FRI, NSTDA and SBFT) under the overall leadership of UNAAB who have an excellent track record in demonstration activities from the C:AVA project and elsewhere.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	4.00
6	UNAAB	6.00
7	FRI	10.00
8	FIIRO	2.00
9	NSTDA	8.00
10	St. Baasah Ghana Lim	10.00
11	Caltech Ventures	10.00
12	SBFT	6.00
13	Peak	10.00
14	Nobex	10.00
15	Sodia	10.00
16	Northeastern Starch	16.00
	Total	102.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D6.1	Web-based platform for South-South interactions	6	3.00	O	PP	6
D6.2	Selection of products and enterprises chosen for the study	6	18.50	R	PU	15
D6.3	Demonstration of new products from WP2, WP3 and WP4	6	80.50	R	PU	33
		Total	102.00			

Description of deliverables

D6.1) Web-based platform for South-South interactions: A web-based platform based on Moodle or other appropriate software will be used to facilitate interactions between the south partners in the project. This will allow sharing of information and knowledge. [month 6]

D6.2) Selection of products and enterprises chosen for the study: Products selected according to the criteria established and include at least one product from each category being a) a new product (WP3) and at least two higher value products derived from WP4 (mushrooms, animal feed, starches, syrups, snack foods). Enterprises selected and based on track record, turnover, expertise and viability. [month 15]

D6.3) Demonstration of new products from WP2, WP3 and WP4: The demonstration activities will be led by the beneficiaries of the potential new products because they will be in the best Potential new products from each WP demonstrated under the guidance of national lead institutions. [month 33]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Communication, dissemination and training strategy defined	1	9	Means of verification: D7.1
MS16	Demonstration of yam storage technologies at field level	7	33	Means of verification: D6.2
MS17	Demonstration of processing options and waste product strategies completed	6	33	Means of verification: D6.3
MS18	Demonstration of selected waste production strategies with SMEs	6	33	Means of verification: D6.4
MS19	Dissemination of technologies capable of reducing post-harvest losses to SME's completed	1	34	Means of verification: Final Project Report

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP7	Type of activity [54]	OTHER
Work package title	Dissemination and Support to Replication		
Start month	1		
End month	36		
Lead beneficiary number [55]	1		

Objectives

The overall objective of this WP is to disseminate knowledge gained and lessons learned from the validation of the technologies to enable replication elsewhere and hence wider scale impact. This will involve consolidation of knowledge, packaging and disseminating information and training materials arising from the research and development activities of the project.
The specific objectives are:
1. To develop a strategic approach to information dissemination which will inform major stakeholders (researchers, academics, agricultural professionals, private sector companies and investors [including donor agencies]) about the project objectives, approaches, partnerships and outcomes.
2. To package and share information on options and techniques for reducing post-harvest losses of yam, for monitoring losses in the fresh product value chain, and for adding value through processing higher value products and new products from waste.
3. To consolidate experience and develop training packages on the reduction of post-harvest losses of yam; on adding value through processing and on new products which utilise cassava processing wastes, such as mushrooms, animal feeds, snack foods, starch and sugars.
4. To support training in business skill development, marketing of new products, food safety and quality assurance.
5. To promote lesson learning and information exchange among all partners and with a wider group of international stakeholders involved in food research, product marketing and policy making in developing countries and Europe

Description of work and role of partners

Led by UOG-NRI, this work package will draw on the contributions and the communications and capacity strengthening skills of all partners. Information and training materials will be prepared in appropriate formats for different audiences and different level of skills and literacy. A range of communication technologies and media skills will be used to reach different audiences through web sites, video, publications etc. The identification of training needs will include analysis of the institutional and business context of partners interested in developing these opportunities commercially in Ghana, Nigeria, Thailand and Vietnam.

Task 7.1 - Development of a communication, dissemination and training strategy (UOG-NRI, PRI-WAG, ESB-UCP, AA, SAB, UNAAB, FRI, FIIRO, NSTDA, SBGL, CV, SBFT, PP, NF, NS and SODIA)
This task will identify and prioritise target audiences and their information requirements relating to the technical. business and policy areas addressed within the project. It will define appropriate communication channels and formats for each audience (at national, regional and international levels), to be implemented throughout the project cycle. The task includes the monitoring of the implementation of the dissemination strategy and its results through collecting feedback on web site features, monitoring web hits and the distribution of publications and training materials. The initial strategy will be regularly updated with the progress of the work, including the publications produced and dissemination activities undertaken. Attention will be given to developing a dissemination strategy to maximize the potential impact on policy that this project might have. Policy impact will be disseminated at the national level in each partner country, at the regional level and at the international level (specifically the EU were appropriate).

Task 7.2 – Design and preparation of training materials and guidelines) (UOG-NRI, PRI-WAG, ESB-UCP, AA, SAB, UNAAB, FRI, FIIRO, NSTDA, SBGL, CV, SBFT, PP, NF, NS and SODIA)
These will respond to identified capacity development and training needs on utilisation of crop wastes for new products and the reduction of losses, targeted for different stakeholder audiences. Training and information materials will be developed on the major areas of the project's research. This task will be undertaken in close collaboration with the leaders of the other work packages that will develop the technical content, while this work package will add value in the production and promotion of the materials. Structured feedback from participants on the quality and usefulness of the training materials and training delivery will be sought at each stage.

Task 7.3 – Raise awareness of the project and its achievements through outreach using a range of media (UOG-NRI, PRI-WAG, ESB-UCP, AA, SAB, UNAAB, FRI, FIIRO, NSTDA, SBGL, CV, SBFT, PP, NF, NS and SODIA)
The formulation of key messages will be coordinated across project partners and participants. An initial activity will be the project launch and press releases and media coverage in the respective countries. Dissemination products will be developed in response to the communication strategy and audience developed under 7.1 and will include private sector investors and policy makers. Close links will be maintained with other work packages for preparation and dissemination of knowledge.

Further activities include;
• Construction of a project web site which will be regularly updated. It will make information accessible on the different research areas and specific country activities and events. Opportunities for interactive use of web based discussions etc. will be explored. The web site will also promote the training activities and materials, including those which are web-based or on CD rom/DVD.
• Publications and reports series; these will be produced in formats designed for different audiences. They will include formats for public outreach – such as newsletters, articles, case studies etc. and for more specialised professional audiences – technical publications, workshop reports etc.
• Visual communications: photographic records of project activities; video clips to use in information and training, presentations.

Efforts will be made to monitor the influence of the dissemination strategy through collecting feedback on web site features and monitoring web hits, distribution of publications etc. The visibility of the project as an EU funded programme will be consistently maintained.

Task 7.4 – Host a dissemination workshop with major stakeholders (UOG-NRI, PRI-WAG, ESB-UCP, AA, SAB, UNAAB, FRI, FIIRO, NSTDA, SBGL, CV, SBFT, PP, NF, NS and SODIA)
This will both enhance cross country learning among project partners and provide an important vehicle for sharing the project outputs more widely among major national and international stakeholders.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	8.00
2	Wageningen Universit	1.00
3	ESB	3.00
4	Accord Associates	1.00
6	UNAAB	7.00
7	FRI	15.00
9	NSTDA	2.00
10	St. Baasah Ghana Lim	1.00
11	Caltech Ventures	1.00
12	SBFT	3.00
13	Peak	1.00

WT3:
Work package description

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
14	Nobex	1.00
15	Sodia	1.00
16	Northeastern Starch	2.00
	Total	47.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D7.1	Web site, video, interactive media on project achievements and results	1	5.50	R	PU	5
D7.2	Initial project publicity information produced – press releases, briefs and handouts	1	6.00	R	PU	6
D7.3	Development of a communication, dissemination and training strategy	1	5.50	R	PU	9
D7.4	Communication, dissemination and training strategy- Mid term update	1	3.50	R	PU	18
D7.5	Training materials and guidelines designed and produced	1	18.00	R	PU	36
D7.6	Communication, dissemination and training strategy- Final Stage	1	3.00	R	PU	36
D7.7	Dissemination workshop with major stakeholders and publication of the proceedings	1	5.50	R	PU	36
		Total	47.00			

Description of deliverables

D7.1) Web site, video, interactive media on project achievements and results: Construction of a project web site which will be regularly updated. It will make information accessible on the different research areas and specific country activities and events. Opportunities for interactive use of web based discussions etc. will be explored. The web site will also promote the training activities and materials, including those which are web-based or on CD rom/DVD. [month 5]

D7.2) Initial project publicity information produced – press releases, briefs and handouts: The formulation of key messages will be coordinated across project partners and participants. An initial activity will be the project launch and press releases and media coverage in the respective countries. Dissemination products will be developed in response to the communication strategy and audience developed under 7.1 and will include private sector investors and policy makers. Close links will be maintained with other work packages for preparation and dissemination of knowledge. [month 6]

D7.3) Development of a communication, dissemination and training strategy: Identification and prioritisation of target audiences, particularly policy, and their information requirements relating to the technical and business areas addressed within the project. It will define appropriate communication channels and formats for each audience (at local (ie., householders, farmers and SME's), national, regional and international levels), to be

implemented throughout the project cycle. The influence of the dissemination strategy will be monitored through collecting feedback on web site features and monitoring web hits, the distribution of publications and feedback etc. The initial strategy (to be delivered in Month 6) will be regularly updated with the progress of the work, as the results evolve, but at least at month 18 (D 7.2) and 36 (D 7.6). The updates will also include success rate analysis and will indicate the new dissemination opportunities to be pursued. The strategy updates will also include a report on publications produced as well as updates relating to the training materials and guidelines designed and produced. The final strategy (D 7.6) will include a complete picture of all dissemination activities undertaken and most importantly providing information on the future steps to be taken after project end. The visibility of the project as an EU funded programme will be consistently maintained. [month 9]

D7.4) Communication, dissemination and training strategy- Mid term update: This will bring together the stategy for the purposes of the mid-term review and reporting [month 18]

D7.5) Training materials and guidelines designed and produced: Report on identified capacity development and training needs on utilisation of crop wastes for new products and the reduction of losses., targeted for different stakeholder audiences. Training and information materials will be developed on the major areas of the project's research. This task will be undertaken in close collaboration with the leaders of the other work packages that will develop the technical content, while this work package will add value in the production and promotion of the materials. Structured feedback from participants on the quality and usefulness of the training materials and training delivery will be sought at each stage. [month 36]

D7.6) Communication, dissemination and training strategy- Final Stage: Lessons learned from the project activities and outputs will be fed into the final stage of the communication, dissemination and training strategy [month 36]

D7.7) Dissemination workshop with major stakeholders and publication of the proceedings: This will both enhance cross country learning among project partners and provide an important vehicle for sharing the project outputs more widely among major national and international stakeholders. [month 36]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS1	Website (project and moodle) is operational	1	5	Means of verification: Deliverable 7.4
MS2	Communication, dissemination and training strategy defined	1	9	Means of verification: D7.1
MS14	Dissemination of best strategies for reducing losses in fresh yam in Ghana and Nigeria identified	7	30	Means of verification: D2.6
MS19	Dissemination of technologies capable of reducing post-harvest losses to SME's completed	1	34	Means of verification: Final Project Report

WT3:
Work package description

Project Number [1]	289843	Project Acronym [2]	Gratitude

One form per Work Package

Work package number [53]	WP8	Type of activity [54]	MGT
Work package title	Management and Monitoring and Evaluation		
Start month	1		
End month	36		
Lead beneficiary number [55]	1		

Objectives

1. Ensure proper coordination of scientific, human and financial resources
2. Coordination and integration between the work package activities
3. Ensure the appropriate functioning and effectiveness of the project management committee
4. Ensure full and timely reporting to the EU
5. Undertake monitoring and evaluation activities to ensure delivery of project milestones

Description of work and role of partners

This WP will be undertaken by UoG-NRI. Funding will be provided to cover the inputs of the Project Coordinator, Administrative Staff and for the direct costs of the Annual Review meetings. This WP is related to non-scientific coordination and management of the project activities.The scientific coordination and/ or management tasks and costs linked thereto are reimbursed according to the funding rate of the RTD type of activity. Only administrative and financial coordination and/or management can be reimbursed according to the funding rate of the MGT type of activity.

Task 8.1: Project coordination
Activities will be monitored, through an established monitoring and evaluation mechanism, along established lines of communication, principally with WP Leaders – mainly by e-mail and visits to each beneficiary. The Project Coordination and Support Office in Chatham will be supported by NRI scientific staff as necessary. NRI will be assisted by specialists from each of the beneficiary organisations to ensure coherence issues that cross WPs. Country Managers will ensure coordination at a national level.

Legal, contractual, financial and administrative activities will be coordinated through the Project Coordination and Support Office.

Consortium partnerships will be developed and monitored through established communications channels, reporting, meetings and visits in the region.

Organisation of the scientific and administrative meetings will be initiated at a kick off meeting. Annual review meetings (involving the Project Management Committee and Project Partners) will be held, but the Project Management Committee will also meet regularly on a virtual basis using electronic communications (see below).

Ethical issues will be monitored throughout the project as described in part B.4. NRI has a code of practice on Ethics to cover interview technique and provide ethical screening. Ethical issues of a deeper level will be assessed by the University of Greenwich Research Ethics Committee and local ethics committees of partner organisations as required.

Agreements will be put in place for the management of intellectual property with month 1 of the project starting.

Task 8.2: Managing planning, implementation and reporting:
Under the leadership of the Project Coordinator, the Project Management Committee will manage the planning, implementation and reporting procedures at all project levels through regular planning and review meetings focussing at WP level and through the annual planning and review meetings within the project mentioned above. Management reviews will focus on two elements. Attainment to plan (did we do what we planned to do) and performance (did it work). Management will be based on the principle of positive feedback: Reporting on

implementation will advise planning, which in turn will advise implementation. Reports will be submitted to the Commission according to agreed schedules.

Linkages with pertinent on-going external projects. The project will seek contacts with pertinent EC desks in order to inform and link with other activities. The Project Management Committee will also play a role in this. Contact with ongoing European projects, for example the EU ACP Science and Technology Programme project on tropical root and tubers; Bill and Melinda Gates Foundation C:AVA project etc. Are vital to the success of the project.

Task 8.3: Monitoring and evaluation
A project monitoring and evaluation system will be developed during the initial stage of the project in order to assess project progress and impact. We will develop a set of indicators based on the project objectives, activities, deliverables and milestones as identified in the proposal. WP coordinators will be asked to report every 6 months on project progress against these progress indicators. Monitoring activities will be conducted at two levels:

• Evaluation of project progress: Regular monitoring of progress of project outputs and outcomes against indicators and milestones, and expenditures. This will enable the project management to assure the delivery of project outcomes and adapt project activities if needed.

• Monitoring of changes in post-harvest losses of direct project beneficiaries (SMEs): The initial project activities (in particular WP1) will provide information on the baseline conditions of post-harvest losses. Following the development of practices and technologies to reduce post-harvest losses in WPs 2-5, these practices will be disseminated amongst the participating SMEs in WP6. Uptake and impact of these practices will be monitored, including the levels of participation of men, women and youth in the development and adoption of technologies and the outcomes experienced by different groups.

Person-Months per Participant

Participant number [10]	Participant short name [11]	Person-months per participant
1	UoG-NRI	16.00
	Total	16.00

List of deliverables

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D8.1	Kick-Off Meeting	1	3.00	R	PU	3
D8.2	Project Management Committee	1	4.00	R	PU	5
D8.3	Project Management Committee meeting	1	9.00	R	PU	36
		Total	16.00			

Description of deliverables

D8.1) Kick-Off Meeting: Project meeting minutes will be prepared after the corresponding meeting. These meetings will be under the leadership of the Project Coordinator and the Project Management Committee. Planning and review meetings will focus at WP level including deliverables and milestones and budgeting. Reporting on implementation will advise planning, which in turn will advise implementation. [month 3]

D8.2) Project Management Committee: Under the leadership of the Project Coordinator, the Project Management Committee will manage the planning, implementation and reporting procedures at all project levels through regular planning and review meetings focussing at WP level and through the annual planning

and review meetings within the project mentioned above. Management reviews will focus on two elements. Attainment to plan (did we do what we planned to do) and performance (did it work). Management will be based on the principle of positive feedback: Reporting on implementation will advise planning, which in turn will advise implementation. Reports will be submitted to the Commission according to agreed schedules. [month 5]

D8.3) Project Management Committee meeting: Project meeting minutes will be prepared after the corresponding meetings and delivered at 13, 25 and 36 months. These meetings will be under the leadership of the Project Coordinator and the Project Management Committee. Planning and review meetings will focus at WP level including deliverables and milestones and budgeting. Reporting on implementation will advise planning, which in turn will advise implementation. [month 36]

Schedule of relevant Milestones

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS3	Ethical approvals completed and agreed by the University of Greenwich Research Ethics Committee	1	12	Continuous monitoring during the project

WT4:
List of Milestones

Project Number [1]	289843	Project Acronym [2]	Gratitude

List and Schedule of Milestones

Milestone number [59]	Milestone name	WP number [53]	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS1	Website (project and moodle) is operational	WP7	1	5	Means of verification: Deliverable 7.4
MS2	Communication, dissemination and training strategy defined	WP1, WP3, WP4, WP6, WP7	1	9	Means of verification: D7.1
MS3	Ethical approvals completed and agreed by the University of Greenwich Research Ethics Committee	WP8	1	12	Continuous monitoring during the project
MS4	Value chain assessments completed	WP1, WP2, WP3, WP4	1	12	Survey complete and data quality validated. Means of verification: D1.1 and 1.2; 2.1
MS5	Procedure for SME production of high quality yam flour defined for Ghana and Nigeria.	WP1, WP2, WP3, WP5	7	14	Means of verification: D3.1
MS6	Options for mushroom production understood and economic viability as a business enterprise defined	WP1, WP4, WP5	2	18	Means of verification: D4.1, 4.2
MS7	Options for use of root crop peels for animal feed. determined	WP1, WP1, WP1, WP4, WP5	6	18	Means of verification: D4.4, 4.5
MS8	Post-harvest characteristics of key yam varieties	WP2	1	20	Means of verification is Deliverable 2.2
MS9	Innovations in cassava (yam) drying defined.	WP3	6	20	Means o Verification: Deliverable 3.4
MS10	Options for development of other higher value products from wastes defined	WP1, WP4, WP5	5	24	Means of verification: D4.7 and 4.9

WT4:
List of Milestones

Milestone number [59]	Milestone name	WP number [53]	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS11	Food safety strategies defined	WP3, WP4, WP5	3	24	Annual Progress Report
MS12	Commercial opportunities for cassava and yam defined	WP1, WP3	4	24	Means of verification: Annual progress reports towards deliverables 3.5 and 3.6
MS13	Package of best strategies for on-farm yam storage defined for intervention	WP2	7	28	Means of Verification: Annual progress reports leading to deliverables 2.3, 2.4 and 2.5
MS14	Dissemination of best strategies for reducing losses in fresh yam in Ghana and Nigeria identified	WP1, WP7	7	30	Means of verification: D2.6
MS15	Demonstration of production of yam flour in Ghana and Nigeria completed	WP1, WP3	7	30	Means of verification: Deliverables associated with WP6
MS16	Demonstration of yam storage technologies at field level	WP6	7	33	Means of verification: D6.2
MS17	Demonstration of processing options and waste product strategies completed	WP1, WP3, WP6	6	33	Means of verification: D6.3
MS18	Demonstration of selected waste production strategies with SMEs	WP1, WP4, WP6	6	33	Means of verification: D6.4
MS19	Dissemination of technologies capable of reducing post-harvest losses to SME's completed	WP3, WP4, WP6, WP7	1	34	Means of verification: Final Project Report

WT5:
Tentative schedule of Project Reviews

Project Number [1]	289843	Project Acronym [2]	Gratitude

Tentative schedule of Project Reviews

Review number [65]	Tentative timing	Planned venue of review	Comments, if any
RV 1	21	NSTDA, Thailand	This is a mid project review
RV 2	35	FRI, Ghana	This is the final project review

WT6:
Project Effort by Beneficiary and Work Package

Project Number [1]	289843	Project Acronym [2]	Gratitude

Indicative efforts (man-months) per Beneficiary per Work Package

Beneficiary number and short-name	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	WP 8	Total per Beneficiary
1 - UoG-NRI	11.00	24.00	8.50	6.00	1.00	4.00	8.00	16.00	78.50
2 - Wageningen Universit	0.00	0.00	0.00	29.00	0.00	0.00	1.00	0.00	30.00
3 - ESB	0.00	0.00	0.00	10.00	29.00	0.00	3.00	0.00	42.00
4 - Accord Associates	0.00	0.00	3.00	3.00	0.00	0.00	1.00	0.00	7.00
5 - SABmiller	0.00	0.00	8.00	3.00	0.00	0.00	0.00	0.00	11.00
6 - UNAAB	8.00	18.00	16.00	18.00	4.00	6.00	7.00	0.00	77.00
7 - FRI	11.00	29.00	26.00	20.00	6.00	10.00	15.00	0.00	117.00
8 - FIIRO	0.00	0.00	0.00	11.00	0.00	2.00	0.00	0.00	13.00
9 - NSTDA	6.00	0.00	14.00	16.00	0.00	8.00	2.00	0.00	46.00
10 - St. Baasah Ghana Lim	0.00	0.00	6.00	6.00	0.00	10.00	1.00	0.00	23.00
11 - Caltech Ventures	0.00	0.00	6.00	6.00	0.00	10.00	1.00	0.00	23.00
12 - SBFT	6.00	0.00	25.00	15.00	3.00	6.00	3.00	0.00	58.00
13 - Peak	0.00	0.00	6.00	6.00	0.00	10.00	1.00	0.00	23.00
14 - Nobex	0.00	0.00	6.00	6.00	0.00	10.00	1.00	0.00	23.00
15 - Sodia	0.00	0.00	6.00	6.00	0.00	10.00	1.00	0.00	23.00
16 - Northeastern Starch	0.00	0.00	10.00	10.00	0.00	16.00	2.00	0.00	38.00
Total	42.00	71.00	140.50	171.00	43.00	102.00	47.00	16.00	632.50

WT7:
Project Effort by Activity type per Beneficiary

Project Number [1]	289843	Project Acronym [2]	Gratitude

Indicative efforts per Activity Type per Beneficiary

Activity type	Part. 1 UoG-NRI	Part. 2 Wagenin	Part. 3 ESB	Part. 4 Accord	Part. 5 SABmill	Part. 6 UNAAB	Part. 7 FRI	Part. 8 FIIRO	Part. 9 NSTDA	Part. 10 St. Baa	Part. 11 Caltech	Part. 12 SBFT	Part. 13 Peak	Part. 14 Nobex
1. RTD/Innovation activities														
WP 1	11.00	0.00	0.00	0.00	0.00	8.00	11.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00
WP 2	24.00	0.00	0.00	0.00	0.00	18.00	29.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WP 3	8.50	0.00	0.00	3.00	8.00	16.00	26.00	0.00	14.00	6.00	6.00	25.00	6.00	6.00
WP 4	6.00	29.00	10.00	3.00	3.00	18.00	20.00	11.00	16.00	6.00	6.00	15.00	6.00	6.00
WP 5	1.00	0.00	29.00	0.00	0.00	4.00	6.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00
Total Research	50.50	29.00	39.00	6.00	11.00	64.00	92.00	11.00	36.00	12.00	12.00	49.00	12.00	12.00
2. Demonstration activities														
WP 6	4.00	0.00	0.00	0.00	0.00	6.00	10.00	2.00	8.00	10.00	10.00	6.00	10.00	10.00
Total Demo	4.00	0.00	0.00	0.00	0.00	6.00	10.00	2.00	8.00	10.00	10.00	6.00	10.00	10.00
3. Consortium Management activities														
WP 8	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Management	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Other activities														
WP 7	8.00	1.00	3.00	1.00	0.00	7.00	15.00	0.00	2.00	1.00	1.00	3.00	1.00	1.00
Total other	8.00	1.00	3.00	1.00	0.00	7.00	15.00	0.00	2.00	1.00	1.00	3.00	1.00	1.00
Total	78.50	30.00	42.00	7.00	11.00	77.00	117.00	13.00	46.00	23.00	23.00	58.00	23.00	23.00

WT7:
Project Effort by Activity type per Beneficiary

Activity type	Part. 15 Sodia	Part. 16 Northea	Total
1. RTD/Innovation activities			
WP 1	0.00	0.00	42.00
WP 2	0.00	0.00	71.00
WP 3	6.00	10.00	140.50
WP 4	6.00	10.00	171.00
WP 5	0.00	0.00	43.00
Total Research	12.00	20.00	467.50
2. Demonstration activities			
WP 6	10.00	16.00	102.00
Total Demo	10.00	16.00	102.00
3. Consortium Management activities			
WP 8	0.00	0.00	16.00
Total Management	0.00	0.00	16.00
4. Other activities			
WP 7	1.00	2.00	47.00
Total other	1.00	2.00	47.00
Total	23.00	38.00	632.50

WT8:
Project Effort and costs

Project Number [1]	289843	Project Acronym [2]	Gratitude

Project efforts and costs

Benefi-ciary number	Beneficiary short name	Estimated eligible costs (whole duration of the project)						Total receipts (€)	Requested EU contribution (€)
		Effort (PM)	Personnel costs (€)	Subcontracting (€)	Other Direct costs (€)	Indirect costs OR lump sum, flat-rate or scale-of-unit (€)	Total costs		
1	UoG-NRI	78.50	422,429.00	12,690.00	150,000.00	343,457.40	928,576.40	0.00	763,630.00
2	Wageningen	30.00	145,350.00	0.00	90,575.00	103,414.00	339,339.00	0.00	263,374.00
3	ESB	42.00	94,161.00	0.00	79,658.00	104,291.40	278,110.40	0.00	218,519.00
4	Accord Ass	7.00	47,000.00	0.00	22,500.00	41,700.00	111,200.00	0.00	91,800.00
5	SABmiller	11.00	104,166.00	0.00	0.00	20,833.20	124,999.20	0.00	62,499.00
6	UNAAB	77.00	157,500.00	2,700.00	156,000.00	188,100.00	504,300.00	0.00	386,300.00
7	FRI	117.00	115,625.00	0.00	176,000.00	174,975.00	466,600.00	0.00	350,850.00
8	FIIRO	13.00	30,000.00	0.00	35,500.00	39,300.00	104,800.00	0.00	74,800.00
9	NSTDA	46.00	115,000.00	0.00	171,484.00	29,541.00	316,025.00	0.00	233,747.00
10	St. Baasah	23.00	14,750.00	0.00	18,600.00	20,010.00	53,360.00	0.00	34,860.00
11	Caltech Ve	23.00	14,750.00	0.00	18,600.00	20,010.00	53,360.00	0.00	34,860.00
12	SBFT	58.00	76,200.00	0.00	165,500.00	48,340.00	290,040.00	0.00	219,240.00
13	Peak	23.00	14,750.00	0.00	18,600.00	6,670.00	40,020.00	0.00	24,270.00
14	Nobex	23.00	12,000.00	0.00	18,600.00	18,360.00	48,960.00	0.00	32,360.00
15	Sodia	23.00	14,750.00	0.00	18,600.00	6,670.00	40,020.00	0.00	24,270.00
16	Northeaste	38.00	12,280.00	0.00	20,925.00	20,223.00	53,428.00	0.00	35,034.00
	Total	632.50	1,390,711.00	15,390.00	1,161,142.00	1,185,895.00	3,753,138.00	0.00	2,850,413.00

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It cannot be changed unless agreed so during the negotiations. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

53. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

54. Type of activity

For all FP7 projects each work package must relate to one (and only one) of the following possible types of activity (only if applicable for the chosen funding scheme – must correspond to the GPF Form Ax.v):

• **RTD/INNO =** Research and technological development including scientific coordination - applicable for Collaborative Projects and Networks of Excellence

• **DEM =** Demonstration - applicable for collaborative projects and Research for the Benefit of Specific Groups

• **MGT =** Management of the consortium - applicable for all funding schemes

• **OTHER =** Other specific activities, applicable for all funding schemes

• **COORD =** Coordination activities – applicable only for CAs

• **SUPP =** Support activities – applicable only for SAs

55. Lead beneficiary number

Number of the beneficiary leading the work in this work package.

56. Person-months per work package

The total number of person-months allocated to each work package.

57. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

58. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

59. Milestone number

Milestone number:MS1, MS2, …, MSn

60. Delivery date for Milestone

Month in which the milestone will be achieved. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

61. Deliverable number

Deliverable numbers in order of delivery dates: D1 – Dn

62. Nature

Please indicate the nature of the deliverable using one of the following codes

R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

63. Dissemination level

Please indicate the dissemination level using one of the following codes:

• **PU =** Public

• **PP =** Restricted to other programme participants (including the Commission Services)

• **RE =** Restricted to a group specified by the consortium (including the Commission Services)

• **CO =** Confidential, only for members of the consortium (including the Commission Services)

• **Restreint UE =** Classified with the classification level "Restreint UE" according to Commission Decision 2001/844 and amendments

• **Confidentiel UE =** Classified with the mention of the classification level "Confidentiel UE" according to Commission Decision 2001/844 and amendments

• **Secret UE =** Classified with the mention of the classification level "Secret UE" according to Commission Decision 2001/844 and amendments

64. Delivery date for Deliverable

Month in which the deliverables will be available. Month 1 marking the start date of the project, and all delivery dates being relative to this start date

65. Review number

Review number: RV1, RV2, ..., RVn

66. Tentative timing of reviews

Month after which the review will take place. Month 1 marking the start date of the project, and all delivery dates being relative to this start date.

67. Person-months per Deliverable

The total number of person-month allocated to each deliverable.

2. PART B

Contents

Acronyms and abbreviations

ACCA	Association of Chartered Certified Accountants
ACP	Africa Caribbean Pacific
AFTER	African Food Tradition Revisited by Research project
AIDLINK	Irish International Non-Governmental Organisation
AIDS	Acquired Immune Deficiency Syndrome
BAT	Best Available Technique
BMGF	Bill and Melinda Gates Foundation
BSG	Brewer's spent grain
C:AVA	Cassava: Adding Value for Africa
CBQF	Centre for Biotechnology and Fine Chemistry
CEO	Chief Executive Officer
CM	Country Manager
CSTRU	Cassava and Starch Technology Research Unit
CV	Caltech Ventures
DANIDA	Danish International Development Agency
DEG	Deutsche Investitiions- und Entwicklungsgesellschaft
DEM	Demonstration
DFID	UK Department for International Development
DVD	Digital Video Disc
EC	European Commission
EEC	European Economic Community
ESB-UCP	Escola Superior de Biotecnologia – Universidade Católica Portuguesa
EU	European Union
EULAFF	European Federation of Biotechnology Latin America Action on Functional Foods
FAO	Food and Agriculture Organization
FIIRO	Federal Institute of Industrial Research, Oshodi
FM	Frequency Modulation
FP7	Framework Programme 7
FRI	Food Research Institute
GHC	Ghanaian currency
GRUB'UP	Recycling and Upgrading Wastes from Food Production for use within the Food Chain
GSHE	Granular Starch Hydrolyzing Enzyme
HACCP	Hazard Analysis and Critical Control Points
HQCF	High Quality Cassava Flour
HUST	Hanoi University of Science and Technology
IBIS	Independent Danish development organisation
IDRC	International Development Research Centre
IFAD	International Fond for Agricultural Development

IFC	International Finance Corporation
IITA	International Institute of Tropical Agriculture
INSOLEX	Innovative Solutions for Extracting High Value Natural Compounds
ISO	International Organization for Standardization
MBA	Master of Business and Administration
MD	Managing Director
MGT	Management of the consortium
MiDA	Millennium Development Authority
NF	Nobex Foods
NGO	Non Governmental Organisation
UoG-NRI	Natural Resources Institute, University of Greenwich
NSDTA	National Science and Technology Development Agency
NSCL	Northeastern Starch (1987) Co., Ltd
PC	Project Coordinator
PMC	Project Management Committee
PP	Peak Products
Wageningen Universit	Stichting DLO, Wageningen
PSCO	Project Coordination and Support Office
RTC	Roots and Tuber Crops
RTG	Research and Technological Development
RTIMP	Root and Tuber Improvement and Marketing Programme
SABMILLER	SAB Miller plc
SBFT	School of Biological and Food Technology
SBGL	St. Baasah Ghana Limited
SME	Small Medium Enterprise
SODIA	Social Development and Improvement Agency
TRUEFOOD	Traditional United Europe Food
TTSA	Thai Tapioca Starch Association
UK	United Kingdom
UNAAB	University of Agriculture
UNDP	United Nations Development Programme
UNIDO	United Nation Industrial Development Organization
UoG	University of Greenwich
WAD	West African Dwarf
WP	Work Package

B1. Concept and objectives, progress beyond state-of-the-art, S/T methodology and work plan

B 1.1 Concept and project objective(s)

Concept

Cassava and yams are important food security crops in much of sub-Saharan Africa and also in Asia because their presence in the cropping system increases the resilience of farmers in the face of climate change, drought, and fluctuations in the price of durable commodities. Post-harvest losses of cassava and yams are significant and come in three forms: (a) physical losses; (b) economic losses through discounting or the need to process into low value products rather than selling fresh or (c) from the bio-wastes such as the peels of the roots.

This project aims to reduce these three types of post-harvest losses in order to enhance the role that these crops play in food and income security for small-holder households. Cassava and yam are amongst the most important root crops, but differ in terms of their sale as fresh produce, the importance of storage and the scale and importance of processing. This project will use these differences to develop a comprehensive approach to reducing post-harvest losses with lessons that could be applied to other perishable commodities, delivering outputs that will benefit millions of producing and consuming households across the developing world.

A key approach to this project is to address both technical and socio-economic aspects of losses and waste management. The development of the entrepreneurial capacities of small and medium-scale enterprises is important to manage and profit from waste management. Managing food losses and waste in less developed countries offers the potential to improve livelihoods, which can contribute to rural development, poverty reduction and food security. In Ghana and Nigeria, women play an important role in the processing, storage and marketing of cassava and yam. There are potential benefits to poor women and women headed households through improved efficiency and profitability of their processing enterprises and through the employment opportunities created. The project will take account of gender relations in the household, exploring the impacts of new food products, technologies and training on workloads, time, access and control over resources, and meeting livelihood needs. Assessment of the labour demands and investment levels in relation to new products is important in this context. Over the past few years, the rise and expansion of integrated supply chains, and the renewed emphasis on efficiency and food safety, has spurred a major paradigm shift in the way the post-harvest system, including processing, is conceived from a series of individual components to an integrated value chain linking producers, intermediaries and consumers. By adopting a value chain approach to post-harvest loss reduction and managing wastes, a clearer picture of the various participants and benefits derived along the value chain emerges, so that sustainable and cost-effective solutions can be implemented.

An important aspect of the project will be on south-south learning – with joint activities between research partners in sub-Saharan Africa and Asia where the situations are different but may offer opportunities for common learning and accelerated impact. In terms of the comprehensiveness of the approach, technologies and systems will be developed, validated, demonstrated and more widely disseminated that focus benefits on small-holder households whilst offering increased income earning opportunities through the development of small to medium scale enterprises and provide an example of a linkage to a large scale user of

cassava. These different avenues not only contribute to the comprehensiveness of the approach, but also offer a diverse set of leaning opportunities.

Including Asian partners in the consortium adds to the comprehensiveness of the project approach in that it enables the project to take a more holistic view of post-harvest losses within the context of global food security. Including Thailand and Vietnam allows post-harvest losses to be addressed within the context of the food versus biofuel (bioethanol) debate and in terms of the substitutability of commodities in the face of global commodity price increases, which in part is influenced by the substitutability of commodities. Cassava in Asia is likely to be better able to produce reliable yields in the face of climate change and be able to substitute for imported or more expensive commodities having therefore national impact on food security. Reducing physical losses, economic losses and losses due to waste is likely to have a major positive impact.

A critical mass of partners with complementary skills from Africa (Ghana and Nigeria), Asia (Thailand and Vietnam) and the EU (UK, Portugal, and the Netherlands) has been assembled that includes researchers, the private sector and extension services. This project will build on a previous EC-funded Framework 5 project (CASSAVA-SMES) that resulted in viable cassava-based enterprises producing value added forms of traditional cassava products and high quality cassava flour, and will work in collaboration with an on-going project on the commercialisation of cassava (in the form of high quality cassava flour) funded by the Bill and Melinda Gates Foundation in the Cassava: Adding Value for Africa Project (C:AVA; http://cava.nri.org/). There will also be a linkage with work on capacity building of root and tuber crop researchers funded by the ACP Science and Technology Programme (FED/2009/217073). These linkages create the critical mass to have significant impact and wide dissemination.

Tropical root crops are an increasingly important component of agricultural systems in much of the developing world. They are important food security crops for more than 700 million people. They provide an important part of the diet as they produce more edible energy per hectare per day than any other crop group. In addition, they meet local food preferences, and are important sources of income through direct sale and processing.

Post-harvest physical losses are exceptionally high: in the order of 30% for cassava and 60% for yam. These losses can occur throughout the post-harvest value chain. Losses in economic value of root crops can also be very high. Due to the poor shelf life of fresh cassava (usually less than 2-3 days), the discounting of fresh roots after harvest can be as high as 85% within a couple of days. Wastes can come in various forms e.g. peeling losses can be as high 15-20%. In small-scale processing, these peels from either cassava or yams are largely unused by factories and add to their operating costs through the need for disposal. In several cases, waste from possible processing opportunities has no economic value and this can make the processing itself a marginal or non-viable business proposition.

The project has three main impact pathways:

1. Reduction of physical losses – mainly focussing on losses of yams in storage.
2. Value addition through processing as a means of reducing both post-harvest losses and economic losses though providing alternative opportunities to storage or sale of fresh roots, which could be applied to either yams or cassava. Products could range from high quality yam flour or cassava flour for expanding urban markets and other value added products. Value addition for root and tuber crops requires an improved understanding of management of the crop at household level.
3. Through the improved utilisation of wastes, specifically peels from cassava and yam.

Understanding decision making in terms of how to deal with tropical root and tuber crops will be an important feature of the project – for example in the relative benefits of undertaking

processing compared with, for example, storage of fresh tuber as strategies for reducing losses.

Figure 1 illustrates the existing value chain for yam, as an example, and how addressing the researchable issues followed by demonstration and wider dissemination will help to expand the value chain into new areas thereby reducing post-harvest losses and increasing value of waste.

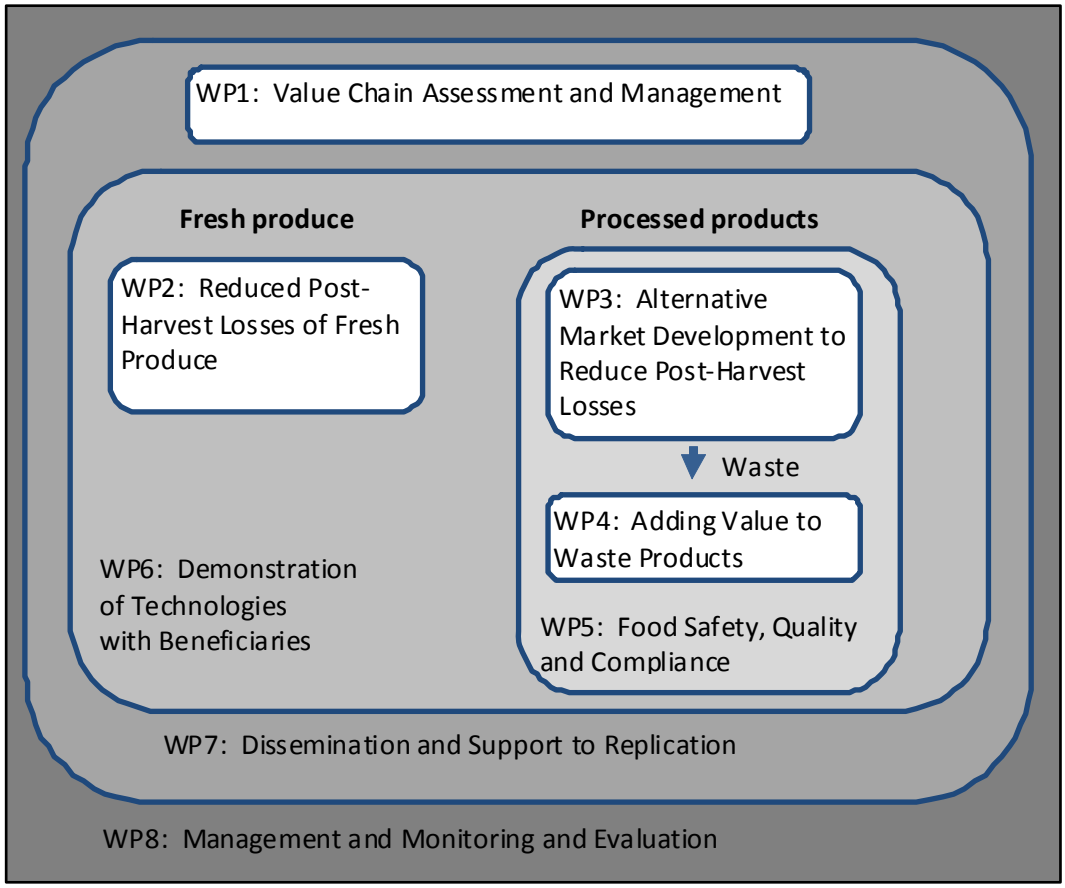


Figure 1. Work packages description for the project 'GRATITUDE'

Objectives

The **overall objective** of GRATITUDE (Gains from Losses of Root and Tuber Crops) is to improve the post-harvest management of cassava and yams leading to reduced physical losses, reduced economic losses through value-added processing and valorisation of waste products.

The project has the following **general objectives**

1. Reduce physical post-harvest losses of fresh produce (focussing mainly on yams).
2. Reduce economic losses through value added processing (focussing on both cassava and yams).
3. Valorise wastes from the value chain (focussing mainly on cassava).

The project has the following **specific objectives**:

1. To evaluate the value chains for cassava and yams within the context of their role in food security.
2. To benchmark the post-harvest improvements against each other and the initial levels of loss.
3. To develop and validate technologies for reducing losses by up to 50% in fresh produce focussing specifically on yams based on increasing their shelf life and dormancy.
4. To develop and validate improved processing and utilisation options for cassava and yam to reduce economic post-harvest losses.
5. To add value to wastes from the cassava and yam value chains (peels, liquid waste, spent brewery waste) producing products for human consumption.
6. To ensure the quality and safety of products from the value chain.
7. To support enterprise development to ensure the sustainable uptake of interventions through demonstration activities of technologies and product development.
8. To share appropriate technologies amongst the food actors and more widely to encourage similar approaches in different parts of the world and extension to other commodities.

The quantifiable impact of these interventions will be to develop and validate technologies capable of reducing post-harvest losses by the equivalent of 50%. This will be benchmarked as part of one of the work packages. The target has been set at the equivalent of 50% to take into account the adding value activities in some of the work packages.

Beyond these direct results, the lessons learnt and the methodologies for the assessment of reducing losses and increasing the value of what are currently waste products will be shared with other countries from all continents, and also with other groups of countries (Asia, South America) in order to disseminate the results among the research community involved in food research in developing countries.

These general and specific objectives specially address the call by addressing post-harvest losses of major food crops by taking a comprehensive approach involving a range of technologies and involving a wide range of potential stakeholders. It specifically addresses the dual issues of post-harvest losses and generating higher value products from bio-waste whist addressing issues of the quality and safety of food. The approach allows the benchmarking of the improvements achieved by different approaches. Demonstration activities with farmers through NGOs, SMEs and other relevant stakeholders in the agri-food chain will be carried out in each of the focus developing countries. South-south networking and links with European centres of excellence and wide dissemination of findings will ensure contributions to mutual interest and shared benefit. Important lessons on the impact on different approaches to reducing losses of major crops and the role of SMEs, and large businesses/market opportunities may well have lessons within Europe also.

B 1.2 Progress beyond the state of the art

Cassava and yam in food security

Root and Tuber crops (RTC) such as cassava and yam are increasingly becoming important in the food systems of the developing countries. The world production of cassava is 228 million tons (mt) and yams 52mt. The world production of RTC has steadily increased from 688mt in 2001 to 740mt in 2007 (FAOSTAT, 2008). The volume of production and large amount of contribution to calories and nutrition per unit area that come from cassava and yam make them a viable panacea to poverty alleviation and food security in developing countries. As a group of crops they meet local food preferences, provide an important part of the diet as they produce more edible energy per hectare per day than any other crop groups and provide important sources of income through direct sale and processing. This enables cassava and yam to contribute to food security. Significant improvement had been achieved on production of root and tuber crops these last decades but rather than focusing almost entirely on production issues, research should also explore post-harvest losses reduction, better processing technologies, value addition of waste and marketing techniques with a view to helping farmers and actors in the value chain increase their incomes, improve quality of life, nutrition and sustained food security.

Recent analysis shows that cassava in particular is expected to play an increasing role in stabilising food consumption and supporting food security (International Development Working Paper –, Michigan State University, November 7, 2008). It is anticipated that by 2020, more than two billion people in Asia, Africa, and Latin America will depend on RTC's for food, feed, or income (Scott *et al*., 2000), with a great proportion of them very poor. Putting this in perspective, the current global population is ~ 6.7 billion. As population increases in these areas more and more RTC would need to be produced for both on-farm consumption and for sale in local markets for urban consumption. Cereals have been a competitor to RTC but now in some trouble creating more opportunity for RTC. Relative to cereals RTC are expected to take on a greater burden in supplying world's basic foods (basically carbohydrates and bulk in the diet), especially in the tropical and sub-tropical regions of Africa, central and South America, Asia and the South Pacific Island Countries.

Post-harvest losses in cassava and yams

The reduction of post-harvest losses and the transformation of roots and tubers into various forms for food, feed, and industrial raw material has the potential to help developing countries improve food security, create additional value in rural settings, generate income and employment and develop a more favourable balance of trade.

A main constraint with RTC is the amount of post-harvest losses generated. Post-harvest losses are a problem because of their high perishability especially under tropical conditions (high temperatures) that accelerate the physiological process of deterioration.

Post-harvest losses of cassava

Post-harvest losses can occur in the fresh product food chain and during processing. In the fresh food chain, the rapid post-harvest deterioration of cassava restricts the storage potential of the fresh root to 2-3 days. Two types of post-harvest deterioration are established: primary physiological deterioration that involves internal discoloration that is the initial cause of loss of market acceptability and second deterioration due to microbial spoilage (Booth and Coursey 1974). According to various estimations post-harvest losses in cassava are between 5 and 30% (Wenham 1995). As well as direct physical loss of the crop, post-harvest deterioration causes a reduction in root quality, which has implications on marketing of cassava leading to price discounts and contributing to economic losses (Wenham, 1995; Westby *et al*., 2002).

In addition to post-harvest losses, there can be further losses due to change in use. For example, if harvested fresh roots cannot be marketed within 2 days of harvest they may be processed into dried products of low quality, which have lower value (Westby *et al*., 2002). There is also a "lost potential" because of non-harvesting. The flexibility in harvesting that cassava has means that this is not an immediate loss, but there is a loss in potential. (Westby *et al*., 2002)"

Rapid deterioration means that processing is important for cassava than for many other root crops. In addition to extending the storability of the crop, processing can also add value to it and expand market opportunities (Westby, 2002). More than 40% of cassava is currently processed, mainly into traditional food products (e.g. gari, attieke) and recently high quality cassava flour (HQCF). Processing provides a way of making a safe product by breaking cyanide that can be present in bitter varieties of cassava. In addition, processing provides a means of producing shelf stable products (thereby reducing losses), adding value at a local rural level and reducing the bulk to be marketed (Westby *et al*., 2002). Physical losses of the dried commodity (cassava chips) range from 3 to 15% (Westby *et al*., 2002). Cassava chips of different qualities sell for different prices in Northern Tanzania (Ndunguru *et al*., 1999).

There is a 25% price premium for non-mouldy dried cassava chips in Ghana (Wareing *et al*., 2001;Westby *et al*., 2002). In many processing enterprises, handling these wastes can be a major challenge involving significant costs (Adebayo *et al*., 2003). Solid waste from cassava processing constitutes about 30% by weight. A common practice for cassava processors is to dump wastes (comprising peel and pulp) less than 100 metres from the processing centres and set fire to them, thus emitting carbon dioxide and producing a strong offensive smell (Adebayo *et al*., 2003). If this waste can be converted into a higher value product, this may positively alter the dynamics of cassava processing.

Post-harvest losses of yam

Post-harvest losses of fresh yams can be exceptionally high and have been identified as a major constraint for the crop; 10-60% of tubers are lost during on-farm storage (Amusa *et al*., 2003) and a further 10-40% during transport due to damage and rots (Rees and Bancroft, 2003). In contrast to cassava, yam is mostly eaten fresh. While the storage techniques of fresh cassava have been extensively studied, losses during storage of fresh yam is still high and this area is still under researched compared to other crops

The value of yam can be retained by processing. An approach to reducing losses is drying of fresh yam tubers to produce a semi-processed product that is more compact and resistant to damage and therefore easier to store, transport, and transform into higher value consumer products. A key feature of yam processing is peeling and cutting the tubers into sticks, and then sun-drying. Solid waste from yam processing constitutes 12% by weight. In many processing enterprises, handling these wastes can be a major challenge involving significant costs. Studies in Benin and Nigeria have indicated that there is a food safety problem of aflatoxin contamination as a result of poor drying and storage (Adeleke, 2009).

Value chain analysis

A key feature of this proposal is the understanding of how value is managed in the post-harvest system for the fresh product and also in the processed form. This may offer food security benefits through improved income opportunities. To reduce post-harvest losses and foster development along a commodity value chain (i.e. in this case the cassava and yams value chains), the full range of activities required to bring a product through different stages of production, processing, and marketing until it reaches the end-user is evaluated (Kaplinsky and Morris, 2001; Global Development Solutions, 2007). A Value Chain Analysis (VCA) provides the approach for such an understanding in that it is a process of tracing a product's flow from the point of production to the point of consumption along with tracing the roles and

relationships of different actors and stakeholder, including gender dimensions, at different points in the value chain. This provides an understanding of the different aspects of input supply, constraints and competitive advantages that a producer has. In doing so, it traces the path of all value adding and non-value adding activities associated with the production and processing of cassava and yams, estimates costs involved at each stage, and calculates the relative significance of each cost to the overall value of the end product.

Existing recent developments in cassava value chain

Studies conducted by the Natural Resources Institute of the University of Greenwich (UoG-NRI) in collaboration with overseas partners demonstrate the complexities of roots and tubers value chains, but also the opportunities that exist in terms of value addition and evolving end-user markets (e.g. Kleih *et al*., 2008; Onumah *et al*., 2008; Posthumus *et al*., 2009). This includes up-grading of existing products such as cassava flour as well as value addition to by-products from processing. End-user markets are conditioned by factors such as urbanisation, consumer preferences, demographic changes, and purchasing power. Development of value chains of high quality cassava flour (HQCF) has been carried out as part of the C:AVA project (2008-2012) funded by the Gates Foundation (See box 1). The project is being conducted across five countries in Africa (Ghana, Tanzania, Uganda, Nigeria and Malawi) to improve the livelihoods and incomes of at least 90,000 smallholder households as direct beneficiaries including women and disadvantaged groups. It promotes the use of HQCF as a versatile raw material for which diverse markets have been identified in pilot studies. The project focuses on three potent intervention points: (i) ensuring a consistent supply of raw materials; (ii) developing viable intermediaries acting as secondary processors or bulking agents in value chains and (iii) driving market demand and building market share (in, for example, bakery industry, beer industry, components of traditional foods or plywood/paperboard applications). Farmers and farmer/processors are supported in production and primary processing activities through partnership with NGOs or other extension services. Analysis of gender and diversity and gender audits with partner organisations (e.g. Butterworth *et al* 2008; Quartey and Martin, 2008; Forsythe *et al* 2009) have sensitised project participants to gender dimensions of technology development and assessment and encouraged approaches which engage with men, women, and with youth. Business development supports intermediaries to meet the requirements of end users.

Box 1 : Cassava: Adding Value for Africa (C:AVA) Project is an initially four year project that started on 1 April 2008 with the aim of developing High Quality Cassava Flour (HQCF) based value chains in Ghana, Tanzania, Uganda, Nigeria and Malawi to improve the livelihoods and incomes of at least 90,000 smallholder farmers

The Project is funded by the Bill and Melinda Gates Foundation and is coordinated by UoG-NRI working in partnership with national organizations in each of the focus countries.

C:AVA promotes the use of HQCF as a versatile raw material for which diverse markets have been identified in pilot studies. The project will focus on three potent intervention points: (i) ensuring a consistent supply of raw materials; (ii) developing viable intermediaries acting as secondary processors or bulking agents in value chains and (iii) driving market demand and building market share (in, for example, for food (e.g. bakery, traditional foods), industrial uses (plywood/paperboard applications).

Farmers and farmer/processors will be supported in production and primary processing activities through partnership with NGOs or other extension services. Business development and other specialists will support intermediaries to meet the requirements of end users. End users will be supported technically in adopting HQCF. Benefits to smallholder households have been estimated to be $190/smallholder household/year for a one off investment of $166/smallholder household (not including research costs). Allowing for 10% spill-in from other smallholders the cost reduces to US$99/farmer after 10 years. There will be additional

benefits including: employment at the village and intermediary level, reduced raw material costs for end users and a reduced need to import wheat or other substituted raw materials.

C:AVA is not a research project, but this project will link with it to provide a platform for testing innovations and also for wider dissemination. C:AVA has highlighted some research issues that are addressed in the project.

Box 1. Description of BMGF C:AVA project

Existing recent developments in yam value chain

93% of the world's production is in the 'yam belt' countries of West Africa. In this region, yam is the mainstay of at least 60 million resource-limited farmers, processors and consumers, playing a key role in food security, income generation, and socio-cultural life. Farmers cultivate yams for home consumption and sale of surpluses of fresh and seed yam: there is minimal commercial processing of yam. All three yam sub-sectors (i.e. fresh, seed and processed) are seen as having potential for income generation, but their respective production and marketing systems are underdeveloped and fail to deliver significant returns to investment. Fresh yam marketing systems in West Africa are characterized by numerous traders, wholesalers and retailers who function in a highly fragmented and informal way having to access yams from a large number of small-scale farmers who produce yams on relatively small plots of land averaging about 0.2 ha. Farmers' income opportunities are relatively low (the majority farmers experience incomes below 300 US $ a year). The key requirement is to turn these fragmented, undervalued supply chains into more coherent value chains that create greater and more permanent purposeful linkages between all of the market actors so that all can benefit from investments.

Technologies for reducing post-harvest losses of fresh yam tubers

Post-harvest loss of yams is a major constraint for the crop in West Africa. Following harvest, yams may be stored on farm for weeks or months before home use or marketing. Defining best post-harvest practices is complicated by the range in behaviour of the different yam species and varieties. Nevertheless, losses on-farm could be reduced by improved storage structures and post-harvest practices to reduce sprouting and improve "curing". This would also provide tubers of better quality to withstand damage during transport.

Wound-healing of tubers by "curing" can reduce losses

Harvest damage of tubers increases rates of deterioration through water loss and rots. In common with other root crops, yam tubers can heal surface wounds when kept under the right conditions (warm and with high humidity) (Passam *et al*., 1976) It is common practice to place root crops (such as sweet potato and potato) under conditions to promote wound-healing (curing) immediately after harvest and before storage. Curing of yam tubers significantly reduces rotting during storage (Bancroft*,* 2000), but despite clear advantages, curing of yams is not widely practiced in West Africa. This may be partly because as optimum curing conditions vary by variety/species and maturity, it has been difficult to define the conditions to be used in each situation. Optimum conditions for curing have been determined for a range of yam species (Gonzalez and Rivera, 1972; Adesuyi, 1973; Martin, 1974; Been *et al*. 1976; Nnodu and Nwankiti, 1986, Thompson *et al*. 1977) There is agreement on the use of high humidity (>70^{o}C) but a wide range in optimum temperature (25-40^{o}C) and duration (2-15 days). An alternative practice of "sun curing", in which tubers are allowed to dry before storage, is almost certainly detrimental to successful storage, and has further confused the issue. Within this project emphasis will be placed on determining the optimal curing environment for the major yam species/varieties grown in the target areas, so that appropriate curing practices can be disseminated. In addition information will be obtained on key varieties about the efficiency of curing and the potential for reducing losses by selecting for better curing varieties.

Reducing losses through control of tuber sprouting
The length of yam tuber dormancy prior to sprouting ranges from 4-18 weeks depending on variety/species and is a major factor in potential storage time (Lebot, 2009; Diop and Calverley, 1998; Passam, 1982). Not only does sprouting directly affect yam quality, but dormancy break is associated with an increased susceptibility to rotting and high rates of respiration that lead to weight loss due to metabolism of stored starch. Thus extension of dormancy and control of sprouting is key to improve storability. In addition to species/varietal effects, dormancy period is known to be affected by temperature, humidity, O_2 and CO_2 content of the storage atmosphere (Diop and Calverley, 1998) and harvest date (Swannel *et al*., 2003). It is a widespread practice to reduce sprout growth through the physical removal of sprouts. Most studies indicate that a program of sprout removal can reduce losses, and is not detrimental to productivity of seed yams. The use of chemical sprout suppressants has so far not been feasible in West Africa due to lack of capital for available chemicals and the absence of appropriate cheap alternatives. Despite trials on the use of gibberellins to suppress sprouting, no appropriate technology has been disseminated (Tschannen *et al.* 2003). Given the growing body of knowledge on sprout control in other root crops, a number of other options emerge that justify investigation. Natural products such as caraway extracts are effective in potato, and ethylene is now known to act as a sprout growth suppressant in a range of root crops. In this project the emphasis will be on determining the benefits of sprout removal, appropriate sprout suppressants, and selection of varieties with longer dormancy.

Selecting optimal storage structures:
Where facilities are available for temperature control, optimum storage conditions for most yam species are 15-16ºC and 70 – 80% relative humidity (Anon, 1982), and storage for 6-7 months is possible. In West Africa temperature control is obviously not an option, and ambient storage leads to more rapid deterioration and shorter storage times. However, a wide range of yam storage structures have been documented that vary in the storage environment that they create and can have a significant impact on storage time. The choice of optimal storage structure depends on the value of the crop, which will dictate the appropriate level of inputs/labour, and the most appropriate storage environment, which can change with tuber species/variety and maturity (Rees and Bancroft, 2003).

Potential for reducing post-harvest losses through germplasm selection
Even within each species yam is a very diverse crop. There are several areas where an improvement in our understanding of the post-harvest characteristics of varieties would on the one hand help farmers to select the varieties best suited to their needs, and on the other hand feed back into breeding programmes to help them produce varieties with appropriate post-harvest behaviour. For example, it is important for farmers to know the dormancy and curing characteristics of available varieties. Development of tools to facilitate breeding for extended dormancy and improved wound healing efficiency would be a valuable longer-term strategy, to which the varietal information derived from this project will contribute.

In particular, this project will focus on the use of value chain analysis to better understand the origins of losses in fresh and processed cassava and yam and on the use of improved storage technologies to reduce losses in fresh yam. Waste resulting from fresh root or tuber deterioration or as a by-product of processing should be further utilised for value addition. The options to add value to cassava and yam waste in order to produce food products that will increase food security as well as creating business opportunities are listed below.

Utilisation of waste
Losses or waste resulting of spoilage of the fresh root and of processing can be converted into a range of existing and novel products (see Figure 1 below).

Animal feed production from waste from cassava and yam
One way of using losses from cassava and yam is to use them for animal feeding. Feeding animals that would provide meat and milk to humans contributes to food security.

Small ruminant production in Africa depends largely on the quantity and nutritive value of uncultivated and un-supplemented guinea grass (*Panicum maximum*) and centro (*Centrosema pubescens*) forages, available for free or zero-grazing. However, supplementary concentrate feeding is a common strategy for meeting the dietary needs of ruminants (Adebayo and Ajayi, 2001). Adeneye and Sunmonu (1994) have demonstrated that dry matter intake is higher among goats fed on cassava waste supplement and this is positively correlated to higher feed digestibility and nitrogen retention compared to goats reared on green forage alone. Similarly, in a project supported by the World Bank's Development Marketplace, Iposu *et al*. (2009) have successfully piloted a scheme in Nigeria where West African Dwarf (WAD) goats fed cassava waste supplements attain market weight (25-30kg) in six months compared to goats kept on free-range that took almost 12 months to attain the similar weight. The proposed project seeks to develop stable and commercialisable animal feed supplements from cassava and yam wastes (peel and chaff) that can enhance rapid weight gain in ruminant animal production and therefore increase the quantity of animal proteins available to people.

Mushroom production from waste from cassava and yams
Besides the use of cassava and yam losses into animal feed, there are possibilities of using these to cultivate edible mushrooms.

There is an increasing interest in using fungi in solid state fermentation to increase value of organic waste products (Martinez *et al*., 2005). Utilisation of (hemi) celluloses for conversion to sugars and further processing is restricted by the presence of recalcitrant lignins. A number of filamentous fungi, in particular white rot fungi, are able to specifically degrade/modify lignin resulting in an increase in enzymatic degradability of (hemi) celluloses (Lundell *et al*., 2010). As a result, this pre-treatment leads to an increase in digestibility by ruminants (Cone *et al*., 2010; Arora *et al*., 2011). A number of these fungi also produce edible mushrooms adding the possibility to convert organic waste to valuable human nutrition. Although previous research has shown that fungi can be used to upgrade organic waste including cassava (Antai and Mbongo, 1993; Lateef *et al*., 2008), the technology has not been implemented for upgrading cassava/yam waste streams into feed or for production of mushroom. This project will use spawn and fermentation technology used in the mushroom industry to optimize the conversion of cassava and yam waste into feed and edible mushrooms. A large collection of fungal strains is available for testing species/strain on colonization and modifying these waste products. Not only cassava peels but also remaining above ground plant wastes can be used for pre-treatment with fungi. Implementation of spawn technology and fermentation technology needed for these waste treatments can be implemented on low tech levels on the spot and used on larger or smaller scale.

Starch and sugars from cassava and yam waste
Cassava and yam's main component is starch. In cassava tubers, starch granules are trapped inside fibrous cell wall materials. During cassava processing, mechanical means are applied to break down cell wall tissues so that starch granules are liberated and collected. The mechanical force still does not completely disintegrate the tissues, some starch granules are trapped inside the solid wastes. Suitable enzyme cocktails are applied to re-extract starches from pulps and peels. Alternatively, at the small-scaled production, the enzymes can be possibly added directly during starch extraction to reduce starch loss in waste. The recovered starches can be further enzymatically hydrolyzed to sugar syrups. On the other hand, the syrup can be produced directly by enzyme hydrolysis of pulps and peels. The conventional process of making starch syrup is cooked process so that starches are

gelatinised and be more susceptible to enzyme hydrolysis. Cooking of cell-wall containing materials is a high energy-consuming process due to their water absorption ability, resulting in a high viscous, less flowable product. National Science and Technology Development Agency (NSTDA), Thailand, working with enzyme companies, demonstrated that formulated enzyme cocktails can be applied to pre-treated fresh roots and tubers such as cassava and yam and solid wastes to liquefy feedstock and improve starch susceptibility, prior to cooking and hydrolysis. Recently, by the development of commercially available granular starch hydrolyzing enzyme (GSHE), the production of sugars from cassava feedstock is achievable without the need of cooking. This energy-effective technology of using GSHE can be further applied in a combination with cell wall degrading enzymes to simply produce syrups from pulps and peels.

Use of derived products (mash and spent yeast) from beers made with cassava in snack food production

Cassava beer is a potential new innovation by SABMiller. The by-products generated by the process that are mostly mash and spent yeast could be used for food and other purposes. Traditionally the classical brewers use the by-products of the brewing process from malt to recycle into animal feed (Mussatto *et al*., 2006). Brewer's spent grain (BSG) is a by-product of beer brewing consisting of the residue of malt and grain which remains in the mash-kettle after the mashing and lautering process. BSG represents around 85% of the total by-products generated. Due to BSG's high content of protein and fibre, Mussatto *et al*. (2006) showed that it can be used as an attractive adjunct in human nutrition. Recently, attempts have been made to use BSG in biotechnological processes, such as a source of value-added products (extracts). The novel idea would be to use the by-products (mash and spent yeast) from cassava beer for similar applications. The high nutritional content of spent yeast (rich in proteins and vitamins) could open opportunities for novel products such as snack food and high energy products with a potential to tackle malnutrition.

Figure 2 shows the flow process diagram of potential value added products from cassava and yam.

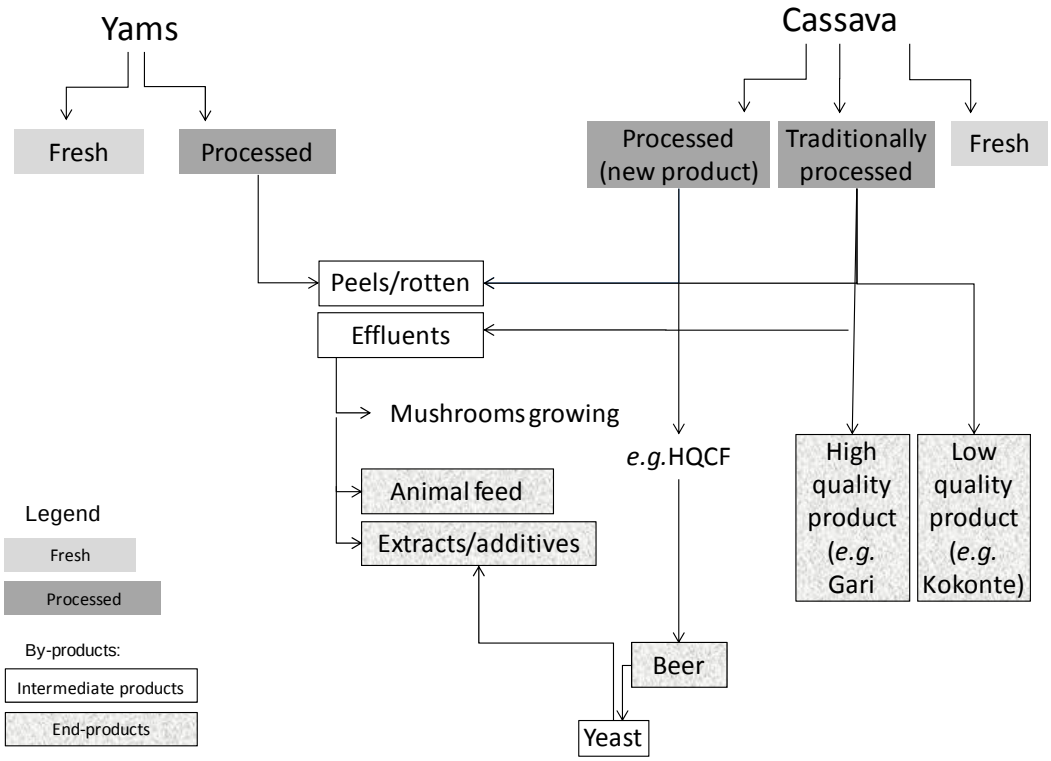


Figure 2: Flow process diagram showing the potential value added products

Food safety concerns

The production of novel valuable compounds is a very promising and important way to use the food waste; such processes, however, have to be performed ensuring the safety and the quality of the final products. In general, there are specific European legislations dealing with these issues, to guarantee the safety of the products obtained from agricultural and animal wastes; therefore they will all be taken into account when considering the valorisation process. These include the principles/regulations of HACCP and the use of the Best Available Technique (BAT) in the processes of valorisation of food by-products (AWARENET 2004).

Regarding the HACCP, the principle of Critical Control Points will be applied, to determine which are the potential risks for the production of these compounds. A similar approach was already adopted in other processes using natural sources or their waste, for instance for the production of aloe vera extracts (He *et al.* 2005) or of essential oils from various plants (Smith *et al.* 2005). These methodologies will tailored for the cases of cassava and yam wastes, considering the possible risks associated with their agricultural production. In the past, for example, it was reported that in the cultivation of some crops – including yams – there were environmental risks, due to the presence of heavy metal (Mireri *et al.* 2007). To avoid this type of contamination, the quality of the starting material has to be screened, applying the appropriate analysis of the possible pollutants. Alternatively, the techniques to obtain the final products can be chosen, with the aim of reducing the level of pollutants; an example can be the use of heavy metal absorbers, such as an ion-exchanger column.

The safety finding and guidelines suggested by the European Food Safety Authority will also be considered and implemented. Previous studies were performed, for instance, on the safety of botanical products for food use (Speijers. *et al.* 2010); again, the same principle will be tailored to the products considered here. In the specific case of cassava and its by-products, an additional problem is the possible production of cyanide; this is due to the presence of a specific enzyme, linamarase (Cereda *et al.* 1996). Major diseases associated with cassava consumption are konzo and tropical ataxic neuropathy, which is prevalent only in cassava consuming populations, and associated with high cyanogen intake due to the consumption of improperly processed bitter cassava (Nambisan 2010). The cyanide concentration can easily be reduced to in order to achieve safe levels of 10 µg/g in cassava products by simple treatments, such as washing and/or heating of the solids or the liquid (Nambisan 2010; Chisté *et al.* 2010); therefore, the same procedures will be applied to the valorisation process.

Toxicological studies of Cassava starch fermentation wastewater showed that there were no treatment-related changes of toxicological significance in rats assuring its safety (Avancini *et al.* 2007).

Microbial contamination of cassava products namely wet fufu is generally high and commonly coliforms, Bacillus cereus and Staphylococcus aureus are isolated from the wet fufu (Obadina *et al.* 2007). The presence of these microorganisms indicates that the processing is carried out in a highly contaminated environment. So naturally waste products must be controlled for these microorganisms in order to assure a good waste quality for valorisation in safe high added products. Some thermal processes may be applied to waste to reduce these microbial load, however reduction of nutritional quality must be taken in account in order to select the minimum processing condition that assure safety and lowest nutritional losses.

When processing techniques are simplified enough and made affordable for traditional processing, then traditional stakeholders from African countries can contribute meaningfully to food safety as well as take advantage of the surge in cassava waste valorisation in Africa.

Small and medium enterprise development

Small and medium enterprises (SMEs) are key actors in more efficient RTC value chains promoting shorter storage time and reducing both physical and opportunity losses (World Bank 2010). Although the technical aspects of root and tuber production and processing are vital for sustainable business development, other crucial factors have to be taken into account as well: in addition to issues of management and business planning (UNCTD 2001) cost and financial benefits of the interrelated investments have to be considered. A deep understanding of the market, the competitive position (Webber *et al*. 2010) of SMEs, and key success factors (KIT, Faida and IIRR 2006) as much as critical constraints (Jayne *et al*. 2010) is of great importance. This is particularly relevant when investigating the opportunities for new cassava and yam products, as the entrance of new markets involves risks and challenges which require sound business strategy. In recent literature (Danis *et al*. 2010), it is more and more emphasised that cluster development can overcome individual SMEs' constraints. Clusters (geographic and sectoral agglomerations of enterprises) enhance horizontal as well as vertical linkages which help to achieve economies of scale, reduce costs and expand market opportunities. Moreover, they can improve negotiating power with buyers and suppliers; facilitate access to market information and services; create spill-over effects from one firm's investment to another[i]; and allow exchange of knowledge and machinery which leads to more efficient adaptation of technology. However, the existence of clusters in itself does not guarantee dynamic growth for SMEs (UNIDO 2009): enterprises therefore will be supported in the sustainable uptake of interventions. As one of the best ways to maintain competitive advantage is by innovation (Aubert 2005), the project aims to facilitate not only technological innovation but also improvements in management, marketing and distribution, business planning and administration. Advances have been made in giving farmers the tools to improve RTC yields and generate a stable income by adding value to the products (Weathley *et al*. 2002). Recent research has made significant progress in efforts to use high quality cassava flour in baking and biscuit manufacture, and in packaging, plywood and food processing industries (Abedayo 2010), while other studies explored additional applications of cassava and yam such as the brewing and soap industry (Daramola *et al*. 2006). Challenges are to supply products that comply with strict standard qualities, which can be achieved by good management; and to ensure competitiveness. Using this knowledge to support both SME capacity strengthening and cluster development, the reduction of cassava and yam losses and new utilisation of the products' waste will go hand in hand with the development of economically viable enterprises.

Baseline descriptions

A main constraint with RTC is the amount of post-harvest losses generated. Post-harvest losses are a problem because of their high perishability especially under tropical conditions (high temperatures) that accelerate the physiological process of deterioration. Post-harvest losses can occur in the fresh product food chain and during processing. Losses in fresh cassava are between 5 and 30% and subsequent post-harvest deterioration has implications on marketing of cassava leading to price discounts and contributing to economic losses. Additional losses can be due to changes in use where fresh roots (which cannot be marketed) may be processed into dried products of low quality, which have lower value. There is also a "lost potential" because of non-harvesting. Physical losses of the dried commodity (cassava chips) range from 3 to 15%.

Post-harvest losses of fresh yams can be exceptionally high and have been identified as a major constraint for the crop; 10-60% of tubers are lost during on-farm storage and a further 10-40% during transport due to damage and rots. In contrast to cassava, yam is mostly eaten fresh. While the storage techniques of fresh cassava have been extensively studied, losses during storage of fresh yam is still high and this area is still under researched compared to other crops. The value of yam can be retained by processing such drying.

Solid waste from yam processing constitute 12% by weight and in many processing enterprises, handling these wastes can be a major challenge involving significant costs.

A key feature of this proposal is the understanding of how value is managed in the post-harvest system for the fresh product and also in the processed form. This may offer food security benefits through improved income opportunities. Studies have demonstrated the complexities of RTC chains, but also the opportunities that exist in terms of value addition and evolving end-user markets. This includes up-grading of existing products such as cassava flour as well as value addition to by-products from processing. End-user markets are conditioned by factors such as urbanisation, consumer preferences, demographic changes, and purchasing power. Development of value chains of high quality cassava flour (HQCF) has been carried out as part of the C:AVA project (2008-2012) funded by the Gates Foundation and has focused on three potent intervention points: (i) ensuring a consistent supply of raw materials; (ii) developing viable intermediaries acting as secondary processors or bulking agents in value chains and (iii) driving market demand and building market share. Analysis of gender and diversity and gender audits with partner organisations have sensitised project participants to gender dimensions of technology development and assessment and encouraged approaches which engage with men, women, and with youth. In the case of yam, value chains are often fragmented. Business development supports intermediaries to meet the requirements of end users.

In the yam value chain, a number of technologies for reducing post-harvest losses of fresh yam tubers are available. Following harvest, yams may be stored on farm for weeks or months before home use or marketing. Defining best post-harvest practices is complicated by the range in behaviour of the different yam species and varieties. Factors than can influence water loss and rots through ineffective wound healing and curing can play in important role but despite clear advantages, curing of yams is not widely practiced in West Africa. This may be partly because as optimum curing conditions vary by variety/species and maturity, it has been difficult to define the conditions to be used in each situation. Factors include the use of high humidity (>70^{o}C) and a wide range in optimum temperature (25-40^{o}C) and duration (2-15 days). Losses can be reduced through the control of yam tuber sprouting. *S*prouting directly affects yam quality, but dormancy break is associated with an increased susceptibility to rotting and high rates of respiration that lead to weight loss due to metabolism of stored starch. Thus extension of dormancy and control of sprouting is key to improve storability. In addition to species/varietal effects, dormancy period is known to be affected by temperature, humidity, O_2 and CO_2 content of the storage atmosphere and harvest date. A program of sprout removal can reduce losses, and is not detrimental to productivity of seed yams. The use of chemical sprout suppressants has not been feasible in West Africa but technologies using gibberellins to suppress sprouting have been developed. Natural products such as caraway extracts are effective in potato, and ethylene is now known to act as a sprout growth suppressant in a range of root crops. Reduced losses of yam during storage can be achieved by selecting optimal storage structures, that control temperature (15-16ºC) and RH (70 – 80%) enabling and storage for up to 6-7 months. Where temperature control is not an option a wide range of yam storage structures have been documented. Losses can also be reduced through appropriate germplasm selection for dormancy and curing characteristics of available varieties.

The utilization of waste from cassava and yam value chains can be utilized in a number of ways. These include using losses from cassava and yam is to use them for animal feeds. Solid waste from cassava processing constitutes about 30% by weight. A common practice for processors is to dump wastes (comprising peel and pulp) less than 100 metres from the processing centres and set fire to them, thus emitting carbon dioxide and producing a strong offensive smell. Feeding animals that would provide meat and milk to humans contributes to food security. The dry matter intake is high among goats fed on cassava waste supplement and this is positively correlated to higher feed digestibility and nitrogen retention compared to

goats reared on green forage alone and the a project supported by the World Bank's Development Marketplace have successfully piloted a scheme in Nigeria. Besides the use of cassava and yam losses into animal feed, there are possibilities of using these to cultivate edible mushrooms. There is an increasing interest in using fungi in solid state fermentation to increase value of organic waste products. A number of filamentous fungi, in particular white rot fungi, are able to specifically degrade/modify lignin resulting in an increase in enzymatic degradability of (hemi) celluloses. As a result, this pre-treatment leads to an increase in digestibility by ruminants. A number of these fungi also produce edible mushrooms adding the possibility to convert organic waste to valuable human nutrition. Cassava and yam waste can also be converted into starch. During cassava processing, mechanical means along with enzyme cocktails are applied to re-extract starches from pulps and peels. Alternatively, at the small-scaled production, the enzymes can be possibly added directly during starch extraction to reduce starch loss in waste. The recovered starches can be further enzymatically hydrolyzed to sugar syrups. Additionally, the syrup can be produced directly by enzyme hydrolysis of pulps and peels. NSTDA, Thailand, demonstrated that formulated enzyme cocktails can be applied to pre-treated fresh roots and tubers such as cassava and yam and solid wastes to liquefy feedstock and improve starch susceptibility, prior to cooking and hydrolysis. Recently, a more energy efficient technology using the development of a commercially available granular starch hydrolyzing enzyme (GSHE), the production of sugars from cassava feedstock without the need of cooking has been developed. Other uses of cassava waste include the use of derived products (mash and spent yeast) from beers made with cassava in snack food production. Cassava beer is a potential new innovation by SABMiller. The by-products generated by the process that are mostly mash and spent yeast could be used for food and alternative purposes. Brewer's spent grain (BSG) is a by-product of beer brewing consisting of the residue of malt and grain which remains in the mash-kettle after the mashing and lautering process and represents around 85% of the total by-products generated. BSG's is high in protein and fibre. Recently, attempts have been made to use BSG in biotechnological processes, such as a source of value-added products (extracts).

The production of novel valuable compounds is a very promising and important way to use the food waste; such processes, however, have to be performed ensuring the safety and the quality of the final products. In general, there are specific European legislations dealing with these issues, to guarantee the safety of the products obtained from agricultural and animal wastes; therefore they will all be taken into account when considering the valorisation process. HACCP has been adopted in other processes using natural sources or their waste, for instance for the production of aloe vera extracts or of essential oils from various plants.
Major diseases associated with cassava consumption are konzo and tropical ataxic neuropathy is due to the consumption of improperly processed bitter cassava. The cyanide concentration can be reduced to safe levels in cassava products by simple treatments. Microbial contamination of cassava products namely wet fufu is generally high and commonly coliforms, Bacillus cereus and Staphylococcus aureus are isolated from the wet fufu.

Small and medium enterprises (SMEs) are key actors in more efficient RTC value chains promoting shorter storage time and reducing both physical and opportunity losses. Although the technical aspects of root and tuber production and processing are vital for sustainable business development, other crucial factors have to be taken into account as well: in addition to issues of management and business planning cost and financial benefits of the interrelated investments have to be considered. The competitive position of SMEs and key success factors as much as critical constraints is of great importance. In recent literature cluster development can overcome individual SMEs' constraints. Clusters (geographic and sectoral agglomerations of enterprises) enhance horizontal as well as vertical linkages which help to achieve economies of scale, reduce costs and expand market opportunities. Moreover, they can improve negotiating power with buyers and suppliers; facilitate access to

market information and services; create spill-over effects from one firm's investment to another[ii]; and allow exchange of knowledge and machinery which leads to more efficient adaptation of technology. Advances have been made in giving farmers the tools to improve RTC yields and generate a stable income by adding value to the products. Recent research has made significant progress in efforts to use high quality cassava flour in baking and biscuit manufacture, and in packaging, plywood and food processing industries while other studies explored additional applications of cassava and yam such as the brewing and soap industry. Challenges are to supply products that comply with strict standard qualities, which can be achieved by good management; and to ensure competitiveness.

Description of performance and research indicators.
The description of the performance and research indicators is as follows:

Evaluate the value chains for cassava and yams within the context of their role in food security.
Significant improvement had been achieved on production of root and tuber crops in the last decades. However, rather than focusing almost entirely on production issues, the research will also explore post-harvest losses reduction, better processing technologies, value addition of waste and marketing techniques in the context of the value chain and livelihoods, in particular to consider gender with a view to helping farmers and actors in the value chain increase their incomes, improve quality of life, nutrition and sustained food security.

Therefore the research will seek to gain new knowledge through understanding the existing value chains for cassava and yams in selected target areas. In this context, the levels and causes of post-harvest losses for cassava and yam will be explored and options identified for reducing losses. This information will be key for developing new processing technologies and ways of increasing value from waste. The value chain analysis will document levels of waste generated and examine alternative value chains/markets for products from waste which will be key for income generation. This analysis will provide baseline information to enable benchmarking of different approaches to post-harvest loss reduction and use monitoring data to undertake these benchmarking exercises.

Research to understand household decision making with respect to the options for reducing post-harvest losses including the options of processing for value addition; gender roles will be explored. Models to measure the impacts of developing strategies for reducing losses and adding value to waste will be developed to gain a comprehensive understanding of the impacts on the value chains for yam and cassava and their contributions to food security.

Reduce physical post-harvest losses of fresh produce (focussing mainly on yams).
Research regarding technologies for the reduction of post-harvest losses of fresh yam will be developed and validated. This will focus on practices to control tuber sprouting, water loss and rotting which are major causes of loss. The research will seek to identify ways to reduce losses in the fresh yam value chain and hence improve food security and increase incomes with a focus on small-holder farmers. In parts of West Africa 10-50% of tubers are lost during on-farm storage and a further 10-40% during transport due to damage and rots. This would also provide tubers of better quality to withstand damage during transport. Therefore the research will develop and validate strategies to improve curing of yam tubers, strategies for yam tuber sprout control and identify appropriate storage structures to optimise tuber quality/storage. As a result, best strategies identified will be demonstrated and information more widely dissemination to reduce yam tuber losses.

Reduce economic losses through value added processing (focussing on both cassava and yams).
The research will seek to develop alternative novel markets for processed cassava and yam products that reduce levels post-harvest loss and provide increased incomes for small-

holder farmers and so contribute to food security. A key issue will be the development of viable new processed products for yam and cassava that provide options of households to sell their produce for reasonable prices and result in reduced physical or economic losses. Research will explore the balance between selling or storing less fresh produce and amounts of lower value products that are processed. This will be an important balance to strike between products prepared and stored for household use and the generation of income – with the income contributing to food security. In this context, experiences from the C:AVA project that has already had success with producing high quality flour from cassava at the household level as well as at the SME level will be fed into this product. The technology should be easily adaptable to yams of which 60% of fresh yams are currently considered to be a loss. Although there is some yam flour on the market in West Africa, there are issues in quality and the production at the SME level is limited. Urbanisation in West Africa is a driver of changing food habits and is therefore likely to offer an opportunity for composite flours or more convenient forms of traditional products. Therefore by converting some of this 60% loss into high quality yam flour should present value addition opportunities. This will be in collaboration with value chain studies to ensure the approaches are economically viable and that markets exist and research to ensure that they are safe. As appropriate technologies will be demonstrated in collaboration with SMEs.

In addition, GRATITUDE has synergies with the C:AVA project (which is not a research project) and the impact that this project has could be enhanced by researching new market outlets for High Quality Cassava Flour. The C:AVA project also provides a mechanism for the dissemination of the activities of this research.

Therefore, research will develop and validate technologies and systems that allow production of high quality yam flour of acceptable quality providing a new market outlet for yam produced by small-holder households, improve the systems for drying of cassava, increasing the potential to produce higher quality products, with lower levels of loss and more efficient use of fuel and develop new novel market outlets for high quality cassava flour as a versatile raw material for diverse markets.

Valorise wastes from the value chain (focussing mainly on cassava).
GRATITUDE seeks to develop new technologies, systems and products that add value to the waste products from processing (mainly from cassava and to a lesser extent from yam). The specific wastes selected in part from the work on the value chain analysis, but are also produced from the traditional processing systems and from current industries.

There will only be work on added value products that will feed into the human food supply value chains, e.g. mushroom production using peels as substrate; use of peels as a raw material for animal feed and using peels as a raw material for added value products, such as sugars and other raw materials for the food industry. There may be the option to work on brewing waste if brewing is one of the options developed using high quality cassava flour as a raw material (from research involving this project and with links to C:AVA).

These wastes can result either from the fresh roots due to their perishable nature or from the processing of cassava and yam (*e.g.* peels, waste water, waste from brewing etc...). The multi-disciplinary research requires technical knowledge and expertise that would result in practical applications to increase food security at the low level of technology and at a higher level, increase business opportunities and reduce the damage done to the environment by providing new solutions to use the wastes. The aim of this work is to expand/open new market opportunities for new products and added valued products generated from the waste of cassava and yam. Specifically this will involve developing technologies for making food products from waste which is either in the form of food products, animal feeds or mushrooms made from composting waste while ensuring that they are safe. In conjunction with this the project will assess the technologies at the

household food security level and also appropriate technologies at the pilot scale level. This will be linked with the potential for enterprise development based on these technologies.

Beyond these direct results, the lessons learnt and the methodologies for the assessment of reducing losses and increasing the value of what are currently waste products will be shared with other countries from all continents, and also with other groups of countries (Asia, South America) in order to disseminate the results among the research community involved in food research in developing countries.

These general and specific objectives specially address the call by addressing post-harvest losses of major food crops by taking a comprehensive approach involving a range of technologies and involving a wide range of potential stakeholders. It specifically addresses the dual issues of post-harvest losses and generating higher value products from bio-waste whist addressing issues of the quality and safety of food. The approach allows the benchmarking of the improvements achieved by different approaches. Demonstration activities with farmers through NGOs, SMEs and other relevant stakeholders in the agri-food chain will be carried out in each of the focus developing countries. South-south networking and links with European centres of excellence and wide dissemination of findings will ensure contributions to mutual interest and shared benefit. Important lessons on the impact on different approaches to reducing losses of major crops and the role of SMEs, and large businesses/market opportunities may well have lessons within Europe also.

B 1.3 S/T Methodology and associated work plan

B 1.3.1 Overall strategy and general description

The project has eight work packages (WPs) to achieve the objectives. WP8 concerns non-technical management, monitoring and evaluation. The technical work packages are as follows:

- WP1 = Value-chain assessment and management
- WP2 = Reduced post-harvest losses of fresh produce
- WP3 = Alternative market development to reduce post-harvest losses
- WP4 = Adding value to waste products
- WP5 = Food safety, quality and compliance
- WP6 = Demonstration of technologies with beneficiaries
- WP7 = Dissemination and support to replication.

WP1 seeks to evaluate value chains for cassava and yams (fresh and processed) from the farm to the consumers. Specific emphasis will be placed on understanding the levels and causes of post-harvest losses and identifying and evaluating alternative options for reducing such losses. It will also document for specific cases the levels of waste generated, examine related value chains for these products and the impact of developing these alternative value chains.

In **WP2** technologies for the reduction of post-harvest losses of fresh yam in particular will be developed and validated. This will focus on storage losses in yams looking at improved storage systems and controlling dormancy which are major causes of loss.

In **WP3** alternative novel markets for processed cassava and yam products will be developed and validated that reduce levels of post-harvest loss and provide increased incomes for small-holder farmers. The key issue in this WP will be the development of viable processing options for yam and cassava that provide options for households to sell their produce for reasonable prices and that result in reduced physical or economic losses. There will be an important balance to strike between products prepared and stored for household use and the generation of income – with the income contributing to food security. Understanding these different processing options and their implications for food security will be an important element of WP1**.**

WP4 seeks to develop new technologies and products and add value to the waste products from processing (mainly from cassava and to a lesser extent from yam). Work will focus on added value products that feed into the human food supply chains, e.g. mushroom production using peels as substrate; use of peels as a raw material for animal feed and using peels as a raw material for added value products, such as sugars and other raw materials for the food industry. There may be the option to work on brewing waste if brewing is one of the options developed using high quality cassava flour as a raw material.

WP5 will ensure that the new higher value products from waste are safe and that appropriate food safety and quality management systems are in place. The success of the project will depend on the development of viable enterprises to market the value added products developed in **WPs 3** and **4**.

WP6 will support the demonstration of outputs from the research activities in either rural setting (for example for improved storage technologies in collaboration with extension services or in collaboration with SMEs. Lessons from these demonstration activities will serve to support wider dissemination of the technologies developed.

Finally, **WP7** will disseminate knowledge gained and lessons learned from the validation of the technologies to enable replication elsewhere and hence wider scale impact.

The main risks and contingencies are shown in table 1

Table 1: Risks and contingencies

WP	Risks	Contingency
1	Poor crop production during the food chain assessment	Actors in food chain will know their product and market. Poor production will be included in the assessment. Working in several countries minimises this risk.
	Prices are unstable	Actors in the food chain will know their product and market and can be accounted for the assessment. This is actually one of the variables in the project and operation in different countries will be helpful.
2	Variable climatic conditions result in poor crop yields or lack of access to different varieties	Yams are grown over a wide range of areas in West Africa. It is therefore expected that locations with typical production will be available.
	New technologies are not economically viable	An economic assessment will be undertaken during WP1 to select 'best bets'
3	Yam not available for technology development such as flour production	Several technology options will be available. Previous experience with cassava flour will enable barriers to be overcome
	New technologies are not economically viable	An economic assessment will be undertaken during WP1 to select 'best bets'
	Beer from cassava not acceptable	Initial trials studies in test brewery (small scale) do not indicate problems
4	Difficulties converting waste from yams and cassava into compost for mushroom production	A wide range of spawn and fermentation technologies will be tested
	Animal feed from waste is not accepted by the animals	A range of formulations will be tested
	Lack of a market for starches and syrups	A range of different markets will be approached
	Snack food from waste from brewing not acceptable	Consumer acceptance studies will test the market. Product is expected to umami characteristic with may be similar to products already locally consumed.
5	Products are not safe	HACCP is a systematic approach to food safety and quality management. All of the food safety hazards and their likely risk will be assessed.
	Improved food safety is too costly to implement	Experience suggests that implementing food safety management tools reduces costs and improves

		consumer confidence in the products.
6	Too few products to demonstrate	The project will widen the scope of products if necessary
	Products are not economically viable	The householders, SME and large scale industries will be involved throughout the development process. Only best bets will be selected. Product criteria will be widened if needed. Ensure coordination with activities in WP2, 3 and 4.
7	Delays in technology development	PMC will closely monitor project activities and develop action plans to overcome any delays.
	Ethical concerns regarding the viability of the products	Ethical issues will be continuously monitored during the project to avoid any ethical concerns.
	Meetings not attended by key parties	Organisers will consult with all parties to ensure that the meetings on dissemination are appropriate.
8	Delay in submission of outputs and lack of coordination of partners	Project Coordinator with support of PMC will monitor progress and regularly monitor partners
	Delay in production of deliverables	Review the status of deliverables on a monthly basis and action plan developed when problems identified.

B 1.3.2 Timing of work packages and their components

Figure 3 shows the timing of the work packages.

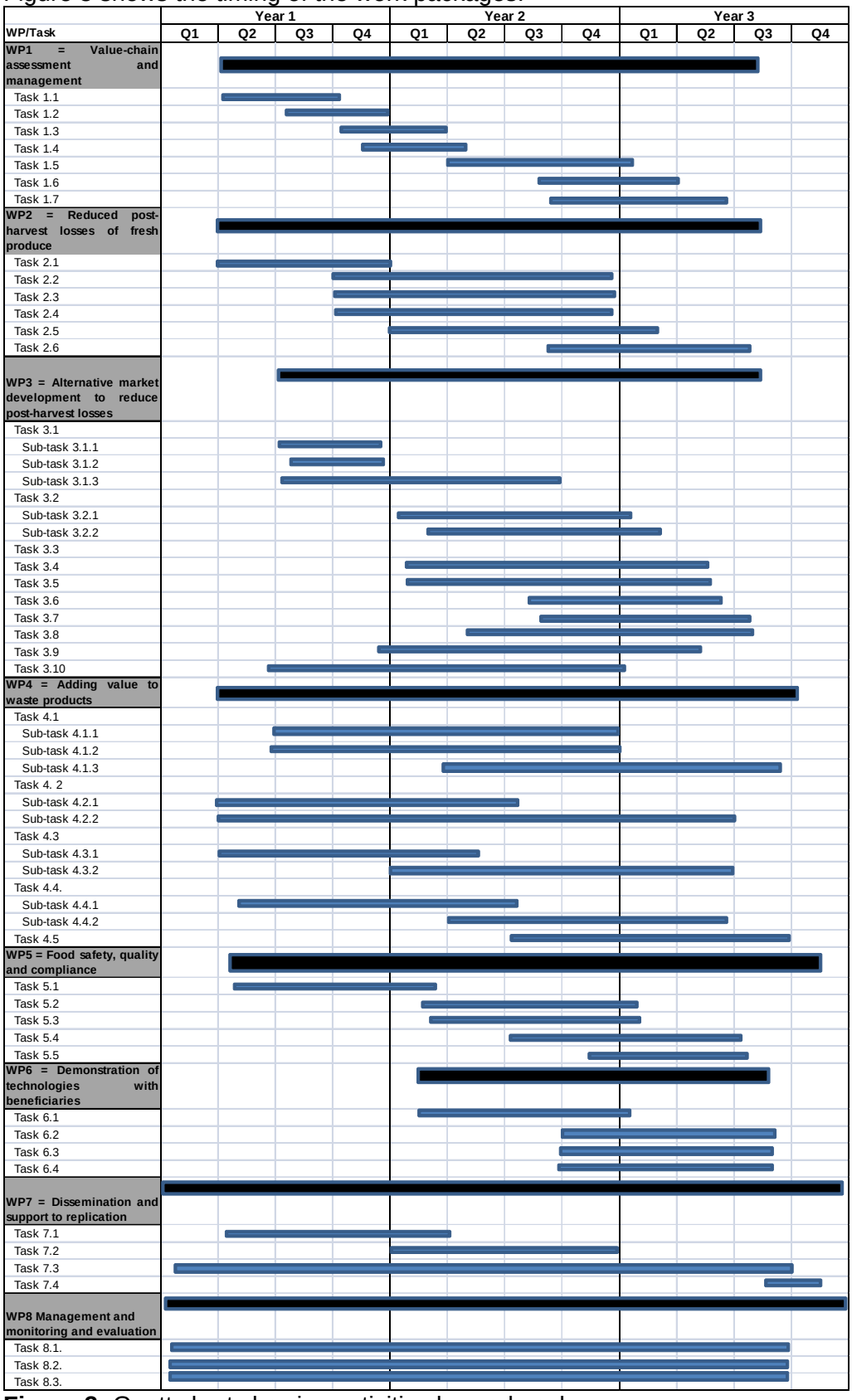


Figure 3: Gantt chart showing activities by workpackage

B2. Implementation

B 2.1 Management structure and procedures

The management of the project (led by UoG-NRI) will ensure the following:

1. Proper coordination of scientific, human and financial resources
2. Coordination and integration between the work package activities
3. Appropriate functioning and effectiveness of the project management committee
4. Full and timely reporting to the EU
5. Undertake monitoring and evaluation activities to ensure delivery of project milestones

Management structure

The management structure consists of the following management and advisory bodies:

1. Project Coordinator (PC)
2. Project Coordination and Support Office (PCSO)
3. Project Management Committee (PMC)
4. Work packages leaders (WPL –WP1-8)
5. Country Managers (CM)
6. Advisory Committee

Project Coordinator (PC)

UoG-NRI (Partner 1) will be responsible for overall management of the project. Dr Keith Tomlins will be the Project Coordinator (PC). Dr Tomlins is an experienced project manager having led multi-organisational projects for the United Kingdom's Department for International Development and other agencies. UoG-NRI is registered to ISO 9001 by the British Standards Institute (BSI) for research and project management. The PC carries out, on behalf of the beneficiaries of the consortium, the responsibility for the overall coordination of the technical activities of the project, and the overall legal, contractual, ethical, financial and administrative management. The PC will act as an intermediary between the Commission and the Project.

Project Coordination and Support Office (PCSO)

The Project Coordination and Support Office will take responsibility for the effective day to day operation of the project liaising with collaborating organisations and WP Leaders through the Project Coordinator including monitoring and reporting of the project progress, execution of financial monitoring of the consortium partners, communication with stakeholders, legal, financial and secretary matters. The PCSO is comprised of the following:

1. The PC, who also chairs the PCSO.
2. The UoG-NRI Project Controller responsible for the day to day financial management of the project.
3. The PC will also be able to call on the advice and inputs of Professor Andrew Westby, a leading world authority on tropical root and tuber crops, Director of the C:AVA project and Director of UoG-NRI for advisory support.

The PCSO will also have the support of the Natural Resources Institute's Contracts issues and University Administrative Secretary in dealing with issues relating to the consortium agreement and of legal and IPR issues.

Project Management Committee (PMC)

The Project Management Committee (PMC) is the main management body of the Project, where decisions will be made regarding project strategy, progress, major project revisions, exchanges of tasks and budgets, intellectual property, dissemination strategies, communication, interaction with other activities and political issues. The PMC will be composed of the Project Coordinator, the seven Work Package Leaders and the Country

Managers (See below). The project follow-up will be performed by the PMC organizing meetings and teleconferences.

Work Package Leaders/ Country Managers
The Work Package Leader is responsible for the co-ordination of the work of the partners collaborating on specific work package (WP). They are also responsible for the delivery of the agreed deliverables and milestones. For each WP, a representative of a project partner has been identified as the Work Package Leader.

Country Managers
In addition to the Work Package Leader Role, a Country Manager has been identified for each country (Table 2). There is some overlap between Work Package Leaders and Country Manager for efficiency. Country Managers will have responsibility for ensuring that all of the research activities in a specific beneficiary country are well coordinated and integrated to ensure delivery of the project deliverables. The country partner will also be responsible for day to day liaison with the national partners in the respective country.

Table 2: Country Managers.

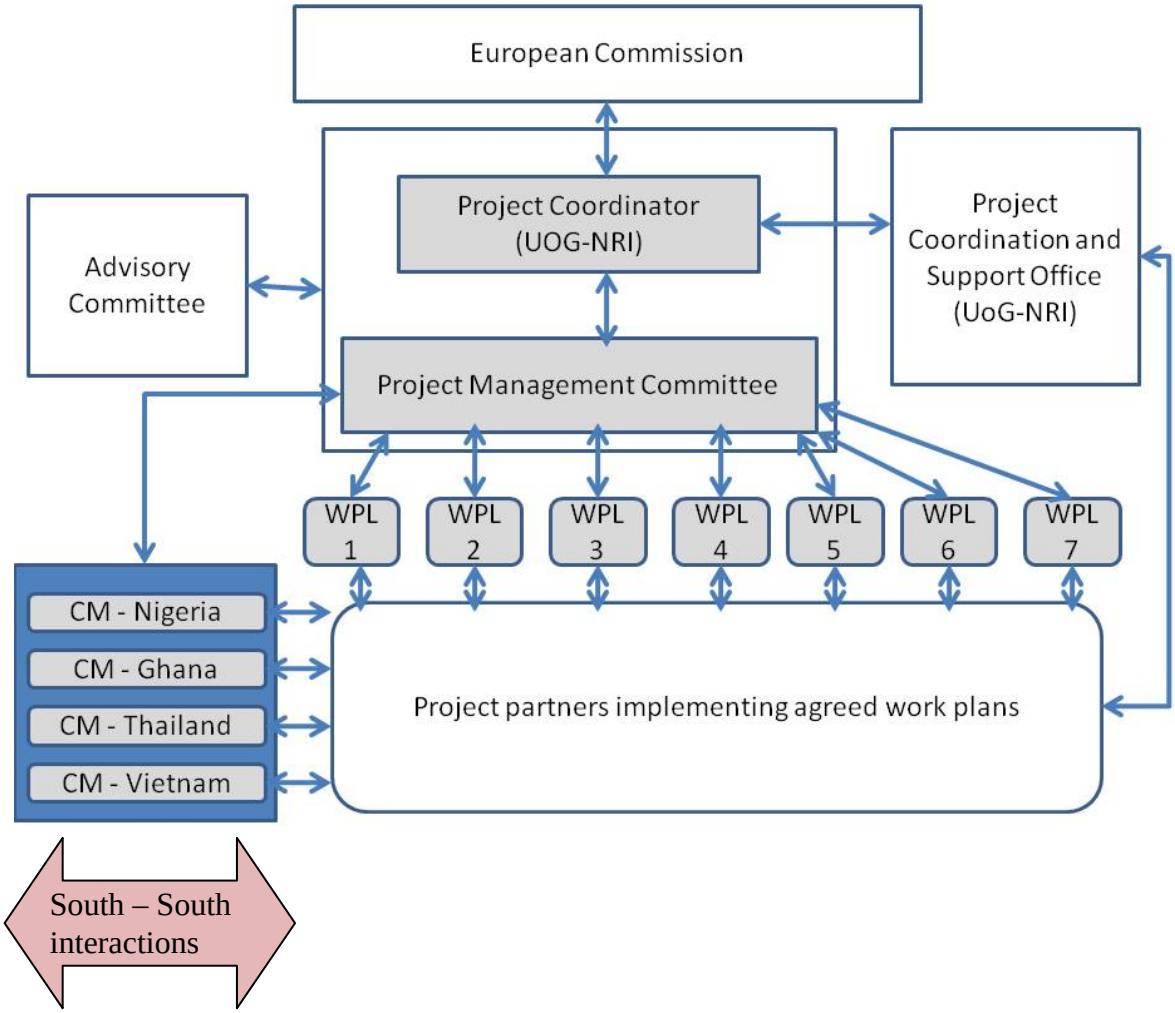
Country	Country Manager
Ghana	Nanam Tay Dziedzoave, FRI
Nigeria	Lateef Sanni, UNAAB
Thailand	Kuakoon Piyachomkwan, NASTDA
Vietnam	To Kim Anh, HUST-SBFT

Advisory Committee
The Advisory Committee will consist of 3-4 experts on tropical root and tubers who will provide strategic guidance to the programme. The Advisory Committee will meet virtually (Skype/telephone) once every six months and will have access to all of the outputs of the project. Provisionally the following (Table 3) have been identified as potential members and their membership will be confirmed once that the project has been approved.

Table 3: Proposed membership of the Advisory Committee.

Name	Experience
Professor William Otim Nape	Former Director General of the National Agricultural Research Organisation in Uganda; Cassava Specialist.
Dr Robert Asiedu	Director, International Institute of Tropical Agriculture, Nigeria. Yam specialist.
Dr Regina Kapinga	Root and Tuber Crops Specialist, Bill and Melinda Gates Foundation, USA
Professor Satish Chandra	Former AusAid M&E specialist and root crops specialist, Councillor for the International Society for Tropical Root Crops.

The interaction of the elements of the project management structure is shown in figure 4.



Note members highlighted in grey are all members of the Project Management Committee.

Figure 4: The project management structure.

Project coordination

Activities will be monitored, through an established monitoring and evaluation mechanism, along established lines of communication, principally with WP Leaders – mainly by e-mail and visits to each beneficiary. The Project Coordination and Support Office in Chatham will be supported by UoG-NRI staff as necessary (where scientific inputs are made, this will be charged at the RTG rate). UoG-NRI will be assisted by specialists from each of the beneficiary organisations to ensure coherence issues that cross WPs. Country Managers will ensure coordination at a national level.

Legal, contractual, financial and administrative activities will be coordinated through the Project Coordination and Support Office.

Consortium partnerships will be developed and monitored through established communications channels, reporting, meetings and visits in the region.

Organisation of the scientific and administrative meetings will be initiated at a kick off meeting. Annual review meetings (involving the Project Management Committee and Project

Partners) will be held, but the Project Management Committee will also meet regularly on a virtual basis using electronic communications (see below).

Ethical issues will be monitored throughout the project as described in part B.4. UoG-NRI has a code of practice on Ethics to cover interview technique and provide ethical screening. Ethical issues of a deeper level will be assessed by the University of Greenwich Research Ethics Committee and local ethics committees of partner organisations as required.

Agreements will be put in place for the management of intellectual property with month 1 of the project starting.

Managing planning, implementation and reporting:

Under the leadership of the Project Coordinator, the Project Management Committee will manage the planning, implementation and reporting procedures at all project levels through regular planning and review meetings focussing at WP level and through the annual planning and review meetings within the project mentioned above. Management reviews will focus on two elements. Attainment to plan (did we do what we planned to do) and performance (did it work). Management will be based on the principle of positive feedback: Reporting on implementation will advise planning, which in turn will advise implementation. Reports will be submitted to the Commission according to agreed schedules.

Platform for South-South interaction and engagement

The Project is keen to encourage and support the development of a platform for south-south interaction and engagement between the project partners and other potential parties. This platform will be led by UNAAB who are leaders of WP6. To promote this dialogue and interaction, the project will set up a Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free source e-learning software platform. While it was originally used in education as virtual learning environment is can also be used for the exchange of information and learning of ideas for partners in research projects. Moodle is a managed space; therefore proprietary information can be shared between member partners exclusively. Individuals and groups of partners can set up their own exclusive spaces for dialogue if required. Moodle has the potential to promote training, staff development and internal communication. An advantage for this project is that Moodle is free to use and hence can be cost-effective as a business model and will be sustainable beyond the duration of this project. The Moodle will be set up in association with the planned GRATITUDE web site.

Linkages with pertinent on-going external projects

The project will seek contacts with pertinent EC desks in order to inform and link with other activities. The Project Management Committee will also play a role in this. Contact with ongoing European projects, for example the EU ACP Science and Technology Programme project on tropical root and tubers and the Bill and Melinda Gates Foundation C:AVA project.

Monitoring and evaluation

A project monitoring and evaluation system will be developed during the initial stage of the project in order to assess project progress and impact. We will develop a set of indicators based on the project objectives, activities, deliverables and milestones as identified in the proposal. WP coordinators will be asked to report every 6 months on project progress against these progress indicators. Monitoring activities will be conducted at two levels:

- Evaluation of project progress: Regular monitoring of progress of project outputs and outcomes against indicators and milestones, and expenditures. This will enable the project management to assure the delivery of project outcomes and adapt project activities if needed.

- Monitoring of changes in post-harvest losses of direct project beneficiaries (SMEs): The initial project activities (in particular WP1) will provide information on the baseline conditions of post-harvest losses. Following the development of practices and technologies to reduce post-harvest losses in WPs 2-5, these practices will be disseminated amongst the participating SMEs in WP7. Uptake and impact of these practices will be monitored.

B 2.2 Beneficiaries

1	**Natural Resources Institute of the University of Greenwich** *www.nri.org/*	**UoG-NRI**	**UK**

Description and Experience
The Natural Resources Institute is a specialist institute of the University of Greenwich. Established more than 100 years ago, UoG-NRI provides research, consultancy, training and advisory services to underpin sustainable development, economic growth and poverty reduction. UoG-NRI has a programme of work focussed on post-harvest aspects of tropical root and tuber crops (cassava, yam and sweet potato) in which research and development activities have been undertaken in Africa, Asia and South America supported by a range of donors including DFID, the EC, the Bill and Melinda Gates Foundation. The Institute leads the Cassava Adding Value for Africa (C:AVA) project, a US$12 million initiative to development value chains for High Quality Cassava Flour in Ghana in Nigeria, Tanzania, Uganda and Malawi. Specific skills that UoG-NRI brings to the project include: post-harvest technology, processing, food quality and safety, value chain assessment and enterprise development.

Tasks
UoG-NRI will lead the project. The Institute has systems, registered to ISO 9001 by the British Standards Institute, for project management. Staff are experienced in management of European Union funded projects. Staff will lead WPs 1,7 and 8 and make technical contributions to other work packages to complement the skills of other partners.

Short profile of the staff members involved in the project

Name	Profile
Keith Tomlins	Reader in Food Safety and Quality. Over 20 years experience in international project management, research and consultancy. Expert in food quality, food safety sensory evaluation and consumer acceptability. Professional experience in Africa, Asia, Europe and North America. He will be the Project Coordinator and leader of WP8.
Andrew Westby	Director of UoG-NRI and Professor of Food Technology. Post-harvest technologist with over 20 years experience of root and tuber crops. Experienced project manager and leader of C:AVA. President of International Society for Tropical Root and Tuber Crops. He will provide strategic guidance and linkages to other initiatives
Ben Bennett	Marketing economist. Twenty years experience in commodity marketing and value chain analysis; participatory methods; market research; and economics of post-harvest systems and agribusiness. Experience in 28 countries and will lead WP1
Ulrich Kleih	Economist. Twenty years experience in agricultural marketing analyses, trade policy, rural non-farm livelihoods, rural transport, market information services, participatory approaches, combinations of qualitative and quantitative survey methods, food security with a commodity focus on roots and tubers. Country experience in Africa and Asia. He will contribute to WP1 and 7
Debbie Rees	Reader in Plant Physiology, and plant biochemist. 21 years research experience including: post-harvest technologies, photosynthetic mechanisms; cultivar selection to reduce post-harvest deterioration. Experience in Africa and South America. She will contribute to WP2
Louise Abayomi	Food technologist. Ten years experience in post-harvest technology of perishable produce incl. implementation of food safety and quality assurance systems, including HACCP; product development and shelf-life evaluation; and supplier-base auditing. Short-term overseas assignments in sub-Saharan Africa. Will participate in WPs 2,3 5 and 7
Adrienne Martin	Social and institutional development specialist; 28 years experience. Skills in:

	planning and evaluation; community-participation methodologies; gender and technology development; indigenous knowledge; agricultural policy and institutions. Experience in Africa and Asia. She will lead WP7 and contribute to WP1.
Aurelie Bechoff	Food technologist. Experience in root crop processing, post-harvest technology and food quality. Long-term experience in Burkina Faso, Ecuador and Uganda. Short term experience elsewhere in Africa. She will participate in WPs 3, 4 and 7.
Andrew Graffham	Food technologist with 14 years experience in food microbiology, food safety and quality assurance, Extensive experience of post-harvest processing and marketing of cassava. Has worked extensively in Africa. He will contribute to WPs 1, 3 and 4.

2	**Plant Research International of the University of Wageningen UR** *www.pri.wnr.nl*	**Wageningen Universit**	**NL**

Description and Experience

Plant Research International (Wageningen Universit) specialises in strategic and applied research. Thanks to the combination of knowledge and experience in genetics and reproduction, genomics, proteomics, metabolomics, bioinformatics, crop protection, crop ecology and agrosystems, it offers a unique range of perspectives for government and industry. Wageningen Universit serves the entire agro-production chain with scientific products, from the DNA level to production system concepts. Plant Research International regularly has articles in the leading scientific journals and has a superb infrastructure.

The Department of Plant Breeding is a merger between Plant Science Group of Wageningen Universit and Plant Breeding Wageningen University. It has a research group specialized in mushroom genetics, breeding and substrate utilisation.

Tasks

Wageningen Universit will lead WP4 (Adding Value to Waste Products). It has ample experience in research on substrate utilisation for the production of edible mushrooms. In a previous project (2003-2006), financed by the Dutch Ministry of Agriculture, Wageningen Universit has done capacity building on an applied research station in Indonesia (Lembang) for mushroom production (spawn technology, substrate production). Wageningen Universit has an extended collection of fungal strains that is not only used for mushroom production but also to pre-treat organic waste materials thus liberating (hemi)cellulose for enzymatic digestion. This pre-treatment also increases digestibility of organic waste for ruminants thus upgrade wastes into animal feed. Wageningen Universit has ample experience in leading and participating in EU projects.

Short profile of the staff members involved in the project

Name	Profile
Anton Sonnenberg	Senior Researcher in Mycology and leading for the last 15 years a research group on mushroom genetics, breeding and substrate utilisation. Professional experience in Indonesia, Europe and USA. Coordinator for a number of public-private partnership research programs. He will lead WP4
Johan Baars	Senior Researcher of Mushroom Breeding & Genetics. Baars has a biochemical background and experiences in nitrogen and carbon metabolisms in fungi. His expertise will be used in substrate formulations for mushroom production and pre-treatments of waste to animal food. He has ample experience in leading research projects.
Patrick Hendrickx	Research Assistant with ample experience in substrate research, fungal strain maintenance (slant tubes/liquid nitrogen) and spawn technology.
Ed Hendrix	Manager of Experimental Mushroom Production Facility. More than 20 years experience in experimental mushroom crop research with emphasis on new substrate formulas, new mushroom species and varieties and climate controls. His experience will be invaluable for testing substrates prepared with organic wastes.
X	PhD student to be appointed. This researcher will be appointed on a project titled "Increasing utilization of organic waste and low value feeds with the help of lignin degrading fungi " starting in February 2011 and financed by the foundation of technical research (STW; http://www.stw.nl/English). He/she will participate in WP4

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3	**Escola Superior de Biotecnologia – Universidade Católica Portuguesa**	**ESP-UCP**	**Portugal**

Description and Experience

ESB is a College of the Catholic University of Portugal, founded in 1984. ESB harbours the Centre for Biotechnology and Fine Chemistry (CBQF), a research unit that hosts over 100 researchers, ca. 15% holding doctoral degrees and ca. 50% postgraduate students. CBQF has consistently achieved the rating of Very Good in international evaluations promoted by the national research agency. In 2005, the Centre became a State Associate Laboratory in the Food and Environmental sectors.

ESB has a strong background in R&D in the Food and Environmental areas, collaborating in national and international projects. In recent past, ESB was involved in a Coordination Action of the Sixth Framework Programme, Food Quality and Safety - GRUB'S UP, Recycling and Upgrading Wastes from Food Production for use within the Food Chain, with an emphasis on recovering high-value products from by-products and EULAFF - European Federation of Biotechnology Latin America Action on Functional Foods and INSOLEX - Innovative Solutions for Extracting High Value Natural Compounds and TRUEFOOD - Traditional United Europe Food. Currently, ESB is involved in FP7 funded AFTER African Food Tradition Revisited by Research project. ESB research interests include biotechnology - carry out research in a range of key technologies for the production, characterization, and preservation of industrially processed food products as well as valorisation and sustainability of food residues or by-products. We are national reference for Food Safety owing our competences and research in risk assessment in food and environment field. The experience of research group that will be involved in the project and relevant to the project can be summarized into: (i) development and validation of bioactivity and safety of functional ingredients (biopeptides, antioxidants, probiotics, prebiotics and polysaccharides) and study applications on the development of novel functional foods (ii) by-product upgrading through fermentation and extraction processes aiming to obtain high-added value products (iii) optimization of quality product based on consumer acceptance and safety according European norms (iv) risk assessment in food chain particularly microbiological food safety- prevalence/incidence of pathogens in foods

Tasks:

Due to our competences and background we will be involved in WP4 developing new ingredients with high added value from cassava peel and brewing wastes and we are the leader of WP5 for Food Safety, Quality and Compliance.

Short profile of the staff members involved in the project

Name	Profile
Maria Manuela Pintado	Professor and Researcher (BSc in Pharmacy and PhD in Biotechnology – option Food Technology) – research field: Functional foods and fermented food products. She will lead WP5.
Paula Castro	Professor and Researcher (BSc in Food Engineering and PhD in Biotechnology) – research field: Environment and Valorisation of Food Products
Paula Teixeira	Professor and Researcher (BSc in Food Engineering and PhD in Biotechnology) – research field: Food Safety
Clara Priscillo	Post-Doc Researcher (PhD in Biomaterials) – research field: Valorisation of Food by-products and development of new materials

4	**Accord Associates** *http://www.accordassoc.biz/*	**Accord Associates**	**UK**

Description and Experience

Accord Associates is a business type enterprise with extensive experience in advisory work mainly in Africa and Asia. Its expertise is in the following areas:

- feasibility studies and business planning for new investments
- appraisals of commercial enterprises and projects
- market studies to identify opportunities
- establishing market linkages and the development of new markets
- strategic development of horticultural, floricultural and added-value industries
- training, contact promotion and monitored test marketing programmes to initiate and develop trade
- integration of the small-farmer sector into the commercial economy

Accord Associates is specialised in the commercial development of sustainable crops and processed products (including cassava). Clients range from development banks and venture capital funds to governments and private sector businesses. Prominent international organisations among its clients are the World Bank, USAID, FAO, IFAD, DEG, EU and IFC.

Tasks

Accord Associates will contribute to the enterprises development aspects of WPs 3 and 4.

Short profile of the staff members involved in the project

Name	Profile
Andrew Sergeant	Agri-Business - Dr Andrew Sergeant MBA has managed horticultural export enterprises since the 1980s, and has carried out consultancies identifying market opportunities and developing business strategies. This experience coupled with an MBA and a PhD in agronomy enables him to appraise and define real business opportunities for agricultural development. The practical background and considerable experience evaluating value-chains is a powerful base to develop new business opportunities
Peter Jaeger	Market Research, Analysis and Linkage - Dr Peter Jaeger identifies market opportunities through researching international trade in horticultural and agricultural products. He monitors trends and changes throughout the value chain from farm-gate to consumer. He has a clear perception of the international markets and the commercial realities of export trade developed from over 18 years in the field. Peter is also an accredited commercial mediator.
James Cartwright	Horticultural Export Management - James Cartwright MSc has some 20 years of diverse experience in developing countries. He is a Director of a major Kenyan horticultural export company and has managed both commercial export enterprises and International Aid projects. He has carried out short-term consultancy assignments in 28 countries. He has proven commercial skills across the range of horticultural businesses and products.

5	SABMiller PLC www..SABMiller.com	SABmiller	UK

Description and Experience
SABMiller plc is one of the world's largest brewers with brewing interests and distribution agreements across six continents.

SABMiller operates in numerous emerging countries in Africa, Asia and Latin America and believes that its business is not something separate from society. It is at one and the same time, an employer, a customer, a supplier and a taxpayer. The interests of SABMiller and the wider community are therefore inextricably linked. SABMiller has a track record of successful projects within its sustainable development program of “10 priorities” with enterprise development, waste and water reductions as 3 of the key deliverables.

Tasks
SABMiller will support UoG-NRI with technical expertise, access to pilot and manufacturing plants (WP4)

Short profile of the staff members involved in the project

Name	Profile
Wolfgang Tosch	Group Technology Consultant, leading product development within the R&D and Technical Innovation function of SABMiller plc. Extensive global experience in the Beverage, Food, and Biotech Industry. Expertise in starch/carbohydrate agromaterials and bio-conversion processes.

6	University of Agriculture, Abeokuta *www.unaab.edu.ng/*	UNAAB	Nigeria

Description and Experience

The University of Agriculture, Abeokuta (UNAAB) is one of the three universities of agriculture established by the Federal Government of Nigeria in January 1988. UNAAB provides teaching, research, and extension services including consultancy, training and advisory services to ensure sustainable agricultural development, income generation and poverty alleviation in Nigeria. UNAAB has a programme of work focussed on pre-and post-harvest issues on tropical commodities such as cassava, yam, banana, cocoyam, sweet potato as well as other food, industrial and livestock sectors in Nigeria. UNAAB is an active partner with the UoG-NRI on research and development of tropical root crops through funds from DFID, the EC, the Bill and Melinda Gates Foundation. The University is the country coordinator on behalf of UoG-NRI of the C:AVA project Specific skills that UNAAB bring to the project include: post-harvest technology, processing, food quality and safety, value chain assessment and enterprise development – all with a specific emphasis on tropical root and tuber crops.

Tasks

UNAAB will lead WP 6 and make technical contributions to other WPs. UNAAB will serve as the coordinating hub in Nigeria. The UNAAB has Staff that is experienced in project management and capacity building of private SMEs in root and tuber crops. UNAAB's extension arm (AMREC) that will undertake the demonstration storage technologies for yam with small-holder households.

Short profile of the staff members involved in the project

Name	Profile
Lateef Sanni	Professor in Food Science and Technology. Post-harvest technologist with more than 18 years experience of tropical root crops. Experienced project coordinator on cassava value chain. Country Coordinator to the UoG-NRI's Cassava: Adding Value for Africa (C: AVA) project sponsored by the Bill and Melinda Gate Foundation (2008-2013). He will be the Country Manager of the Project and Coordinator of WP6.
Kolawole Adebayo	Reader in Agricultural Extension and Communication. Research spanning 20 years include uptake and dissemination of agricultural innovations in smallholder farming systems, management and sustainable funding of agricultural development as well as rural livelihoods and management of the environment. Experience in project management includes leadership of the Adding Value to Waste in the Cassava Processing-Goat Keeping Systems in Nigeria for The WBDM (2009-2011) and the C:AVA project (2008-2013).
Shamsideen Oladehinde Iposu	Lecturer/Researcher in Ruminant Livestock Production; 18 years research experience in utilization of cassava in ruminant stock feeding; expertise in formulating cassava-based concentrate supplement for ruminant livestock. He will be in charge of livestock trials.
Segun Obadina	Lecturer in Food Safety. PhD in Food Microbiology. Over 8 years experience in Good Manufacturing Practices of staple foods especially from cassava, Microbiological analysis of foods from tropical root crops. Desk officer of DFID/AAU sponsored project on Food Science and Nutrition Network in West Africa. He will contribute to food safety aspect of the project.
Bernard Siwoku	Business Development specialist with over nine years experience in market linkages, community enterprise development and procurement. Involved in the pilot programme of the Sustainable Tree Crop Programme (STCP) and C:AVA Project. He will be in charge of the enterprise development and market linkages

7	**Food Research Institute of the Council for Scientific and Industrial Research.** *www.csir.org.gh/*	**CSIR-FRI**	**Ghana**

Description and Experience

The Food Research Institute (FRI) of the Council for Scientific and Industrial Research (CSIR) conducts market-oriented applied research in the area of food science and technology and provides technical services and products to the food industry in Ghana. It assists in poverty alleviation through creation of opportunities for generating and increasing incomes within the micro, small, medium and large scale food industry; contributes to food security, foreign exchange earnings and the application of cost-effective food processing technologies that are environmentally friendly. FRI is the lead institution for post-harvest research and development in Ghana, and is the first institute in West Africa to receive accreditation to ISO 17025. The Institute has collaborated with several government and non-governmental organisations, private sector partners, educational institutions, and community associations in the implementation of a number of post-harvest related projects in all the nine regions in Ghana. Notable amongst these are: The Millennium Development Authority (MiDA) project, C:AVA Project, The Expanded Markets for Cassava project, The sustainable uptake of Cassava as an Industrial Commodity project; Capability building for research into traditional food fermentation processing in West Africa project; Poverty alleviation and enhanced food availability in West Africa through improved yam technologies project. Root and Tubers Improvement and Marketing Programme, and the West African agricultural productivity programme. These projects have been variously funded by IFAD, DANIDA, BMGF, IDRC, DfID, and the EU amongst others.

Tasks

The Food Research Institute will lead in WP2- Reducing post-harvest losses of fresh produce, whilst making inputs in the implementation of WPs 1, 3, 4, 5, 6 & 7.

Short profile of the staff members involved in the project

Name	Profile
Dr. Nanam Tay Dziedzoave	Ph.D. in Food Technology. Has over 20 years experience in R &D, quality management, project management and consultancy. Specialist in post-harvest handling of root and tubers. Professional international experience in Zambia, Malawi, Tanzania and Mozambique. Project leader for the FRI, Country Manager whilst exercising direct responsibility for WP2.
Dr. Paa-Nii Johnson.	Ag. Director of the FRI. Holds a Ph.D. in Food Technology. Has over 20 years experience as a research scientist and in research management. Will provide professional advisory support and guidance on the project.
Mrs. Wilhemina Quaye	MSc in socio-economics, with specific experience in baseline studies and evaluation studies. Currently a Ph.D. student in rural sociology. 14 years of experience in research and development. Previously worked in the capacity of an M&E specialist. Will contribute WPs 1 and 6.
Dr. Charles Torto	Senior Research Scientist in food processing and specialised in dehydration of roots and tubers, fruits and vegetables. 11 years experience in R&D and participated in the implementation on donor-funded projects - , C:AVA, MiDA, RTIP, and RTIMP,. Ph.D. in Food science and dehydration. Will contribute to WPs 2, 5 and 7.
Mr. Gregory Komlaga	MSc in Food Science and Technology with over 10years experience in R &D in the areas of brewing, development of glucose syrups from cassava, and other root and tubers related works. Worked on the UNIDO Sorghum malting and brewing project, CAVA project, DFID-funded cassava projects etc. Will contribute to.

8	**Federal Institute of Industrial Research. Oshodi** *www.fiiro-ng.org/*	**FIIRO**	**NIGERIA**

Description and Experience

Federal Institute of Industrial Research, Oshodi (FIIRO) is a parastatal under Federal Ministry of Science and Technology. The Institute was established more than 50 years ago. FIIRO provides research, consultancy, training and advisory services to accelerate the industrialization of the Nigerian economy through finding industrial utilization for the country's raw materials and upgrading indigenous production techniques. FIIRO over the years worked extensively on post-harvest technology of root and tuber crops such as cassava, yam, cocoyam and sweet potato in which research and development activities have been sponsored by FAO, UNIDO, EEC, Bill and Melinda Gates Foundation, National Agricultural Research Programme (World bank sponsored programme). The Institute is involved in Cassava Adding Value for Africa (C:AVA) project in Nigeria. Specifically FIIRO is involved in processing, food quality and safety, value chain assessment and enterprise development.

Tasks

FIIRO will be a partner in the project. The Institute has staff that are experienced in management of funded projects. Staff will make technical contributions to the project and complement the skills of other partners specifically in WPs 3 and 4.

Short profile of the staff members involved in the project

Name	Profile
Dr Wahabi B. Asiru	Chief Research Officer and Registered Agricultural Engineer. PhD in crop processing and storage. Over 14 years experience in post-harvest technology, research and consultancy. Expert in Drying and storage technology, Design of processing machines and training of entrepreneurs. Member, Flash dryer design committee, IITA, Ibadan. Assistant coordinator for C: AVA in FIIRO. He will be the Coordinator of inputs from FIIRO.
Dr O. B. Oluwole	Deputy Director in Food Processing (PhD Food Processing and Storage Technology). Division of the Federal Institute of Industrial Research, Oshodi, (F11RO) Lagos, Nigeria. Post-harvest technologist with at least 20years. Experience on Root and Tuber crops Processing and Food Product Development. Experience in Research Projects on Food Processing and Food Product Development particularly from root and tuber crops for local and foreign funding. Member of Nigerian Institute of Food Science and Technology. Technical Committee Member of World Bank Step B Project Currently sponsored in FIIRO.
Felicia S. Adeyemo	Statistician, Business administrator and Technology manager. 29 years experience in technology marketing and economic studies of developed technologies, business plan and feasibility report preparation on developed technologies, organisation and resource person on technology transfer training workshops, business advisory services to prospective and practicing investors.
Dr Agnes Asagbra	Deputy Director. Waste utilization Division. PhD (Food and Industrial Microbiology) with more than 20 years experience in the utilization of fruits, cereals and agro-industrial wastes in fermentation to produce industrially important biochemical's, strain improvement; including implementation of food safety, quality assurance systems and HACCP auditing; product development and shelf-life evaluation. CAVA Training on the use of cassava for cultivation of edible mushroom in Akure Ondo state Nigeria in November 2010

9	**National Science and Technology Development Agency** *www.nstda.or.th*	**NSTDA**	**Thailand**

Description and Experience

The National Science and Technology Development Agency (NSTDA) is an Agency with a high degree of autonomy and mobility in order to conduct, support, coordinate, and promote efforts in scientific and technological development between the public and private sectors. At BIOTEC, the center aims to induce dynamics in research, development and application of biotechnology to support and transfer technology for the development of industry, agriculture, natural resources, environment and consequently the social and economic well-being of Thai people. As being one of the most important economic industrial crops of Thailand, cassava R&D program has been established since 1995 under BIOTEC. The program include three main laboratories including 1) Starch Biosynthesis laboratory which aims of achieving a complete understanding of the molecular regulation and biochemistry behind storage root development and starch biosynthesis in cassava and eventually being applied to develop new cassava varieties with desired properties; 2) The Excellent Center of Waste Utilization and Management (ECoWaste) which emphasizes in the anaerobic technology for the treatment of wastewaters from cassava starch factories and 3) Cassava and Starch Technology Research Unit (CSTRU) which focuses on R&D, human resource development and technology transfer concerning properties, processing and utilization of cassava and starch technology. Long experiences in R&D of cassava characterization, conversion and utilization as chips, flour and starch as well as undertaking applied researches in mechanical, chemical and enzyme process will be significantly support the project's goal achievement. The solid networking between BIOTEC/NSTDA and industry will further synergize to possibly demonstrate project's outputs as technology prototype at a pilot-scale.

Tasks

BIOTEC/NSTDA will involve in the project for developing value addition to waste products (WP4).

Short profile of the staff members involved in the project

Name	Profile
Klanarong Sriroth	Director of CSTRU, Faculty member of Dept. of Biotechnology, Kasetsart University, Technical committee in many National Boards for cassava, sugar, bioethanol & bioplastic researches, Honorary member of Thai Tapioca Starch Association. Involved in sugar and starch industry for more than 20 years. He is very prominent in starch, sugar and fermentation processing. He will participate in WP4.
Kuakoon Piyachomkwan	Food scientist. 13 years experience in properties, processing and application of cassava and starch in food products. Applying biotechnological process to convert cassava and starch to value-added or functional products. She will lead WP3 and contribute in WP4.
Sunee Chotineeranat	Food biochemist/ microbiologist. High expertise for more than 10 years in conversion technology of cassava to flour and glucose syrups.
Sittichoke Wanlapatit	Food engineer. 10 years experience in process engineering of starch, syrup and ethanol production from cassava feedstock including cassava pulp. Will contribute to WP4.

10	St Baasa Ghana Limited	SBGL	Ghana

Description and Experience

St. Baasa Ghana Limited was established on 24th December, 2009 as a limited liability company and is located in the Sunyani-West municipality in the Brong Ahafo Region of Ghana and is in the business of non-traditional food processing for the domestic and overseas markets, with the aim of adding value to our farm produce and also help our farmers have easy access to market their farm produce. To be nearer to direct source of raw material supply for production thereby avoiding buying from agents or middlemen who ply between farmers and food processing companies. St Baasa stands to help reduce rural-urban migration,

Tasks

SBGL will participate in the implementation of WP3, WP4 and WP5 involving improved value-added cassava products, validation and uptake of technologies developed for value addition to cassava waste and the uptake and implementation of Quality Management Systems.

Short profile of the staff members involved in the project

Name	Profile
Baah Dapaah	General manager, a farmer by profession. He has experience in food processing and has worked with many food processing companies for over 15 years. He holds a middle school leaving certificate.
Constance Frimpong	Food Technologist and head of Production And Quality control. She holds a bachelors degree in laboratory technology with five years working experience in the food industry. She has worked with Fan milk Ltd and Primo Industries Ghana Ltd and also has experience in food safety standards, quality assurance systems including GMP & HACCP and product development
Maxwell Adu Gyamfi	Administrator, he holds an A- Level certificate and has eight years working experience as a teacher and hotel administrator.
Kwame Danquah	Accountant, he is a certified chartered accountant with ACCA and a member of Ghana Institute of Chartered Accountants. He has fifteen years working experience as an accountant.
Kwasi Amponsah	Sales & Marketing Manager, He holds a bachelors degree in marketing and has five years working experience in marketing. He has worked with Adutwumwaa Bitters Co. Ltd and Spirit FM as Marketing Manager.

11	Caltech Ventures Limited www.nri.org/	Caltech Ventures	Ghana

Description and Experience

Caltech Ventures Ltd is an agro-processing company involved in the processing of cassava into higher value products. Caltech was incorporated in December 2005 as a Private Limited Liability Company. Caltech Ventures owns 2,500 ha of farmland at Hodzo, Volta Region 15km north-east of the Regional Capital – Ho. Currently, 400 hectares is cultivated with soybean (200ha) and improved variety cassava (200ha) supplying a 3 ton/day cassava flour factory. Cassava flour is used in the bakery, plywood, packaged food and corrugated paper board industries as a substitute for imported wheat flour. Soybean oil is used to produce biodiesel and used on the plantation while the soybean meal is sold to feed-millers.

Tasks

Caltech Ventures Ltd would participate in the implementation of WP3, WP4 and WP5 involving improved value-added cassava products, validation and uptake of technologies developed for value addition to cassava waste and the uptake and implementation of Quality Management Systems.

Short profile of the staff members involved in the project

Name	Profile
Chris Quarshie	Managing Director of Caltech Ventures. He has a BSc. (Mining Engineering) and MSc. (Mineral Economics) both from Columbia University, New York, U.S.A. He is an accomplished Business Executive with over 18 years extensive project and managerial experience. He will be the Project Coordinator.
Benjamin Bentil	Farm Manager since inception and has overseen the successful ongoing cultivation of both the cassava and soybean plantation. He has worked with the Ghana Cocoa Board and has had training in cassava agronomy and seminars with CIAT in Columbia and Embrapa, Brazil. He will provide strategic guidance to the project.
Edward Sarpong	Flour Factory Manger. He has 20 years of supervisory and managerial experience in various local production firms. He will provide strategic technical guidance to the project.

12	**School of Biotechnology and Food Technology, Hanoi University of Science and Technology** **http://***sbft.hut.edu.vn*	**SBFT**	**VN**

Description and Experience

The School of Biotechnology and Food Technology of Hanoi University of Science and Technology (SBFT) is one of leading institution in the field of biological engineering and food technology. Established since 1956 (as Faculty of Food Technology), SBFT provides training and research in food and biotechnology, equipment development and process control, consultancy service for solving technical problems in related industries. SBFT has expertise in food processing and product development, especially in beverage technology (brewery, ethanol, wine, drinking, juice...), food safety control, valorisation and bio-treatment of food industries wastes and wastewater treatments. Having rich experiences in working with cassava and cassava products development, beer and other food products and leading international and national projects, SBFT can bring its experiences and expertise acting as local coordinator for the project on: cassava product and valorisation of process by-products for value added products, process and equipment design and control, product safety management for local production promotion.

Tasks

SBFT will be the lead partner in Vietnam and participates in a range of WPS for development of cassava products and value added products from cassava process by-products.

Short profile of the staff members involved in the project

Name	Profile
To Kim Anh	Expert in biochemistry and enzyme technology. Over 15 years experience in international project management. Director of the School. Country Manager
Phung Thi Thuy	12 years experience in biochemical analysis and experience in enzymatic hydrolysis of biomass. Experience in project administration work.
Le Thanh Mai	Expert in brewery technology. Over 25 years experience working with yeast and over 15 year working with cassava starch processing. Experience in cooperation work.
Chu Ky Son	Specialised and 11 years research experience on fermentation and working with cassava starch.
Ho Phu Ha	Food technologist. Experience in microbial food safety; over 10 years experience in food processing. Experience in product development.
Tu Viet Phu	Skills in: sensorial analysis and consumer acceptability, marketing the product.
Do Thi Yen	Food technologist. Responsible for the technical hall where the technology can be evaluated at pilot scale. Skills in new product development
Luong Hong Nga	Technologist with 14 years experience in post-harvest technology, especially in starch-based product development.

13	Peak Precision Products Nigeria Limited www.peakproductsng.com	Peak	Nigeria

Description and Experience

Peak Precision Products Nigeria Ltd commenced cassava processing in 1997. The main products produced are high quality cassava flour and cassava starch. The company designed, fabricated and pioneered the use of locally fabricated cassava processing equipment. The company accounts for over 80% of cassava processing equipment used by SMEs in Nigeria. Some of these fabricated equipments have been exported to Tanzania, Mozambique, Zambia and Ghana.

By year 2000, the company became a reference point in cassava processing and cassava processing machinery fabrication for universities, polytechnics, research institutes (e.g. International Institute of Tropical Agriculture, C:AVA, Federal Institute of Industrial Research), State Agricultural Development Programmes, local and foreign investors etc. The organization was also engage in technology transfer to Malawi with participation from Uganda and Tanzania under the aegis of the C:AVA project

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Peak Precision Products Nigeria Limited core activity is Cassava processing machinery fabrication and cassava processing. The firm also engages in cassava farming with over 20 hectares of cassava planted at Ilaro in Yewa South Local government area of Ogun State. Training on appropriate processing methodology and empowerment of farm-gate value-adders by provision of mobile cottage processing equipment are also major lines of our business activities. Others activities include consultancy and marketing of cassava products.

Tasks

Peak *Precision* Products Nigeria Limited will be a key technology partner to the project. The company will participate in the development of appropriate root crop processing equipment and also in the validation and demonstration of developed technologies for root crops/wastes from root crops processing.

Short profile of the staff members involved in the project

Name	Profile
Ayo Olubori	**Chairman /Chief Executive Officer**- B.Eng Agricultural Engineering. Member of the Presidential Task Force on the disbursement of 500 million naira empowerment fund for cassava flour by the flour millers in Nigeria. Member of the ministerial task force of 5% composite flour inclusion level and a serving member of All Farmers Association Commodity Board. Serving member of Ogun state Agro-commodity Marketing Board Committee. National President of Nigerian Cassava Processors and Marketers Association (NICAPMA).
Femi Olubori	**Femi Olubori** is the Executive Director of the company B.ed Guidance and Counselling and N.C.E in Agricultural Science. He has 10 years of experience in the cassava industry.
Toyin Oso (Mrs)	Administrative Director She has over 6 years experience in the cassava enterprise.
Tayo Olubori	Operation manager with over 7 years of experience in cassava processing methodology.
Oladipo Abiodun	Farm manager H.N.D in Farm Management and Extension. Over 4 years of experience with Peak Products.

14	Nobex Technical Company Limited	Nobex	Nigeria

Description and Experience

Nobex Technical Company Limited is an SME engineering firm based in Lagos, Nigeria. The Company was incorporated in 1998 and licensed as fabricator and designer of Agro-Allied/Food processing machinery. We specialized in the designing and fabrication of post-harvest crops processing equipment like multi cassava processing, animal feed, drying, cleaning and storage.

In a nutshell, the company supplies machinery and complete Agro-Allied/Food processing factory equipment needed to convert almost every crop grown in Nigeria to human and animal feed. An order could vary from a small to multimillion industrial plants. Our business is built on integrity and total quality management.

Tasks

Nobex will act as a local technology partner to the project, involved in the development, testing and demonstration of improved cassava/yam processing technologies in WPs 3 and 4.

Short profile of the staff members involved in the project

Name	Profile
Adeoya Idowu	MD/CEO. A thoroughbred engineer with over 20 years hands on experience in the designing and fabrication of high quality Agro-Allied/Food processing equipment in Nigeria.
Felix Oladapo	A Chartered Mechanical engineer with over 20 years experience in the designing, fabrication and maintenance of high quality Agro-Allied/ Food processing equipment.
Ajiboro Ayodeji	An Administrative and business development expert with over 8 years business development experience. Responsible for overall clients' service functions.

15	Northeastern Starch (1987) Co., Ltd.	NEST	Thailand

Description and Experience

Northeastern Starch (1987) Co., Ltd. is one of Thailand's leading manufacturers and exporters of tapioca starch. Around 90 percent of its total output is exported to many countries in the global market, with the majority of shipments destined for Japan, USA, UK, Germany, Australia, New Zealand, Philippines, Singapore, Malaysia, Hong Kong, China and Russia. The company's annual turnover is approximately US$10 million.

Northeastern Starch (1987) Co., Ltd. has invested around US$1 million in its business, laboratory and maintenance, head office in Bangkok and a factory in Nakornratchasima. The company employs a total of 120 employees, including five engineers and six qualify chemist staffs. The company purchases cassava root, an important raw material, from agriculturists to feed into the production process. The company is very conscious of the need for quality in both its product and in its entire production process, so its production line is strictly controlled by qualified and experienced staff. Additionally, the company endeavors to increase the production efficiency by employing modern technology and improving packaging in order to extend product life.

Tasks

The company has great interests in waste utilization and seeks for cost-effective technology of that. In this project, the company will take part as a technology recipient for converting cassava pulps and peels to starch and sugar syrups. A demonstration unit at a pilot scale of using biotechnology for making starch and sugar syrups will conduct at the factory by the support of FP7 via NSTDA.

Short profile of the staff members involved in the project

Name	Profile
Mr. Anuwat Ruthaiyanont	Managing Director of Northeastern Starch (1987) Co., Ltd; Vice President of Thai Tapioca Starch Association (TTSA) Board.

16	Social Development and Improvement Agency	SODIA	Ghana

Description and Experience

Social Development and Improvement Agency (SODIA) is a local Non-Governmental Organisation in the Brong Ahafo Region of Ghana. SODIA was legally registered as an NGO in the year 2000 with both the Registrar Generals Department and The Department of Social Welfare (NGO office). SODIA's vision is to see rural communities live decently and assertive enough to claim for their rights. SODIA currently works in seven districts with around Ten (10) partners and in excess of 100,000 participants and beneficiaries in our programmes. SODIA has 14 full-time staff with an income in 2009 of GHC 360,000. As a result of this experience, it has produced leadership and partnership guides that has been widely circulated and are very much appreciated by our partners.

Since 2000 programmes in the Brong Ahafo and Northern Regions of Ghana had successfully managed projects in a variety of sectors in Health, Education, Water and Sanitation, Health and Hygiene, Agriculture, Environment with funding from UNDP, Action Aid, Concern Universal, Irish Aid, AIDLINK, DANIDA-TOMS, IBIS, Ghana AIDS Commission, Root and Tuber Improvement and Marketing Programme (RTIMP), C: AVA-Greenwich University in UK among others. SODIA is currently managing projects in the Brong Ahafo and Northern Regions including that involve the commercialisation of cassava products (C:AVA project from Greenwich University UK) and has expertise in education and dissemination.

Tasks

SODIA will be an implementing partner to the project specifically contributing to WP6 i.e. the field demonstration of storage technologies for yam and potentially some processing technologies for cassava. The organisation has both technical and field staff who will help in the direct implementation of the project. The staff are experienced in the management of donor funded projects from all over the world.

Short profile of the staff members involved in the project

Name	Profile
Aziizu Issifu	Development Practitioner and Director of SODIA. Over 12 years experience in Development work and consulting in Ghana. He will be the Coordinator of activities undertaken by the organisation.
Prince Gyamfi	Programme Manager with more than 10 years experience in project and programme management in various sectors in Ghana. Responsible for general programme management and quality assurance including M&E. MSc Development Policy and Planning. He will be providing support to the Project Officer in planning, implementation and reporting of the proposed project. Facilitator and trainer. He will be the programme implementation manager.
Isadore Nii Armah	Programme Officer with more than 6 years experience in community level work in Agricultural projects. He is also part of the team managing the C:AVA Project in SODIA.
Grace Dauri	Project Officer responsible for the day-to-day management and implementation of the project and will report to the Executive Director. Will support and supervise partner project coordinator and in consultation with the partner support team.
Eric Appau	Finance and Administration Officer with 8 years experience working on development, monitoring and evaluation of partner financial and administration capacity. MBA in Finance.
Linda Apore	Programme Officer. She has more than 6 years experience in development work. She has expertise in programme planning and participatory methodologies.

B 2.3 Consortium as a whole

This project brings together a critical mass of complementary skills to deliver technologies and systems capable of reducing the losses in cassava and yam value chains to contribute to food security in Africa and Asia.

Each of the developing countries has a national partner (Nigeria – UNAAB; Ghana – FRI; Vietnam - SBFT; Thailand – NSTDA) who is an acknowledged national/regional research leader in cassava and/or yam post-harvest systems. This is important for national credibility and developing linkages within the country. In addition to undertaking technical roles in the project and in some cases acting as WP leader they will act as a national focal point to ensure the coordination of project activities. UoG-NRI is an acknowledged centre of excellence for post-harvest research on tropical root and tuber crops and will provide either complementary or capacity building collaborative inputs to ensure that all the necessary technical, social and economic requirements are covered in the research activities.

Partners with specific technical skills and experience have been brought into the consortium. Wageningen Universit at Wageningen brings specific experience in mushroom production, which is one of the value added options for processing. In addition to working with the national expert partners, they will also work with FIIRO, Nigeria who have already carried out some preliminary work on mushroom cultivation. Experience in use of peels in Animal Feed rations is brought by UNAAB who have had some initial seed funding from when they won the “World Bank Marketplace” in 2008. NSTDA bring specific expertise in utilisation of cassava starch to produce added value products.

ACCORD brings relevant private sector enterprise development experience to the consortium. They are partners in the C:AVA project led by UoG-NRI and so their collaboration is builds on existing working practices with UoG-NRI, FRI and UNAAB.

The consortium is committed to the validation and demonstration of key technologies with the private sector and extension services. In terms of working with small-holder farmers in sub-Saharan Africa, UNAAB has an extension arm (AMREC) and in Ghana the project will work with SODIA. Both organisations have been effective in the C:AVA project at building the capacity of farmers to work with new technologies.

The consortium includes a number of SMEs in Ghana and Nigeria. PP and NF in addition to being companies who are involved in the cassava value chains are also manufacturers and sellers of processing equipment and hence will play a duel role in terms of technology development and testing and also in demonstration of technologies to the sector. PP is a particularly important company since the Managing Director is also President of the Processor Association which will be beneficial in terms of disseminating the technologies. SBGL and CV are two active SMEs in Ghana with whom technologies can be validated and tested. Since the processing based work package (WP3) and the value addition to wastes work page (WP4) both involve the development of sustainable enterprises as part of the demonstration activities, there was no hesitation of bringing on board a number of SMEs. This should contribute to the sustained uptake of the project deliverables.

In Thailand and Vietnam it is anticipated that larger scale industries will play an important part in absorbing produce produced by small-holder farmers. SABMiller is an international beverage company with headquarters in the UK, but with interests in a wide range of developing countries. It is interested to examine the use of cassava in its products and so benefit small-holder farmers. It would like to examine initially the option for doing this in Vietnam. This would be an interesting higher value chain into which cassava could be

placed freeing up other raw materials and so increasing the Food Security of the country. In Thailand the project will work with one of the leading starch companies for the testing and demonstration of technologies. These commercial companies have shown real commitment to the exploitation of the results of this project.

The main emphasis of the project is on the development and validation of technologies capable of reducing the physical and economic losses in the cassava and yam value chains and adding value to the waste from processing. The emphasis on new knowledge generation implies the importance of the research partners. However implementation partners (SMEs, larger scale enterprises and NGOs) are key members of the consortium to ensure the validity of the research outcomes and to demonstrate their potential for scaling up under real life field conditions.

i) Sub-contracting: There will be no subcontracting except for the audit certificates (UoG-NRI and UNAAB).

ii) Other countries: There will not be a need to carry out work in any additional countries.

iii) Additional partners: There are no unidentified participants in the project.

iv) Third parties: No third parties will be involved in the project.

B 2.4 Resources to be committed

A total of 632.5 man months of effort will be committed. WP8 is a management activity, WP1 to 5 are RTD, WP6 is DEM and WP7 is OTHER (dissemination).

Of the total budget requested 66% is RTD, 13% demonstration, 9% management and 12% for other (dissemination, networking, meetings etc). The contribution from the partner consortium will come from R&D-budgets of companies and research organizations and SMEs in contribution do the demonstration activities.

One partner, SABMiller plc, will, in addition to the EU contribution sought, make available their own manufacturing facilities, pay their own travel costs and pay for their own dissemination and demonstration costs where applicable.

The table 4 is an overview of the major costs requested by each partner (e.g. equipment).

Table 4: Equipment required by partner

Participant	**Durable equipment requested**	**Estimated cost (€)**
UoG-NRI (Coordinator)	None	0
PRI-WAG	Compost containers with adjustable ventilators and sensors	26,562
ESB-UCP	None	0
AA	None	0
SABmiller	None	0
UNAAB	Computers, cabinet dryers, colorimeters and a Rapid Visco Analyser	74,286
FRI	Moisture meter, pH meter, colour meter, centrifuge, texture analyser, laptops, photocopier, printers and overhead projector	113753
FIIRO	Equipment compost containers with adjustable ventilators and sensor	13,148
NSTDA	Equipment for starch and sugar syrup analysis	13,440
SBGL	Office equipment	5594
CV	None	0
SBFT	Thermorecycle dryer and an extruder	5,000
PP	None	
NF	None	
NS	None	
SODIA	none	

Regarding the allocation of costs, they are indicated in Table 5 for each partner. The resources have been agreed by the partners and provide sufficient costs to cover personal inputs (at the right levels of expertise and experience), travel to meetings, consumable costs to meet day to day activities and equipment to meet specific requirements. There are two subcontracts which are concerned with external auditing costs (UoG-NRI and UNAAB).

Table 5: Allocation of costs (Euros) for activity type for each partner

	UoG-NRI	Wagen	ESB	Accord	SABmiller	UNAAB	FRI	FIIRO	NSTDA	SBGL Ghan	CV	SBFT	Peak	Nobex	SODIA	NE starch	TOTAL
RTD																	
Rate (%)	75	75	75	75	50	75	75	75	75	75	75	75	50	75	50	75	
Personnel costs (in €)	252,625	138,150	85,689	36,000	104,166	125,000	84,375	25,000	85,000	3,750	3,750	61,800	3,750	3,000	3,750	3,600	1,019,405
Subcontracting (in €)	-																
Other direct costs (in €)																	
Travel	*74,000*	*15,500*	*26,288*	*12,500*	-	*10,375*	*10,000*	*6,000*	*37,056*	*1,765*	*1,765*	*41,250*	*2,000*	*2,000*	*2,200*	*2,000*	244,699
Consumables	*15,000*	*30,710*	*37,000*	-	-	*13,500*	*5,000*	*1,000*	*52,280*	*735*	*735*	*23,000*	*500*	*500*	*300*	*625*	180,885
Equipment	-	*28,165*	-	-	-	*76,125*	*85,000*	*13,000*	*44,405*	-	-	*50,750*	-	-	-	-	297,445
Other	-	-	*0*	-	-	-	-	-	-	-	-	-	-	-	-	-	
Indirect costs (in €)	204,975	91,334	89,386	29,100	20,833	135,000	110,625	27,000	20,015	3,750	3,750	35,360	1,250	3,300	1,250	3,735	780,664
TOTAL	546,599	303,858	238,362	77,599	125,000	360,000	295,000	72,000	238,756	10,000	10,000	212,160	7,500	8,800	7,500	9,960	2,523,094
TOTAL EU REQUESTED	409,949	227,894	178,772	58,199	62,500	270,000	221,250	54,000	179,067	7,500	7,500	159,120	3,750	6,600	3,750	7,470	1,857,321
DEM																	
Rate (%)	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
Personnel costs (in €)	15,368	-	-	-	-	15,000	12,500	5,000	24,000	10,000	10,000	9,600	10,000	8,000	10,000	7,680	137,148
Subcontracting (in €)	-																-
Other direct costs (in €)																	-
Travel	*16,000*	-	-	-	-	*16,000*	*7,000*	*4,500*	*6,662*	*6,000*	*9,000*	*20,000*	*7,700*	*7,700*	*7,700*	*9,700*	117,962
Consumables	*4,000*	-	-	-	-	*4,000*	*4,000*	*5,500*	*9,500*	*1,000*	*1,000*	-	*2,300*	*2,300*	*2,300*	*2,500*	38,400
Equipment	-	-	-	-	-	-	*29,000*	-	-	*3,000*	-	-	-	-	-	-	32,000
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect costs (in €)	21,221	-	-	-	-	21,000	31,500	9,000	5,016	12,000	12,000	5,920	4,000	10,800	4,000	11,928	148,384
TOTAL	56,589	-	-	-	-	56,000	84,000	24,000	45,178	32,000	32,000	35,520	24,000	28,800	24,000	31,808	473,894
TOTAL EU REQUESTED	28,294	-	-	-	-	28,000	42,000	12,000	22,589	16,000	16,000	17,760	12,000	14,400	12,000	15,904	236,947
MAN																	
Personnel costs (in €)	97,113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97,113
Subcontracting (in €)	12,690	-	-	-	-	2,700	-	-	-	-	-	-	-	-	-	-	15,390
Other direct costs (in €)																	-
Travel	*15,500*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15,500
Consumables	*9,500*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,500
Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect costs (in €)	73,268	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73,268
TOTAL	208,071	-	-	-	-	2,700	-	-	-	-	-	-	-	-	-	-	210,771
TOTAL EU REQUESTED	208,071	-	-	-	-	2,700	-	-	-	-	-	-	-	-	-	-	210,771
OTHER																	
Personnel costs (in €)	57,323	7,200	8,472	11,000	-	17,500	18,750	-	6,000	1,000	1,000	4,800	1,000	1,000	1,000	1,000	137,045
Subcontracting (in €)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other direct costs (in €)																	-
Travel	8,000	16,200	15,370	10,000	-	35,000	26,000	5,500	18,581	4,100	5,100	27,500	6,100	6,100	6,100	6,100	195,751
Consumables	8,000	-	1,000	-	-	1,000	10,000	-	3,000	2,000	1,000	3,000	-	-	-	-	29,000
Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect costs (in €)	43,994	12,080	14,905	12,600	-	32,100	32,850	3,300	4,510	4,260	4,260	7,060	1,420	4,260	1,420	4,560	183,579
TOTAL	117,317	35,480	39,747	33,600	-	85,600	87,600	8,800	32,091	11,360	11,360	42,360	8,520	11,360	8,520	11,660	545,375
TOTAL EU REQUESTED	117,317	35,480	39,747	33,600	-	85,600	87,600	8,800	32,091	11,360	11,360	42,360	8,520	11,360	8,520	11,660	545,375
TOTAL	928,576	339,338	278,109	111,199	125,000	504,300	466,600	104,800	316,025	53,360	53,360	290,040	40,020	48,960	40,020	53,428	3,753,134
TOTAL EU REQUESTED	763,631	263,373	218,519	91,799	62,500	386,300	350,850	74,800	233,747	34,860	34,860	219,240	24,270	32,360	24,270	35,034	2,850,413
Total Partner contribution	164,944	75,965	59,591	19,400	62,500	118,000	115,750	30,000	82,278	18,500	18,500	70,800	15,750	16,600	15,750	18,394	902,721

B3. Impact

B 3.1 Strategic impact

GRATITUDE will have the following potential impacts:

Interest and potential benefit to SMEs and a strong participation as partners
This project is strongly focussed on SMEs as delivers of impact. SME partners have already been identified as key partners in Ghana and Nigeria. There is an expectation that additional SME partners will become partners in the research activities in all of the countries as specific technologies are tested out. The development of processing options for cassava and yams as a means for reducing post-harvest losses is an obvious area for SME involvement. Several of the SME partners (Peak Products and Nobex) also have extensive experience in the development and sale of processing equipment – which is an additional added advantage of their collaboration.

Value addition to waste products from cassava and yam processing is another important area for SME involvement. Many of the SMEs have problems dealing with the waste from their processing and the option to add value to sell on for human food via animal feed, mushroom production etc offers new ways of increasing the profitability within the food chain. Work package 1 specifically aims to understand how these benefits will appear and how much of the benefit can be passed on to small-holder farmers and employees of these enterprises. By agreeing to be partners in this project the SMEs are indicating their interest in the research results and in further disseminating them. Some of the partners who manufacture machinery will stand to benefit from wider dissemination and they will see this as a source of future income. The Managing Director of Peak Products is also the President of the Cassava Processors Association which will also contribute to dissemination. These types of strong participation should make major contributions to the realisation of the impact of the project.

There is also recognition that larger scale enterprises also potentially can play a major role in creating demand for tropical root and tuber crops. SABMiller have interest in using cassava in their products and that product is likely to be supplied to them in form of high quality cassava flour produced by SMEs supplied small-holder farmers. This project will be involved in the proof of this concept in Vietnam. Work Package 1 will work to understand the impact of this on post-harvest losses (physical and economic). Similar NE Starch is a supplier of starch, the addition of value to waste products from their processing may well provide opportunities for the development of SMEs as service providers to these larger scale enterprises. The involvement of larger scale enterprises in Asia is a recognition of the different situation for cassava in these countries and the wider impact that there may be on food security created by substitution of more value commodities e.g. in beverage production and also a move away from biofuels into higher value crops in the context of limited land availability.

Not all impact can however be achieved with commercial SMEs and for that reason two of our demonstration partners work more directly with farmers. One is the extension arm of the UNAAB and the other is an NGO in Ghana (SODIA). These are necessary to ensure the comprehensiveness of our approach.

European and international added value
European and international added value comes from the project in a number of ways:

- Such a project allows research and implementation partners with complementary skills to come together to address post-harvest loss issues in the food chain in a comprehensive way that would not be possible without access to such funding.
- South-south learning between Asia and Africa is an essential component of the project that would not be possible without these funds.

- The size of the project always allows a critical level of effort to make significant progress.

Farm to fork approach
A value chain approach is proposed in the project that will allow a holistic understanding of the focus commodities, where losses can be reduced. This will natural involve farmers, processors, traders, food manufacturers and consumers. The views of consumers of the products prepared are important and will sensory evaluation and other consumer work will form an important part of the project. Consumer education forms an important part of the dissemination aspects of the project.

Technological advances
The project will assess where in the value chains for these crops post-harvest losses occur and hence the best practices to be developed and promoted. Our review of the "state of the art" and field experience of partners indicate where some of these are e.g. high storage losses in yams. The project will lead to the development of a range of technologies and systems. We have set our overall goal to develop and test systems capable of reducing post-harvest losses by the equivalent of 50%. An equivalence to 50% is used because of the different benefits that will come from better utilisation of waste, value adding through processing compared to the physical losses associated with physical storage losses.

Dissemination and education
Dissemination and education are important aspects of the project to ensure increased awareness of the issues and also to facilitate wider uptake of the project findings leading to a tangible contribution to achieving the Millennium Development Goals. The project potentially contributes to a number of the Millennium Development Goals related to reducing hunger and poverty (i.e. through greater food availability and improved food security) and increased incomes through the income generating activities; promoting gender equality and empowerment of women (the importance of women in post-harvest operations is recognised and a feature of our research will be to specifically benefit them). There is also a benefit to environmental sustainability in terms of reduced post-harvest losses means that resources (water, nutrients etc) have not been lost in terms of producing food that is then wasted. In addition, there are advantages in terms of dealing with some of the wastes from root crop processing some of which can be highly polluting to the environment. These are all tangible outcomes.

Socio-economic dimension of research
The project team have placed great emphasis on the socio-economic dimension to our research. Analysing the intended and unintended consequences of value chain development to reduce post-harvest losses forms an integral component of Work Package 1. The project has access to social, economic, gender and technical orientated researchers to ensure that these issues are understood at the planning and implementation stages. The commercial viability of the technologies developed is an important criterion for the project and will be analysed in work led by ACCORD. The project is committed to engage a range of stakeholder in our research and demonstration activities including from the private sector, civil society and as necessary policy makers. Linkage with other projects working in the same area and managed by UoG-NRI (such as the ACP-Science and Technology Project on Root and Tuber Crops and the Cassava; Adding Value for Africa Project) will help in this respect.

Steps need to bring out these impacts.
The main issue in bringing out these impacts will be in terms of scaling up and scaling out of the research activities.

- In general terms, partnerships are key to bringing about impacts from this research. Partnerships should have a range of expertise and knowledge, which is the case in

our project. NGOs/Civil Society are key conduits for impact since they work with households. SMEs are key for impact at enterprise level and will have been involved in the process from the beginning.

- The project's dissemination activities are really important for making the outcome visible and a good percentage of the project budget has been allocated to these activities. This project delivers technologies that are capable of reducing post-harvest losses by 50% and we are working in only four countries. Widespread adoption of the technologies will be necessary for widespread impact. For this reason the outcomes and outputs to the project will be widely disseminated and promoted to agencies with resources available for widespread impact. These will include the World Bank and the African Development Bank. Last year UoG-NRI (http://www.nri.org/news/archive/2010/20100326-postharvest-loss.htm) completed detailed reports for both the African Development Bank and the World Bank on the prospects and approaches for reducing post-harvest losses in Sub-Saharan Africa. World Bank and African Development Bank are both poised to support loss reduction programmes. African Development Bank has already outlined a programme supported by grants and loans to the tune of US$1.7 billion across a wide range of agricultural products while the World Bank plans to focus on mainly African cereal staples, and co-ordinate its programme thorough a new community of practice. The research from this project provides the kinds of validated technologies required for these implementation programmes.

Why this contribution requires a European (rather than a national or local) approach.
The need for a European or International Approach is mentioned above. A national or local approach would not be sufficient because:

- There are economies to be gained by carrying out research activities that benefit more than one country.
- There are opportunities to bring leading edge European research (in our project in terms of mushroom production, food safety and quality management, socio-economics, enterprise development and post-harvest technologies for root and tuber crops) together and to develop EU wide networks.
- There are opportunities for south-south learning – not only in terms of technologies but also in terms of systems. In several cases Thailand and Vietnam have developed differently to Ghana and Nigeria because of the different roles that cassava plays in the food system.
- There is critical mass of research that would not be achieved by research at a national level.

Taking into account other national or international research activities
The main research activities for tropical root and tuber crops mainly deal with commercialisation of the commodities (such as the C:AVA project described below or the Unleashing the Power of Cassava Project led by the International Institute of Tropical Agriculture) rather than a specific focus on reducing post-harvest losses or improved utilisation of waste. This project therefore fills an important gap in the current international portfolio of projects.

There is important work on the post-harvest physiological deterioration of cassava led by the University of Bath that is funded by the Bill and Melinda Gates Foundation, but since this project will mainly be using GM approaches to solving the problem it will be a longer term option for reducing losses in fresh cassava.

There are a number of research activities that are being undertaken on tropical root and tuber crops. Our partners are well networked into the International Society for Tropical Root and Tuber Crops where the latest developments in root crops development are regularly share. Professor Westby is the President of the Society and Dr Tomlins is the Councillor for

Publications. Involvement with the Society and leading the ACP Science and Technology Project on Tropical Root and Tuber Crops (in which UNAAB and UoG-NRI are key partners) provides mechanism to take into account other national and international research activities. In addition our Country Managers are national leaders in the field of tropical root and tuber crops and so are in regular contact with the activities of national researchers. These linkages also provide important mechanisms for the dissemination of research findings.

UoG-NRI leads the Cassava Adding Value for Africa Project which is a five year project that started on 1 April 2008 with the aim of developing High Quality Cassava Flour (HQCF) based value chains in Ghana, Tanzania, Uganda, Nigeria and Malawi to improve the livelihoods and incomes of at least 90,000 smallholder farmers. The Project is funded by the Bill and Melinda Gates Foundation and is coordinated by the Natural Resources Institute of the University of Greenwich working in partnership with national organizations in each of the focus countries. C:AVA promotes the use of HQCF as a versatile raw material for which diverse markets have been identified in pilot studies. The project will focus on three potent intervention points: (i) ensuring a consistent supply of raw materials; (ii) developing viable intermediaries acting as secondary processors or bulking agents in value chains and (iii) driving market demand and building market share (in, for example, for food (e.g. bakery, traditional foods), or non-food sectors.

Farmers and farmer/processors will be supported in production and primary processing activities through partnership with NGOs or other extension services. Business development and other specialists will support intermediaries to meet the requirements of end users. End users will be supported technically in adopting HQCF. Benefits to smallholder households have been estimated to be $190/smallholder household/year for a one off investment of $166/smallholder household (not including research costs). Allowing for 10% spill-in from other smallholders the cost reduces to US$99/farmer after 10 years. There will be additional benefits including: employment at the village and intermediary level, reduced raw material costs for end users and a reduced need to import wheat or other substituted raw materials.

C:AVA is not a research project, but it provides a platform in which new market opportunities such as those proposed in this project will be able to be tested under commercial conditions. This is a key advantage that this project has that will lead to a wider range of products that just the high quality cassava flour value chain developed in C:AVA.

There a number of design features of this project that specifically relate to interfacing with other initiatives:

- The Advisory Committee have good contacts into the international community which will help keep the project management team up to date.
- The Project Management Team have been specifically tasked to keep up to date with the other initiatives; and
- The dissemination activities of the project will help in creating awareness of our activities.

Other relevant FP projects in which partners have been involved include:

- INSOLEX - Innovative Solutions for Extracting High Value Natural Compounds.
  Type of project: R&D
  Time Period: 2010-13
  Financial Program: FP6 RTN (Research Training Network)
- "EULAFF: European Federation of Biotechnology Latin America Action on Functional Foods".
  Time period: 2006/09-2009/08
  Granting agency: FP6 Framework
- GRUB'S UP Recycling and Upgrading Wastes from Food Production for use within the Food Chain.

Granting agency: FP6 Framework
Time period: 2006-2009

- TRUEFOOD - FP6 Integrating and strengthening the European Research Area(IP)
  Granting agency: FP6 Framework
  Time period: 2006-2010
- AFTER - African Food Tradition Revisited by research. Collaborative Project Small or medium-scale focused research project.
  Time period: 2010-2013
  Granting agency: FP7 Framework
  SEALING FP7-ICT-2009-4 FP7 247648
- BIO CIRCLE FP7-KBBE-2008-2B FP7 227204
- SEA-EU-NET FP7-INCO-2007-1 FP7 212334

Other International projects are:

- IBEROFUN- Incorporation of new food ingredients as a contribution to the promotion of health and / or prevention of diseases of the Latin American population.
  Type of project: R&D
  Time Period: 2005-2013.
  Financial Program: Programa iberoamericano de ciencia y tecnologia para el desarrollo CYTED.
- New antihypertensive ingredients from whey proteins.
  Type of project: R&D
  Time Period: 2008-2010
  Financial Program: Transnational cooperation FCT/CSIC
- PRINSLAC - Valorisation of dairy industry by-products and design of food for vulnerable groups
  Time Period: 2005-2008
  Financial Program: CYTED - Research Program Ibero-Americano de Ciência e Tecnologia para o Desenvolvimento
- Frutactiva:DEVELOPMENT of Bioactive ingredients FROM NON-TRADITIONAL TROPICAL FRUIT (NATIVE AND EXOTIC) of Iberoamerican: IDENTIFICATION, EVALUATION, PRODUCTION AND SAFETY Time Period: 2011-2015.

Assumptions and external factors

Inevitably there will be a number of external factors that could influence the impacts of the project. Importantly, attempts will be made to understand these as the project progresses through the value chain studies. International commodity prices may have positive or negative impacts on the viability of the some technologies development, but understanding these will be part of the research process.

- Climate variability and the weather may impact on the project, but it is hoped that carrying out research in a range of locations should minimise these impacts across seasons.
- The project will be depend on reasonable political stability in the countries in which field work is carried, but this is not anticipated to be a major limitation.
- The political enabling environment could impact some of the initiatives, but it anticipated that good and effective communication will enable to right technologies to be research at the start of the project and the conditions for their uptake understood through the value chain studies.

B 3.2 Plan for the use and dissemination of foreground

A specific project work package has been developed to deal with dissemination activities (WP7). The objective of WP7 is to consolidate knowledge, package and disseminate information arising from the research and development activities of the project. It will also

build capacity for the management and productive use of ways of reduced post-harvest losses on yams (WP2), new products (WP3) and 'wastes' (WP4) from root and tuber crops at different stages of the value chain through training activities.

The specific objectives are:

- To develop a strategic approach to information dissemination which will inform major stakeholders (researchers, academics, agricultural professionals, private sector companies and investors) about the project objectives, approaches, partnerships and outcomes.
- To package and share information on techniques on reducing post-harvest losses of yam, added value through processing and to higher value products from waste and to monitor losses in the fresh product value chain. This will include peer reviewed publications as appropriate.
- To consolidate experience and develop training packages on how to increase value addition from techniques on reducing post-harvest losses of yam, added value through processing and to higher value products from waste products in cassava processing activities through their utilisation in new products such as mushroom production, animal feeds, snack foods, starch and sugars
- To support training in business skill development, marketing of new products, and food safety and quality assurance.

To promote lesson learning and information exchange among all partners and with a wider group of international stakeholders involved in food research, product marketing and policy making in developing countries and Europe.

The formulation of key messages will be coordinated across project partners and participants. An initial activity will be the project launch and press releases and media coverage in the respective countries. Dissemination products will be developed in response to the communication strategy and audience developed under Task 7.1 and will include private sector investors and policy makers. Close links will be maintained with other work packages for preparation and dissemination of knowledge. Further activities include;

- Construction of a project *web site* which will be regularly updated. It will make information accessible on the different research areas and specific country activities and events. Opportunities for interactive use of web based discussions etc. will be explored. The web site will also promote the training activities and materials, including those which are web-based or on CD rom/DVD.
- Publications and reports series; these will be produced in formats designed for different audiences. They will include formats for public outreach – such as newsletters, articles, case studies etc. and for more specialised professional audiences – technical publications, workshop reports etc.
- Visual communications: photographic records of project activities; video clips to use in information and training, presentations. Visual media will be particularly useful for encouraging and sharing feedback from and among women participants.

Efforts will be made to monitor the influence of the dissemination strategy through collecting feedback on web site features and monitoring web hits, distribution of publications etc. The visibility of the project as an EU funded programme will be consistently maintained.

The overall objective of these dissemination activities will be to make the project outputs more widely available and promote replication and uptake thereby increasing the impact of the project. These will support and be in parallel with the demonstration activities that will directly support uptake of the developed technologies and systems.

As indicated above communication of research outputs to donor agencies (including the European Commission, World Bank and African Development Bank are important aspects of the dissemination strategy.

Management of knowledge and Intellectual Property
A Consortium Agreement will be developed and agreed prior to the start of the project. Management of background and foreground intellectual property rights (IPR) will be according to the Grant Agreement and the Consortium Agreement. The following are the main principles:

- Background IPR made available to the project by individual partners will be declared and will only be made available for use in the project. Such knowledge and pre-existing know how will be used only for the purposes for which access rights have been granted.
- Foreground IPR resulting from the project belongs to that beneficiary which generated it. All foreground knowledge produced during the project will be assessed by the PMC in terms of need for IP protection before it is further disseminated. All data and results presented in reports or at project meetings will be deemed confidential to the consortium (including all its employees and (sub-) contractors) and the Commission until it is either properly protected or decided to be free for public dissemination by the beneficiary(s) owning the data or result and by the PMC.

Contribution to policy developments:

As part of the dissemination strategy, the project will produce key policy briefs to influence national and regional policies. These policy briefs will be related to food security, enterprise development, agricultural sector development and economic growth. The dissemination will be through the BMGF C:AVA project which is active in Nigeria and Ghana and a EU ACP Science and Technology project (FED/2009/217073 - Science and Technology for Enhancing the contribution of Tropical Roots Crops to Development in ACP Countries) that will disseminate in the ACP regions and also the International Society for Tropical Root Crops which is active in countries where RTC are produced and consumed.

B4. Ethics issues (if applicable)

Regarding the coordinating organisation (UoG-NRI), the University of Greenwich sets high ethical standards for the research that it carries out and this research is subject to the University of Greenwich Ethics Policy to ensure that ethical issues are adequately addressed (http://www.gre.ac.uk/research/rec/rep). The University of Greenwich Research Ethics Committee is comprised of experts in a range of disciplines, lay members and is independent and unbiased. Within the University of Greenwich, UoG-NRI has a code of practice and procedures (http://in.nri.org/qms/qms-user.php?f=view&document_id=4083) that have been approved by the University of Greenwich Research Ethics Committee. This will be followed for 'lower grade ethical issues' such as the undertaking interviews and participatory research with poor vulnerable communities.

In addition, ethical requirements and procedures of the GRATITUDE partner organisation or country governments where project activities are carried out (Nigeria, Ghana, Thailand, Vietnam, Netherlands, UK and Portugal) will be followed. Most organisations have their own ethics review committees, but some use external ones; for example, the Food Research Institute uses the Ethics Committee of the Noguchi Memorial Institute for Medical Research of the University of Ghana.

The main ethical issues in GRATITUDE are likely to concern the following issues (see also the Ethical Issue Table below):

- Undertaking interviews and participatory research with poor communities involving non-invasive procedures. This research will not involve particularly vulnerable populations (e.g. children under the age of 18 years old, migrants, sex workers, etc.).
- Undertaking sensory evaluation of developed products.
- Undertaking animal feeding studies with the wastes from the value chain.

1) Ethical clearance of the project

The GRATITUDE project will take the following approach:

- Copies of ethical/legal approvals by the competent local*/national Ethics Committees will be submitted to the European Commission prior to the commencement of the relevant part of the research.
- When applying for ethical/legal approval from the competent local*/national Ethics Committees, detailed information will be provided on the procedures that will be used for the recruitment of participants (e.g. number of participants, inclusion/exclusion criteria, direct/indirect incentives for participation, the risks and benefits for the participants etc.) and the nature of the material that will be collected (e.g. sensitive or personal data etc.). It will be explicitly stated if children or adults unable to give informed consent will be involved and, if so, justification for their participation will be provided.
- When applying for legal approval from the competent local*/national Ethics Committees, detailed information will be provided on privacy/confidentiality and the procedures that will be implemented for data collection, storage, protection, retention and destruction and confirmation that they comply with national and EU legislation, including Article 29 workgroup paper n°WP131 on The Processing of Personal Data Relating to Health in Electronic Health Records.
- The ethical standards and guidelines compatible with, and equivalent to, those of FP7 will be rigorously applied, regardless of the country in which the FP7 funded research is carried out.
- The coordinator will provide detailed information to confirm that fair benefit sharing arrangements with stakeholders from low income, non-EU Countries will be effectively managed during the project and that procedures will be implemented to facilitate effective capacity building, where applicable.

2) Participation in the project of an Ethics Advisor

An Ethics Advisor will be appointed to oversee the ethical concerns involved in the research carried out within GARTITUDE. A report by the Ethics Advisor will be submitted to the European Commission with the Periodic Reports, including a section on the training and ethical competence of the participants and any new ethical issues that might arise during the lifetime of the project.

Specific ethical considerations

GRATITIDE will not involve research on Human Embryo/Foetus but will involve research on Humans, involve Privacy, research on Animals and will involve ICP countries. The specific ethical considerations of the GRATITUDE project will be addressed as follows:

- Informed Consent
  Participants will give informed consent to any substantial participation in the GRATITUDE research undertaken. Participants should understand what the research is about, the sorts of questions they are likely to be asked or tasks they are likely to be asked to perform, why the research is being carried out, who is carrying it out and who is funding it, and what the benefits to themselves and their communities are likely to be (and if there is little or no likelihood of direct benefits that should be made clear). Participants should also be informed of who to contact with questions about the research, that their own participation is voluntary and that they can withdraw at any time.

- Confidentiality
  Confidentiality, anonymity and acknowledgement of participants' contributions will be respected. Only necessary data will be collected in GRATITUDE. Because of the multi-partner nature of the study (involving ICP countries) some data from survey maybe transferred from one county to another, but the following guidelines will apply. Researchers will make every effort to keep the identities of participants confidential except with their informed consent. An exception can be made for participants acting in their official capacities where identifying them is relevant to the research (for example, heads of local committees). If the researcher cannot guarantee such anonymity this should be clearly specified at the beginning of the interview. Protection of anonymity will also comply with the UK Data Protection Act 1998 and Freedom of Information Act 2000 and any other national requirements in partner countries. Data will be stored in a safe place, only used for the purpose agreed with the participant and not shared with others unless this has been agreed. Data put in the public domain, for example in reports and publications will not identify individuals or lead to the identification of individuals. While the protection of anonymity should be the norm, it is recognised that it is also important to recognise the contribution of participants to the research process through their knowledge, efforts and ingenuity. Naming individuals and publishing photographs of them, with their informed consent, can in many circumstances be an important part of this acknowledgement, and increase the sense of ownership participants have over the research.

- Conducting research
  Researchers in the GRATITUDE project will avoid undue intrusiveness: "the advancement of knowledge and the pursuit of information are not themselves justifications for overriding other social and cultural values". Examples of undue intrusiveness include applying pressure to start or continue an interview, not allowing participants the option of being interviewed at a later time, asking questions that cause distress or offence, or observing people without their knowledge. Researchers will be cautious in asking participants about the activities of third parties who are not present, or their opinions of third parties, although such questions may sometimes be justified as a means of uncovering inequalities or power structures. While research can itself be a process that helps participants to change institutions in the directions of increased equity and participation, researchers will act responsibly in not creating inflated expectations or exacerbating conflicts and disputes which will adversely affect the

poor and vulnerable. In this and other respects, researchers should have regard to the long-term consequences of their actions which will be felt after they themselves have departed. Sharing research findings shared with participants is an important part of the research process which can have major benefits in terms of empowerment of the participants, as well as creating a favourable environment for future research. Researchers will, wherever possible and appropriate, arrange to have research findings shared with participants. Attention will always be paid to issues of safety, harm and risk to participants, research assistants, researchers, and future researchers in the same locality.

- Sensory evaluation of foods

  The sensory evaluation of foods in considered an invasive procedure and therefore all work on sensory acceptability will be referred to the relevant ethics committees according the country where the work is carried out and the partners involved in the work. All such studies will go through the University of Greenwich Research Ethics Committee because UoG-NRI is the Project Coordinator. Appropriate food safety assessment will be carried in advance of any sensory evaluation work.

- Animal studies

  Goats and other animal currently eat cassava and yam peels on waste dumps. We have demonstrated on a pilot scale that instead of the dump and burn practice, simply sun drying, packaging would make it easier for livestock keepers to buy and use the peels as supplement to feed goats. The key research question here is: Would compounded feed supplements based on cassava and yam peels (dry or fungi treated) improve weight gain, feed digestibility or any other growth parameter of ruminants? To answer this question, WAD goats reputed to be the hardiest of ruminant is the traditional candidate for the investigation. When the investigation takes place at UNAAB a detailed proposal will be submitted to the Board of UNAAB's Institute for Food Security and Research in Agriculture (IFSERA). The University of Greenwich Research Ethics Committee will also receive a copy of this proposal. The proposal will ensure that all national and international guidance and regulations related to the use of animals in research are followed. This will include relevant food safety assessments.

ETHICS ISSUES TABLE

	Research on Human Embryo/ Foetus	YES	Page
*	Does the proposed research involve human Embryos?		
*	Does the proposed research involve human Foetal Tissues/ Cells?	No	
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?	No	
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?	No	
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?	No	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

Research on Humans	YES	Page

*	Does the proposed research involve children?	No	
*	Does the proposed research involve patients?	No	
*	Does the proposed research involve persons not able to give consent?	No	
*	Does the proposed research involve adult healthy volunteers?	Yes	WP1, WP2, WP3, WP4
	Does the proposed research involve Human genetic material?	No	
	Does the proposed research involve Human biological samples?	No	
	Does the proposed research involve Human data collection?	Yes	WP1, WP2, WP3, WP4
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	Yes	WP1, WP2, WP3, WP4
	Does the proposed research involve tracking the location or observation of people?	No	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

	Research on Animals [1]	YES	Page
	Does the proposed research involve research on animals?	Yes	WP4
	Are those animals transgenic small laboratory animals?	No	
	Are those animals transgenic farm animals?	No	
*	Are those animals non-human primates?	No	
	Are those animals cloned farm animals?	No	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

	Research Involving ICP Countries[2]	YES	Page
	Is the proposed research (or parts of it) going to take place in one or more of the ICP Countries?	**Yes**	**WP1 to WP7**
	Is any material used in the research (e.g. personal data, animal and/or human tissue samples, genetic material, live animals, etc):		
	a) Collected in any of the ICP countries?	**Yes**	**WP1 to WP7**

[1] The type of animals involved in the research that fall under the scope of the Commission's Ethical Scrutiny procedures are defined in the Council Directive 86/609/EEC of 24 November 1986 on the approximation of laws, regulations and administrative provisions of the Member States regarding the protection of animals used for experimental and other scientific purposes Official Journal L 358 , 18/12/1986 p. 0001 - 0028

[19] In accordance with Article 12(1) of the Rules for Participation in FP7, 'International Cooperation Partner Country (ICPC) means a third country which the Commission classifies as a low-income (L), lower-middle-income (LM) or upper-middle-income (UM) country. The list of countries is given in annex 1 of the work programme. Countries associated to the Seventh EC Framework Programme do not qualify as ICP Countries and therefore do not appear in this list.

	b) Exported to any other country (including ICPC and EU Member States)?	**No**	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

	Dual Use	YES	Page
	Research having direct military use	No	
	Research having the potential for terrorist abuse	No	
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	As indicated	

B5. Gender aspects

The consortium fully supports the commitment of the EU and FP7 in promoting gender equality. A gender-sensitive approach to research, its management and implementation, will be applied to contribute to upholding research excellence and address issues of gender inequality in science and research.

The consortium will actively support, through leadership and resources, equal opportunities for men and women in research. We will work in line with the principles of the European Charter and Code of Conduct for the Recruitment of Researchers and undertake targeted recruitment of women, encourage participation of women in decision making, and address both practical and strategic gender needs in the workplace. Monitoring and management systems for the project will be developed with gender and diversity in mind, both to track participation levels of men and women in different positions, and collect feedback of staff. Mentorship opportunities will be explored to improve capacity of female scientists.

For investment in research to result in improvement in income, livelihoods, and food security of smallholder households it is important to widen participation including encouraging women and young men to engage in profitable production, processing and marketing. Therefore, the consortium will mainstream a gender approach into all aspects of the project. Our understanding is that men and women have different roles and responsibilities that shift and change over time and context, which interacts with other modes of difference, such as age, ethnicity and religion. These relationships give rise to different experiences, livelihood needs and outcomes.

The research programme will include a gender and diversity analysis that will identify differences in the following areas between women, men and different groups:

- Gendered division of labour, participation and decision making at different points of the cassava and yam value chains, terms of participation and conditions of work.
- Differences in access to and control over technology and capital to invest in technology, impact of new technology on workload, time access to benefits etc.
- Skill levels to use and maintain technology, access and participation to capacity building/support services.
- Impact of project (new food products, technologies and training) on workload, time, access and control over resources, and meeting livelihood needs.

The project will use gender-sensitive methodologies, such as including gender and diversity variables, separating men and women in interviews and focus groups, holding activities in gender-neutral locations, consulting relevant institutions, and holding gender-balanced training sessions, consultations and events. Data collected during the project will be

analysed by sex and diversity indicators. The findings will be used to understand outcomes for different groups and continually feedback into the project.

Finally, the research dissemination phase will present gender and diversity results in project outputs to contribute to the further understanding of gender and equality in science and research. Workforce statistics will be included in regular reporting along with gender-related outcomes of the project.

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