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Climate-Smart Agriculture: A call for action

Synthesis of the Asia-Pacific Regional Workshop
Bangkok, Thailand, 18 to 20 June 2015

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Foreword

The latest scientific reports are unequivocal in their conclusions that climate change as a result of human activities is not some kind of future hypothetical event. The effects are already here, in real time. It is leading to melting of sea ice, thawing of permafrost, sea level rise, heat waves, shifts in precipitation, and increase in extreme weather events leading to floods, droughts and wildfires. Such weather events will have adverse impacts on food security, viz. in terms of availability, accessibility, stability and utilization. The hardest hit will be the poor – climate change will increase hunger and malnutrition, and worsen the living conditions of rural communities that are wholly dependent on natural resources for their livelihoods. Superimposing this on a future scenario where the world's population is expected to reach 9 billion by 2050 brings about a worrisome situation. The situation for the Asia-Pacific region would be far more severe, considering most of the population growth will occur here, and the region is already experiencing the impacts of climate change.

Considering food security will be overwhelmed by climate change, in 2012 FAO, the World Bank and several countries promoted the concept of Climate-Smart Agriculture (CSA) at the first Global Conference on Agriculture, Food Security and Climate Change. The Conference called for mobilizing CSA as a means to enhance agricultural productivity and incomes, resilience to climate change and where possible to reduce or eliminate green house gas (GHG) emissions. While work with CSA approaches is forging ahead in many parts of the world, the Asia-Pacific region has yet to capture the benefits of such developments. Many countries in the region have yet to become acquainted with the concept, and incorporation of CSA into their national agricultural strategies would remain unachievable. In view of this, FAO and other development partners have begun to step up their efforts to mainstream CSA in the region. This workshop is one pivotal start to such an initiative.

This summary report of the workshop brings together knowledge on CSA and puts it at the forefront; and vigorously explores how to implement such technical knowledge on the ground. It also captures the roles that international and regional agencies can undertake to further strengthen agricultural productivity in the region that is already experiencing the impacts of climate change. We can also hear from the countries about their specific concerns, and the routes they intend to pursue in the face of climate change. The report also provides valuable information of successful case studies that agriculturists have been innovating and practicing for centuries in some cases as a means to address food security under adverse circumstances.

Furthermore, one of the recommendations of the workshop calls for initiating an important regional platform for supporting CSA work in the region. This would be a critical initiative to strengthen the development of CSA throughout the region. Clearly, this workshop has laid an important foundation for strengthening the CSA approaches in the region, and I foresee rapid uptake henceforth. However, this excellent start and collaboration should continue if we are to meet the needs of the region. With this short note, I wish to congratulate all the individuals for their outstanding efforts in organizing this workshop, and capturing effectively the proceedings in this summary report.

Hiroyuki Konuma

Assistant Director-General and Regional Representative for Asia and the Pacific
Food and Agriculture Organization of the United Nations

Contents

List of acronyms

ACSA	Alliances for Climate-Smart Agriculture
ADB	Asian Development Bank
AF	Adaptation Fund
AMIS	Agricultural management information system
ASEAN	Association of Southeast Asian Nations
AVA	Agri-food and Veterinary Authority (Singapore)
AWD	Alternate Wetting and Drying
AWG-LCA	Ad-Hoc Working Group on Long-Term Cooperative Action (UNFCCC)
BCR	Benefit-Cost Ratio
CAAS	Chinese Academy Of Agricultural Sciences
CCAFS	Research Program on Climate Change, Agriculture and Food Security
CDM	Clean Development Mechanism
CEO	Chief executive officer
CGIAR	Consultative Group for International Agricultural Research
CoP	Conference of the Parties
CRN	Climate Resilience Network (ASEAN)
CRP	CGIAR Research Program
CSA	Climate-Smart Agriculture
CSO	Civil society organization
CSVC	Climate-Smart Value Chain
CSVs	Climate-Smart Villages
CTCN	Climate Technology Centre and Network
CTNFC	Climate technology network and finance center
EPIC	Economics and Policy Innovations for CSA (FAO)
ESS	Environmental and social safeguards
DEVCO	Directorate-General for International Cooperation and Development (EU)
DSS	Decision support systems
FAO	Food and Agriculture Organization of the United Nations
FMB	Forestry Management Board
FU	Facilitation Unit (GACSA)
GACSA	Global Alliance for Climate-Smart Agriculture
GAP-CC	German Programme on Response to Climate Change
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GFAR	Global Forum on Agricultural Research
GHG	Greenhouse gas
GIZ	German Organization for International Cooperation (*Deutsche Gesellschaft für Internationale Zusammenarbeit*)
GNH	Gross National Happiness
GRA	Global Research Alliance on Agricultural Greenhouse Gases
HQ	Headquarters
ICMP/CCCEP	Integrated coastal and mangrove forest protection/climate change and coastal ecosystems program (GIZ)
ICT	Information and communication technology
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation

IMO	Institute for Marketecology (Switzerland)
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
JPO	Junior Professional Officer
LDC	Least Developed Country
LF	Leasehold Forestry (Nepal)
LFLP	Leasehold Forestry and Livestock Programme (Nepal)
LFUG	Leasehold Forestry User Group (Nepal)
MAM	Mangroves and Markets
MDG	Millennium Development Goal
MOAC	Ministry of Agriculture and Cooperatives (Thailand)
MOAD	Ministry of Agricultural Development (Nepal)
MOOC	Massive Open Online Course
MoU	Memorandum of Understanding
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NAPCC	National Action Plan for Climate Change (Mongolia)
NDAs	National Designated Authorities
NEARC	Northeast Asian Regional Cooperation
NGO	Non-governmental organization
NRM	Natural resource management
NTFPs	Non-timber forest products
NTUC	National Trades Union Congress (Singapore)
OCCD	Office of Climate Change and Development (PNG)
PES	Payment for environmental services
PFES	Payments for forest environmental services
PLs	Post larvae
PPP	Public-private partnership
PRDP	Philippine Rural Development Program
PSF	Private Sector Facility (GCF)
PVC	Polyvinyl chloride
RAP	United Nations Regional Office for Asia and the Pacific (FAO)
RIICE	Remote Sensing-based Information and Insurance for Crops in Emerging Economies
SAARC	South Asian Association for Regional Cooperation
SACAU	Southern African Confederation of Agricultural Unions
SAPA	Sectoral Adaptation Plan of Action (Bhutan)
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDGs	Sustainable Development Goals
SMS	Short Message Service
SPC	Secretariat of the Pacific Community
SPS	Sanitary and Phyto-Sanitary
SRI	System of rice intensification
SWOT	Strengths, weaknesses, opportunities and threats
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

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Executive summary

The "Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action" was held on 18 to 20 June 2015, in Bangkok, Thailand, with the aim of sharing knowledge and experience on implementing Climate-Smart Agriculture (CSA) among stakeholders from the Asia-Pacific region. A total of 61 participants attended the Workshop, of whom 27 were representatives from 21 countries in the Asia-Pacific region. The Workshop resulted in the following conclusions and recommendations.

Conclusions

I. Enabling environment (policy, institutions, legal framework, finance, governance, etc.) for sustainable CSA

- Scientific knowledge to address climate change and opportunity to apply CSA
- Analysis, simulation and climate projections and trends (e.g. are we ready for sea level rise in the coastal zone? Specific trends for specific commodity)
- Policymaking: which options to choose under variable and unpredictable climate change?

II. Priority actions (implementation level) for mainstreaming and scaling up CSA

a) Present situation – Lack of awareness of CSA

   Future challenges associated with the situation – Political commitment in terms of integration of different ministries, and financing and allocation

b) Present situation – Need for mapping CSA practices, including available technology, knowledge, resources and policies

   Future challenges associated with the situation – Capacity building: i) Who is going to do what? ii) Changes in mindsets and breaking the barriers of lack of collaboration

III. Enhancing regional collaboration and networking

Current arrangements are not satisfactory. Therefore, there is a need for platforms both at national and at the regional levels to:

- share knowledge
- facilitate collaboration and cooperation
- set joint goals
- raise awareness, both for farmers and for policymakers
- facilitate exchange of information related to resource mobilization opportunities, both for knowledge creation as well as technical assistance and implementation
- have political support
- be non-prescriptive
- find common goals

a) At the national level, a platform that:
   - has one focal point, from Ministry of Agriculture
   - has membership from a wide range of stakeholders: governmental, academic, civil society, private sector, etc.

b) At regional level:
   - has rotating chair(s)
   - has a facilitating body hosted by a country
   - is composed of the focal points (country members) of the national platforms
   - core functions to be supported by the country members
   - maintains close links with existing networks, e.g. ASEAN, SAARC, SPC and NEARC groups
   - Regional CSA Secretariat be financially supported by the contribution from hosting country, participating member countries, and/or partners
   - can draw upon support from FAO/RAP for initial setting up of the Regional Secretariat including drafting the TOR and other support for networking

Recommendations: The following recommendations were made:

i. Through a collaborative mechanism, improve understanding of climate change in agriculture by mapping climate change effects and scenarios and incorporate them in seasonal climate outlooks.

ii. Through active community participation, increase awareness on the impacts of climate change at community level that is location specific.

iii. Enhance institutional capacity on climate-smart practices for end users, including development of common CSA tools.

iv. Develop a common SWOT analysis for countries to develop their own mechanisms that are based on their experiences, from consultation to implementation and monitoring and evaluation of CSA approaches.

v. Identify appropriate mechanisms for engaging the experiences of stakeholders, including the creation of appropriate regional platforms for listening to grassroots stakeholders.

vi. Include mainstreaming of CSA in all National Reports and communication documents.

vii. Set-up a national committee/steering committee under the auspices of the highest policy making body of the government, through development of concept notes and policy briefs and raising awareness within the government.

viii. Allocate more funds for CSA activities from the national governments by inserting them into national action plan.

ix. Pilot CSA at national level through local administration, by including participants from farmers, governments, civil society and community-based organizations.

x. Forge partnerships with development partners, FAO amongst others, through projects on stocktaking, mapping, inventory of technology, knowledge (including traditional knowledge), expertise and practices.

xi. Countries to initiate the development of national CSA platforms.

xii. Viet Nam, with initial support from FAO/RAP, to host a regional CSA platform.

Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action

Introduction

The latest news to hit the headlines about climate change is that oceans are becoming acidic, and this is beginning to affect life in them. This is one more news item driving home the fact that climate change is not hypothetical, and the effects of global warming are already becoming obvious. We are beginning to witness floods, droughts, shifting of monsoon patterns, and more frequent and intense weather events. These will have wide-ranging effects on the environment, especially on agriculture and food security.

More than any other region, the people in the Asia-Pacific region are likely to be hardest hit as a result of climate change. Agriculture is likely to be the most vulnerable sector because of its dependence on climate and weather. From a livelihood point of view, the people in the Asia-Pacific region are mainly agrarian, with almost 60 percent of its population living in rural areas. This means almost a billion people will face the direct impacts of climate change, with disastrous consequences to their livelihoods. In addition, the region's population is expected to increase by another 850 million people by 2050, which will severely test the region's ability to maintain food security. Producing enough food for the increasing population in the face of decreasing resources and changing climate would be a daunting challenge.

The impacts of climate change in the Asia-Pacific region are expected to be multifaceted. Overall, the region is expected to become warmer. In the Pacific region, rising sea levels may not only affect the livelihoods of the people, but also liveability among the smaller islands. Coastal areas of South and Southeast Asia are likely to face the triple threats of changing rainfall, temperature and sea levels. The cooler northern regions of Asia are likely to become warmer. Changes in rainfall patterns can result in severe water shortages or floods. Rising temperatures can cause changes to crop growing seasons or even reduce their yields. In addition, there will be further knock on effects on the environment which will impair agricultural production as a whole.

The existing dependence of people in the region on agriculture and rural poverty means that careful planning will be required for adaptation to the impacts of climate change. There is therefore a need to explore approaches to reduce vulnerability of the region's agriculture. This could be in many forms, which include improving the markets, changing agricultural policies, enhancing social protection and preparing for disasters. But such reactive adaptations have their limitations. More adaptive improvements are required instead. With this in mind, in 2012 FAO, along with the World Bank and several other countries, held a Global Conference on Agriculture, Food Security and Climate Change. At this Conference, the concept of Climate-Smart Agriculture (CSA) was introduced.

CSA is an integrative approach to address the interlinked challenges facing food security and climate change through the three dimensions of sustainable development: a) economic – sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development; b) social – adapting and building resilience of agricultural and food security systems to climate change at multiple levels; and c) environmental – reducing and/or removing greenhouse gas (GHG) emissions from agriculture (including crops, livestock and fisheries).

CSA is new in the sense that it considers climate risks that are already happening with much more intensity. These new risks require changes in technologies and approaches, and entails greater investment in: managing climate risks, understanding and planning for these adaptive changes that are required, and making use of opportunities for reducing or removing GHG emissions wherever possible. CSA relates to actions both on-farm and beyond, and includes technologies, policies, institutions and investments. The approaches include: a) management of farms, crops, livestock, aquaculture and capture fisheries to manage resources better; b) ecosystem and landscape management to conserve ecosystem services that are critical for increasing resource efficiency and resilience; and c) services for farmers and land managers to ensure they are able to implement the necessary changes.

Since FAO floated this approach at the 2010 Hague Conference, the CSA concept has been achieving wide ownership among governments, regional and international agencies, civil society and the private sector. There are also global and regional alliances on CSA (called Alliances for Climate-Smart Agriculture [ACSA]) which are providing platforms for sharing and collaboration among the interested parties. However, with a few exceptions, the concept of CSA does not seem to have taken roots in the Asia-Pacific region at all. So far, only Japan, the Philippines and Viet Nam are members of the Global Alliance for Climate-Smart Agriculture (GACSA). There is a need to urgently step up the mainstreaming of CSA in the Asia-Pacific region, this Workshop being a beginning in this effort (Annex 1).

Objectives

The objectives of the Workshop are to share knowledge and experience on implementing Climate-Smart Agriculture among public, civil society and development agencies, and promote the mainstreaming and up-scaling of CSA.

Anticipated outputs

Based on those objectives, the expected outputs of the Workshop are:

- Knowledge and understanding of participants on CSA enhanced;
- Good practices and case studies on CSA in different countries shared and discussed;
- Priority actions to mainstream and up-scale CSA are identified and agreed;
- A regional-level collaboration and partnership is forged for facilitating countries to promote CSA as well as to implement priority actions linking the CSA approach with agriculture-related investments, polices and measures in their transition to CSA; and
- A report summarizing the presentations and discussions at the Workshop including conclusions and recommendations (elaborated after the workshop).

Participants

A total of 61 participants attended the Workshop. Of them, 27 participants were representatives from 21 Asia-Pacific countries, and the rest were from other United Nations and International Agencies, regionally based development partners and non-governmental organizations (NGOs).

Summary of the Workshop

I. Session – Opening

The Workshop, convened from 18 to 20 June 2015, discussed what CSA is about and how to mainstream the approach in the Asia-Pacific region, and was attended by 61 participants. It was held in Nai Lert Park Hotel, Bangkok. The focus of the Workshop was the concern with the threat of climate change on food security, and approaches that exist to sustain agricultural productivity and livelihood, building resilience to the expected changes, and how agriculture can also play a role in GHG emission reductions or removals. Considering this focus, the Workshop's presentations and discussions dealt with the rapidly deteriorating state that agriculture is facing, what CSA is in the context of food security, what technological, policy and institutional changes are needed for mainstreaming CSA at local and national levels, the types of support various agencies in the region are providing in this effort, and how from ancient times agricultural communities have been developing traditional agricultural systems to adapt to climate change and what they offer in terms of innovating agriculture in the region. Additionally, the Workshop provided the platform for countries to share the status of development related to CSA, the threats they are facing from climate change, and the need for developing collaboration and networks or alliances at national and regional levels to enhance the implementation of CSA approaches.

The Workshop commenced with welcoming remarks by Mr Hiroyuki Konuma, FAO Assistant Director-General for Asia and the Pacific (Annex 2). He pointed out that FAO and other international agencies have been successful in recent years with the "Zero Hunger Campaign" in reducing the number of hungry people globally. However, this may be a temporary achievement, and the food security situation may be reversed with climate change and the concomitant deterioration taking place with natural resources. So, this Workshop has been devoted to solving the impending food crisis likely to be experienced as a result of climate change. He also pointed out why there is a need to emphasise the CSA approach. It represents a more holistic approach to address issues that are inter-connected. The CSA approach looks at economic, social and environmental aspects of agricultural production simultaneously, and is more likely to succeed under the circumstances. This was followed up by the opening remarks of H.E. Dr Le Quoc Doanh, Vice Minister, Ministry of Agriculture and Rural Development, Viet Nam (Annex 3). He highlighted that the Post-2015 Sustainable Development Agenda and the United Nation's Zero Hunger Challenge recognize food and nutrition and poverty alleviation as a key priority. While much progress has been achieved, the challenge still remains as a billion people still live in poverty. This is further compounded by climate change, which is likely to lead to crop failures and food shortages, especially in the tropics. While there is a need for solutions to increase productivity and incomes, some fundamental changes would be needed in agriculture so it can be part of the solution and not remain as an emitter of GHGs. In this respect, Viet Nam has begun to restructure its production systems and has started implementing adaptation actions. He also called for more collaboration at the regional level to bolster efforts in CSA application.

II. Session – Keynote speeches

Following the opening session, three keynote speeches were delivered by: i) Mr Fred Snijders, Senior Natural Resources Officer, FAO (Annex 4); ii) Mr Arie Veldhuizen, The Netherlands' Agricultural Counsellor for Viet Nam and Thailand (Annex 5); and iii) Dr Suan Pheng Kam, Senior Researcher, WorldFish (Annex 6). The three speeches are summarized below.

Keynote address 1: Food security and climate change – Fred Snijders, FAO, Rome

With the possible threat of climate change to food security, FAO has been promoting the CSA approach to ensure agricultural productivity is sustainable, resilient to climate change, and if possible to reduce GHG emissions. CSA, as defined by FAO, is an approach that helps guide actions to transform agricultural systems to effectively and sustainably support food security in all its aspects. CSA comprises of three pillars: i) increase in productivity and income growth in agriculture; ii) support adaptation to expected climatic changes and build resilience; and iii) reduce where possible GHG emissions. Increasing productivity and income growth has to be achieved against a background where the world's population is expected to increase, and people's diet will be shifting towards more meat-based products. However, agriculture is already facing limitation in arable land, yield stagnation, and deterioration of natural resources and ecosystem services. Furthermore, many of the agricultural practices are resulting in negative side effects as well. Despite these pressures, the agriculture sector has to adapt to expected climatic changes and to build resilience. The expected climate changes would affect growing conditions of crops, livestock, fish, trees, etc. The developing countries, mainly in the tropics, would likely face the brunt of the negative impacts of climate change. Climate change perforce requires that agriculture undergoes adaptation which would include agroforestry, crop diversification and improved crop management. Conservation agriculture is another strong adaptation approach to climate change. And where possible, CSA calls for reduction of GHG emissions from agriculture. The approach being promoted is resource use efficiency, improved management and combining reduction of intensity with productivity increase. Currently Asia is the largest source of emissions from agriculture. There are several entry points to follow with emission reduction, with the adage, "produce more but emit less". To bring about positive change in food security with climate change, there is a need to create an enabling environment, which includes political will, appropriate policies, increase the evidence base and involve all stakeholders in decision-making.

Keynote Address 2: Food security in a changing climate: How to move to action – Mr Arie Veldhuizen, Agricultural Counsellor, The Netherlands

Food security requires strengthening in: increasing sustainability, production, resilience to climate change, reducing emissions, and lowering global food waste and losses. For success with food security, we must rely on the strengths of all its stakeholders, from smallholders to multinationals. Partnerships between the private sector, research institutions, civil society and governments will be crucial to feed the world's growing population in the face of the impacts of climate change. In this regard, The Netherlands is supporting development programmes overseas with a focus on adaptation to climate change. Besides that, The Netherlands is engaged in developing innovative new techniques to minimize impacts of climate change such as harnessing sustainable heat from geothermal sources, development of "climate neutral" tomato, and growing crops adjusted to saline conditions. The Netherlands is also collaborating with other agencies and supporting international forums to galvanize and catalyse climate change action. In this respect, the GACSA was recently launched by the Prime Minister of The Netherlands. The country is also working with institutions such as the Global Research Alliance on Agricultural Greenhouse Gases (GRA), whose mission is to reduce the emission intensity of agricultural production by improving efficiency and productivity. Another initiative of The Netherlands is exploring methods to reduce food waste – worldwide one-third of food is lost or wasted from the production to consumption stages. At a time when climate change undermines food systems and the threat of conflicts are increasing, The Netherlands aims to contribute to worldwide sustainable economic development in the agricultural sector, as an engine for fair income and productive employment, thereby producing enough and safe food for 9 billion people by 2050.

Keynote Address 3: Why climate-smart agriculture? – Dr Suan-Pheng Kam, Senior Researcher, WorldFish Center, Malaysia

Climate change threatens to undo years of progress achieved in agricultural development, with the most severe consequences falling on developing countries and the poor. CSA can ensure agricultural development and food security are not compromised. Climate change simulation models indicate broad trends of warmer, wetter climate with more marked seasonality, and more unpredictable weather events that affect agriculture directly and indirectly. As a result, climate change is affecting crop yields, especially at low latitudes. Climate change is also affecting nutritional quality of food – C_3 grains and legumes grown at elevated CO_2 concentrations have lower levels of zinc and iron. Climate change impacts on meat and fish production will also affect human nutritional balance. Climate change is affecting marine fisheries – many species are moving away from the equator to cooler waters. Livestock too is affected – with decline in pasture productivity; this will lead to decline in meat and milk production. Given the large population in the Asia-Pacific region, with region-wide poverty, the number of people affected by climate change will be much higher than in other regions. To overcome the impact of climate change, an array of interventions for adaptation and mitigation have been tested. Specific adaptation measures include: improved crop varieties and livestock and fish breeds, simple adjustments to land, crop and livestock management, more efficient use of water and energy for food production, better weather forecasts and timely provision of such data to farmers, and sustaining ecosystem services of forests and water sources. Likewise, mitigation of emissions or sequestering carbon can be achieved through soil management, livestock management, improved fertilizer management, etc. Overall, being climate-smart, as illustrated by the livestock sector, entails integrating various aspects of stock breeding and selection, animal health and disease management, grassland and feed management, and manure management. Practicing CSA is often considered a "no-regrets" strategy in that its benefits of sustainable improvements in agriculture will accrue even if climate change impacts turn out not to happen or be as severe as expected. Further, it is important to consider climate-smart management of agriculture within a broad socio-ecological context, recognizing that climate change is one of the many drivers of change influencing the agricultural sector. The CGIAR Research Program (CRP) on Climate Change, Agriculture and Food Security (CCAFS) is piloting projects such as "climate-smart" villages to deal with climate change in a more holistic manner. The research is now being revised to address climate change as a cross-cutting issue to be addressed in meeting the challenges of reducing poverty, improving food and nutrition security, and improving natural resource systems and ecosystem services. Climate change is global, and response to its impacts must be universal.

III. Session – Technical presentations

The Workshop also invited leading experts from the region to provide technical presentations on important themes as a means to increase the understanding of the participants in various aspects that are related to CSA. The areas identified for technical presentations and the specialists were: i) technologies available for scaling out CSA – by Dr Pramod Aggarwal (Annex 7); ii) inclusion of agriculture in United Nations Framework Convention on Climate Change (UNFCCC) negotiations – by Dr Promode Kant (Annex 8); and iii) funding mechanism for climate change adaptation and mitigation – by Mr Leo Hyoungkun Park (Annex 9). Their presentations are summarised below.

Technical presentation 1: Scaling-out climate-smart agriculture in Asia-Pacific: Opportunities and constraints – Dr Pramod Aggarwal, Regional Program Leader (South Asia), CCAFS, India

Asia-Pacific appears to be amongst the most vulnerable regions to climate change impacts. In fact, it is already evident that Asian climate is changing and the impacts are being felt. With almost 1 billion people dependent on agriculture, this vulnerability is likely to take a huge toll on their livelihoods. If the Sustainable Development Goal of ending poverty, achieving food security and promoting sustainable agriculture is to be realized, climate change adaptation and mitigation technologies, practices, services and policies will need to be implemented urgently. CSA offers the means to adapt to climate change. CSA can be promoted through some key activities. The first is to make full use of untapped potential of currently available technologies. There are large yield gaps in almost all crops in most Asia-Pacific countries. These gaps provide huge opportunities for increasing food production even in the face of climate change. For this to happen, investments in land and water management, infrastructure, and research accompanied by enabling policies, sustained regional cooperation and robust institutions are crucial. Next is the potential of information and communication technology (ICT) and insurance for managing climate risks. Short-term changes in weather extremes are not predictable, and can result in fluctuating yields, food price volatility and threatened food security and incomes. While there has been great progress in ICT and crop insurance products, the vast majority of farmers have not received the benefits of weather forecasts and crop insurance schemes. Third is the opportunity to identify and exploit potential benefits of climate change. While climate change is generally seen in negative terms, countries in the higher latitudes could be gainers. In the higher latitudes, change in temperature invariably reduces crop duration for most species, and is suitable for shorter-duration crops/varieties. Research on alternate land-use for various regions needs to be accelerated to enhance our capacity to adapt to climate change. Fourth, there is a need to use science and technology for improved targeting of CSA technologies and policies. Climate-smart interventions have varying costs and environmental and economic benefits. So investment decisions in CSA technologies and policies should be based on relevancy in current and future scenarios of climate and economic impacts. Fifth, there is a need to approach CSA solutions in a holistic and integrated manner. CCAFS is adopting the Climate-smart village as models where researchers, local partners, farmers and policymakers collaborate to select the most appropriate technological and institutional interventions based on global knowledge and local conditions to enhance productivity, increase incomes, achieve climate resilience and enable climate mitigation. Sixth, and last, there is a need to address simultaneously poverty, governance, institutions, and human capital which limit agriculture growth even today. It is critical to address these political and socio-economic constraints if the full potential of CSA is to be realized for farmers and the region as a whole.

Technical presentation 2: Agriculture at UNFCCC: Paris and beyond – Dr Promode Kant, Director, Institute of Green Economy, India

After all, it was food security and hence agriculture, which was the primary concern when the world agreed to meet in Rio de Janeiro in 1992 to negotiate the first framework convention on climate change (UNFCCC). The ultimate objective of the Convention is to limit the concentration of GHGs in the atmosphere at a level that would prevent interference with the climate system to ensure food production is not threatened. With the recognition that warming climate due to uncontrolled use of fossil fuels is threatening agriculture, countries made a commitment to develop, make available, and use technologies and processes to reduce GHGs in agriculture, and to cooperate in preparing for adaptation to the changing climate, particularly in areas affected by drought, desertification and floods. Under the Kyoto Protocol (1997), developed countries agreed to promote sustainable forms of agriculture, and undertake reforms to progressively phase out market imperfections in all GHG emitting sectors. The inclusion of emissions and reductions by agricultural sources remains optional. However, all countries are required to formulate and implement national programmes to mitigate climate change and to adapt to it in the field of agriculture in order to achieve sustainable development. The Annex A to the Kyoto Protocol lists enteric fermentation, manure management, rice cultivation, agricultural soils, prescribed burning of savannas and field burning of agricultural residues as the main mitigation opportunities in agriculture. Later, under the Bali Action Plan, the mandate to bring agriculture into climate negotiations was covered under the Convention's provisions that sought cooperation in the development and diffusion of technologies to reduce emissions in the agriculture sector. Negotiations on agriculture continued at Copenhagen. While there was no further development in Cancun, a major breakthrough took place in Durban in 2012 when the Convention managed to separate agriculture from other sectors and asked the Subsidiary Body for Scientific and Technological Advice (SBSTA) to consider issues relating to agriculture with the aim of exchanging views and enabling a decision in the future. Some developed countries (i.e. the European Union) stated that in parallel to the need for adaptation, there are large opportunities for mitigation in the agriculture sector without affecting food security and livelihood. The Least Developed Country (LDC) group, however, cautioned against this view, and pointed out the overwhelming dependence of their economies on agriculture and the high vulnerability of the sector to climate change, and their priority is with adaptation. Therewith, discussions with SBSTA remained with undertaking scientific and technical work in developing early warning systems and contingency plans in relation to extreme weather events, assessment of risk and vulnerability under different climate change scenarios, identification of adaptation measures, and identification and assessment of practices and technologies to enhance productivity sustainably in farming systems. Nevertheless, agriculture has found a place in the National Adaptation Plans of Action of most LDCs. Going forward, in Paris (December 2015) the Intended Nationally Determined Contributions (INDCs) are likely to form the centre of negotiations for climate architecture beyond 2020. In conclusion, one could say that while agriculture has a good potential for mitigation of climate change, and is the prime candidate for adaptive action, there is still little prominence given to the agriculture sector in the climate change negotiations so far.

Technical presentation 3: State of play: Update from the Green Climate Fund – Mr Leo Hyoungkun Park, Financial Institutions Specialist, Green Climate Fund, Republic of Korea

The Green Climate Fund (GCF), established in 2010, is the operating entity of the financial mechanism of the UNFCCC for long-term climate finance. To date, 33 countries have pledged US$10.2 billion to invest in the green economies of developing countries. The GCF's mandate is twofold: it aims to combat climate change while at the same time giving equal weight to economic development and job creation in a green economy. For preparing countries to be able to access the funds, the GCF has developed a Readiness Programme. It supports countries in building capacity of their focal points/national designated authorities, developing a strategic framework, identifying and supporting local implementing entities to be accredited with the Fund and develop project pipeline, and host events to share information and knowledge. Under this programme, the GCF will disburse US$1 million per year per country. The core funding areas are in two windows, viz. for mitigation (50%) and adaptation (50%). The GCF has identified several strategic impact-results areas within its two funding windows. In the mitigation window, the categories which overlap with agriculture include land use, deforestation, forest degradation, etc. In the adaptation window, a number of areas are linked to agriculture, and include livelihoods, health and well-being of people, food and water scarcity, and ecosystems and ecosystem services. The Fund is currently receiving funding proposals from various accredited entities around the globe. An investment criteria has been established to assess the proposals. The criteria include impact potential, potential to catalyse the impacts beyond the one-off project, potential to provide wider benefits such as creation of jobs, economic and financial soundness of the project, etc. Accreditation to the GCF is open to all entities if they can meet both their fiduciary standards and environmental and social safeguards. The Fund also has a mandate to work with the private sector, for which the Private Sector Facility (PSF) was created. It aims to maximize private sector investment engagement with climate finance in developing countries. The PSF will work on creating synergies among public and private stakeholders to support the development of adequate national climate change strategies that address key investment barriers.

IV. Session – Presentation of climate-smart agriculture success stories from Asia

Introduction

Although the impact of climate change on agriculture is now being intensely debated globally, it should be also recognized that farmers have been experiencing climate change in the region for centuries, and have been adapting their practices to such impacts. At the same time, farmers have in recent years begun to adopt new technologies without much external support. Many of the traditional practices are pre-adapted to climate change, are low-carbon approaches which are sustainable, cost effective, and bring higher yields and incomes. These aside, completely new innovations are also being implemented in the region. These approaches are very valuable, and deserve more publicity with a view to further replication across the region. With this in consideration, FAO identified some of the farming practices, and started their documentation. Seven case studies which have been finalized were presented during the session. The full reports are in Annex 10, and their summaries are as follows.

1. Aquasilviculture: An environmentally friendly mariculture system in Viet Nam – prepared by Dr Vu-Anh Tuan, Research Institute for Aquaculture; presented by Dr Ta Quang Kien, MARD, Viet Nam

The case study was conducted in a current aquasilviculture model at Nhung Mien hamlet, Ca Mau Province, Viet Nam. The model was introduced as an environmentally friendly mariculture system to adapt to climate change. Each farm of about 4 ha was comprised of three components: mangrove forest area, water area for aquaculture, and remaining land for other trees and crops. The waters were stocked with black tiger shrimp and mud crablets. No feed, chemicals or antibiotics were used. The shrimps were harvested after about four months. These farms have received organic shrimp certificates based on the Naturaland standard, and they will receive a premium of 10 percent higher than regular prices in the area. Besides aquaculture, management of the mangrove forest is one of the main targets of this system. The farmers look after the trees, and have signed a contract with the Forestry Management Board for a 95 percent share of the harvested mangrove trees. The farmers have also diversified their income source by raising freshwater fish, chickens, ducks and fruit trees. However, prawn cultivation is still their main income, around US$2 400 per ha per year. This arrangement is a low-carbon agriculture system, with mangroves able to absorb approximately 136 tons/ha of CO_2, valued at US$154/ha/yr. Besides, livelihoods and food security are stabilized and improved based on diversified income from aquatic animals, fruit trees, terrestrial animals, and mangrove forest trees.

2. Seaweed farming: A community-based adaptation to climate change in the Philippines – prepared by Mr Jake Piscano, Centre for Empowerment and Resource Development Inc.; presented by Dr Carlos Magnaye, Department of Agriculture, the Philippines

Demand for seaweed is growing rapidly. It is used in meat and dairy products, pharmaceuticals, and beauty products. The case study was from Barangay Salog, the Philippines. The ideal sites for seaweed farms are located between islands where the current flow is moderate. Floats are spaced at 0.5 m intervals and seedlings are tied to the lines. They are allowed to grow for 45 to 60 days. Following harvesting, the seaweeds are dried in the sun and stored in rice sacks, and small holders sell it to middlemen. Seaweed farming is to augment the livelihoods of fishers – a typical farmer is able to earn about US$800 per year from three crops. The claim is that seaweed farming has brought additional income for 40 percent of the 426 households in Barangay Tulang. Moreover, quite a lot of the work involves women. The unexpected benefits include an increase in number and diversity of fish that shelter under the seaweed. The farms are able to absorb carbon dioxide from the atmosphere – a kilo can absorb 185 mg of CO_2. Several other qualities are attributed to seaweeds: they can be grown without land preparation, do not need fertilizers, are resilient to drought and heavy rain, and are nutritious, supplementing the farmers' regular diets. Seaweed farming is a low-carbon activity that brings many benefits to the community and the environment, and is resilient to climate change.

3. The New Theory of Agriculture: A Thai farmer's climate-smart pathway – prepared by Ms Wirya Khim, FAO; presented by Dr Akarapon Houbcharaun, Office of Agricultural Economics, Thailand

His Majesty King Bhumibol Adulyadej of Thailand promoted the New Theory of Agriculture which encourages farmers to avoid risks, and achieve self-sufficiency by practicing integrated and sustainable agriculture. Under the system, farmers set aside their land for pond and fish culture, rice cultivation, fruit and tree crops, and the remaining for housing, livestock and other activities. This case study reviewed the Thai farm owned by Mr Patphong

Mongkolkachanahun in Kanchanaburi Province. Initially, Mr Patphong focused on monocrops such as chili or sweet corn, but due to high production costs and poor soils, his farm failed. He then switched to integrated farming. He divided his 6.24 ha farm systematically for raising various crops that includes rice, fruit trees, livestock and fish. Following a clear farm management plan, waste from the crops is fed to fish and to raise livestock. In order to improve soils, green cover, compost, animal manure and bioliquid fertilizers are used. Natural systems replaced pesticides for weed control. A sprinkler irrigation system was installed, enabling the pond to supply water for the farm year round. Manure from livestock is used to operate a small biogas unit which meets household energy needs. The farm's income is mainly derived from the sale of organic fruits to both local and international markets. The other crops, livestock and fish meet the needs of the family and the rest sold in the local markets. According to Mr Patphong, his farm income has steadily increased, with a total net income of about US$26 000 in 2014. The farming under the New Theory of Agriculture approach achieves self-sufficiency with improved incomes. Diversification of crops and introduction of the pond ensures the farm is resilient to changes in the weather patterns. Introduction of tree crops, usage of green manure, and biogas go towards reducing GHG emissions, and promote environmental sustainability. These farm practices clearly adhere to the three objectives of CSA.

4. Floating gardens of Bangladesh: Spreading the tradition – prepared and presented by Dr Wais Kabir, FAO Consultant, Bangladesh

With its deltaic topography and low elevation, the coastal areas of Bangladesh are already facing severe flooding as a result of climate change. It is no longer possible to cultivate these submerged areas. Farmers have adapted to this situation by turning to floating gardens, locally known as *dhap*, for raising vegetables. The floating plots are made from mats of aquatic weeds (mainly water hyacinth) and bamboo in layers. The top layer is made of cow dung, rice husk and compost for raising vegetables. The floating plot can rise and fall with the water level, and once anchored to the floor with a stake, it remains in position. The size and shape of the bed is not fixed, but is generally around 1.5 to 3 m wide, 0.6 to 0.9 m thick, and 15 to 60 m long. Around 30 species of vegetables, spices and other crops or seedlings are grown in the water-based production system. Family members, especially women are involved in many of the operations, such as raising of seedlings, nursing the bed, and harvesting and processing the produce. On average, farmers are able to earn US$170 to 230 per season for an estimated 100m^2 size of the floating plot. The beds are constructed from local, biodegradable, and low-cost material. The farming, with very low usage of agro-chemicals for plant nutrition and pest control, is environmentally friendly with minimal GHG emissions. The floating gardens now allow farming in flooded plains, even if they remain waterlogged after the floods. Even though it was developed out of necessity, the poor with local knowledge and skills have shown the capacity to adapt to climate change. The floating gardens can be classified as CSA practice.

5. India's traditional water harvesting systems: Age-old, climate-smart agriculture – prepared by Mr Anupam Mishra and Mr Sopan Joshi, Gandhi Peace Foundation, India; presented by Ms Mayling Flores Rojas, FAO

Since pre-historic times, residents of the Indian subcontinent have made efforts to understand the hydrological cycle, and the behaviour of the Monsoon. About 70 to 90 percent of India's total rainfall occurs in a few days during the Southwest Monsoon. And the amount and timing may vary a great deal from year to year, and from place to place. Therefore, the key to survival has been to build systems to harvest the seasonal rainfall, so that it is available over the remaining period until the next monsoon. Such systems date to prehistoric times and references to their role in agriculture can be found in ancient texts. The most ubiquitous structure is the *taal* (pond or lake). These water bodies are built and maintained by the community. There are some 3 million of them in about half a million villages across the country. Over the centuries communities have fashioned systems that provide a predictable supply of water, despite the unpredictable nature of the monsoon. How people survive in the driest parts of the country, the Thar Desert, provides valuable lessons of local knowledge and use of local material. In parts where there is an impermeable gypsum layer, rainfall does not percolate into the saline groundwater deep beneath the sands. This changes the nature of vegetation on the ground. By observing the vegetation, people have learned to tap water from the ground. When the gypsum layer is not too deep, the soil remains moist enough to cultivate wheat despite annual rainfall of only about 160 mm. A system called *khadin* is built using a compacted embankment to trap water from runoff down the slope of gypsum layer. During the monsoon, this results in a pond in some places. Small wells, known as *kuis*, are also built above the gypsum layer. The walls of the well are porous, going down to the gypsum layer. Sand water trickles down slowly into the shallow wells which are narrow at the top, and wider with depth. This maximizes the surface area for the water to trickle in, while minimizing the surface available for evaporation loss in the desert heat. In some of these areas, *kuis* have seen the people through droughts. In some dry areas of Gujarat, nomadic pastoralists have engineered a system called a *virda* – shallow wells that separate freshwater from saline. Rainwater stays above the saline water due to differences in density. The *virda* are built in depressions in the arid flatland where the chances of collecting rainwater are high. Elsewhere in the south of India, farmers had evolved the *eri*, a system of tank irrigation that makes possible rice cultivation. An *eri* traps rainwater running down the eastward slope to the coast, and also provides soil conservation and flood control. Advances in modern engineering in recent decades have taken the spotlight away from these traditional systems. However, modern systems are not delivering the results they promised, and efforts are underway to retrieve the traditional systems, which are communal based, and costs are borne by them. Since time immemorial, societies in India have dealt with erratic rainfall and weather extremes by creating a culture of water harvesting. These traditional systems will be valuable resources for people to deal with changing climate.

6. Leasehold forestry in Nepal: A new lease of life for rural communities and forests – prepared and presented by Mr Simmathiri Appanah and Mr Kenichi Shono, FAO

Landlocked Nepal remains a poor country, with over 80 percent of its people living in rural areas. These rural communities, with very small landholdings, are heavily dependent on forests to supplement their daily needs. With extensive conversions and over-harvesting, forest resources declined, threatening the food security of the forest-dependent communities. To address this situation, Nepal initiated Community Forestry schemes in 1978. These common-property schemes left out the resource-poor households and socially marginalized people. Recognizing this flaw, the Leasehold Forestry (LF) was developed. Impoverished households received about 1 ha of degraded state forest land for a lease of 40 years. They are required to protect the forest lands against degradation so natural regeneration of trees and other plants can continue. The households were also allowed to cultivate economically valuable trees (NTFPs) and fodder, and received livestock (mainly goats) that were stall fed. Technical advice, training, and other income-generating skills were provided. Surveys six to seven years following implementation showed positive developments. The programme contributed to reduction in poverty, improved nutrition, and women spent less time on fodder and fuelwood collection and pursued other more profitable activities. The environmental benefits were equally impressive. Green cover of the leasehold forest plots surveyed had improved significantly, and natural regeneration of trees accelerated. Assessments also pointed towards improvements in environmental services and biodiversity. The LF programme appears to have clearly achieved poverty alleviation, diversification of income sources and food security. This was achieved simultaneously with improvement of the environment and expansion of forest cover in the hilly areas, contributing to climate change mitigation. The link between LF and CSA has been clearly established.

7. Vertical farming: An innovative agriculture system for producing food in urban areas – prepared by Ms Wirya Khim, FAO; presented by Mr Tay Jwee Boon, AVA, Singapore

Land scarce Singapore is looking into urban farming to partially reduce their dependence on food imports. This case study examined the innovative vertical farming system initiated by a local firm called Sky Greens. Vertical farming is the practice of cultivating plant life within a skyscraper greenhouse. In this case study, vegetables are grown in 9 m tall A-shaped aluminium towers. Each tower consists of troughs which are rotated around the tower to ensure uniform distribution of sunlight, irrigation, nutrients and air flow. The farm covers 3.65 ha with 1 800 towers in operation. It raises four types of green vegetables on a five-week cycle, and can produce from 4 to 9 tons per day. Operational costs include raw material such as soil, seed and electricity. The vertical farming, compared with traditional farming, has several advantages: less land area, less water (which is recycled), low energy, half the labour, and consumes 75 percent less raw materials such as nutrients. The vertical farm produces 4 percent of locally grown vegetables, and adds to the food security needs of the country. The patented vertical farming system can be considered "climate-smart" solution for sustainable food production in land scarce urban areas. Overall, the system achieves a low carbon footprint, this being further boosted through its shorter "food miles" – the distance to take produce to market is very short compared to imported produce. But the potential of vertical farming may go beyond urban areas – the reduced use of raw materials such as water and soil makes it viable for sites where the natural resources have become severely degraded. Currently, the start-up costs are high, but with further innovation and economy of scale, these farms may be part of a solution to feed the world faced with deterioration of natural resources and the harmful impacts of climate change.

V. Session – Panel discussion: CSA work by international and regional agencies

Introduction

The major objective of the panel was to inform the participants about the CSA-related work that the various international and regional agencies are undertaking in the Asia-Pacific region. Besides presenting their CSA-related work, the panellists were also asked to respond to the common theme of: "What are the major challenges, and the way forward for promoting CSA in the Asia-Pacific region?" Four panellists participated in the discussions. The representative from United Nations Environment Programme (UNEP), Dr Wynn Ellis, could not attend the workshop, but he transmitted his views in writing, and it is also summarized here.

Names of panellists:

- Ms Kaisa Karttunen, Senior Natural Resources Officer, FAO, Rome
- Dr Sergiy Zorya, Senior Agricultural Economist, Southeast Asia, World Bank, Bangkok
- Ms Imelda Bacudo, Senior Advisor, ASEAN – German Programme on Response to Climate Change, GIZ, Jakarta
- Mr Michael Sheinkman, Project Scientist, IRRI/CCAFS, Bangkok

Moderator: Dr Promode Kant, Institute of Green Economy, India

1. FAO: Ms Kaisa Karttunen first outlined FAO's understanding of CSA. It takes into account a) resilience, adaptation, food security, productivity and GHG emission reductions; b) linkages between research, policies, institutions and practices; and c) site specific production practices such as agroforestry and reduced deforestation, sustainable crop and grazing land management, etc. The programme also places much emphasis on generating evidence from site specific situations, research by piloting CSA, and learning lessons which are fed into policy and planning processes. In order to strengthen the CSA approaches, FAO is also assessing the impact of climate change on crop yields, water resources, economic impacts and the appropriate policy responses needed at national levels to address the impacts of climate change. Beyond assessment, adaptation to climate change is being pursued through: impact and vulnerability assessment and adaptation; strengthening capacities of institutions, policies and financing; sustainable management of land, water and biodiversity; technologies and practices and processes for adaptation; and disaster risk management. FAO also supports development of National Adaptation Plans (NAPs) for countries including the strengthening of Ministries of Agriculture with development of agriculture adaptation roadmaps, and identifying climate finance or adaptation action, etc. Currently, FAO is working with UNDP to integrate agriculture in NAPs for Nepal, Thailand, Philippines and Viet Nam in the Asia-Pacific region, with funding support from the Government of Germany. With application in mind, FAO has developed a number of tools to evaluate GHG emissions from agriculture: FAOSTAT, GLEAM, EX-ACT, COLLECT EARTH etc, and methods to reduce or remove emissions. Besides solutions to challenges of monitoring and verifying the GHG emissions reductions and other benefits, FAO has been supporting the development of Nationally Appropriate Mitigation Actions (NAMA) in agriculture. FAO, jointly with other agencies, is also paying particular attention to combine financing from different sources to finance climate-smart agriculture. Finally, these knowledge tools are tested for their viability through various field projects.

2. World Bank Group: Dr Sergiy Zorya presented the approach the Bank is fostering with regards to CSA. Dr Zorya identified the challenges, the solutions available, and how the approach the Bank uses in advising its clients and designing projects is related to its agriculture portfolio. The main challenge is to build food systems that meet increasing demand while remaining profitable and sustainable in the face of climate change. The first challenge is the need to ensure food security for the expected 9 billion people in 2050. Asia would have to double its production from current levels, which is far more than the other regions. Food demand by commodities would also differ, with less emphasis on cereals and far more on meat and milk and dairy products. The second challenge is adaptation to climate change. Extreme weather events have already resulted in increased volatility of food prices, and with the impact of climate change, the agriculture sector may witness volatility and decline in crop yields with the increase of production costs in the longer run. The third challenge relates to emissions. Currently, land use change and agriculture are responsible for about 24 percent of the total emissions, with deforestation and poor livestock management being among the highest sources of emissions. If the status quo remains unchanged for agriculture while the other sectors continue to reduce emissions in accordance with the 2°C goal, projections indicate that agriculture and land use change may be responsible for 70 percent of the emissions by 2050. And most of the emissions from agriculture are currently from Asia, about that emitted by the Americas, Europe and

Africa combined. With the need to increase food production in the region, emission levels from the region are likely to increase even further. The World Bank sees solutions in three areas: a) increased productivity in terms of food and nutritional security, higher incomes, and productivity by promoting emission reduction technologies and policies; b) enhanced resilience with reduced short-term risks, enhanced capacity to adapt and develop in the face of shocks and longer-term stresses, while maintaining a healthy ecosystem; and c) lower emissions per kilo of food produced, achieved without deforestation from agriculture, and removing carbon from the atmosphere. The biggest returns lie in delivering the triple win for productivity, adaptation and mitigation. Examples of such wins include restoration of degraded land and improvements of soil macro- and micro-nutrients. The opportunities exist in productivity, resilience and emissions, and they differ among regions. In Asia the promising technology is Alternate Wetting and Drying (AWD) rice fields, in Africa agroforestry, in North America biodigesters and in South America livestock efficiency. The Bank's approach is to engage with its country clients in advising and designing projects to increase productivity, build resilience and reduce emissions. In 2011/2012, 12 percent of the Bank's projects ($850 million) were climate-smart. The Bank is targeting to achieve 50 percent in 2015. The Bank has made it mandatory to use the EX-ACT Tool developed by FAO for measuring ex-ante the carbon balance of all its projects. The Bank collaborates with a number of external partners to bring about its solutions to raise productivity, enhance resilience and reduce emissions in agriculture. The formula is CSA is equal to sustainable agriculture plus resilience and less emissions.

3. ASEAN-German Programme on Response to Climate Change (GAP-CC): GAP-CC is a programme implemented by GIZ in ASEAN. Ms Imelda Bacudo briefed the participants on GAP-CC's approach, which is to support capacities for climate resilience and competitiveness of its main partners, the ASEAN Secretariat, its Working Groups and Networks, and the ASEAN Member States. GAP-CC is made up of two modules, Sustainable Agrifood Systems in Bangkok and Forestry and Climate Change in Jakarta. Besides the regional programmes, the sub-programmes are implemented as bilateral projects – Climate-Smart Value Chains (CSVCs) and Regional Cooperation on Forestry – directly with the Member States. The CSVCs aim to scale up climate-smart practices in agriculture and/or forestry value chains. The main elements of the CSVCs include: support for the ASEAN Climate Resilience Network; regional knowledge exchange; and climate finance. Overall, the work involves projects providing capacity development and advisory services in terms of: a) investment proposals for scaling up climate-smart practices in agriculture and forestry value chains; b) recommendations for implementing climate-smart practices; c) assisting ASEAN Member States to implement pilot climate-smart practices based on regional experiences; d) facilitation of cross-sectoral exchange of knowledge and information among sectoral bodies; e) support for knowledge-sharing in building climate resilience in agriculture and forestry; and f) support Member States in strengthening their capacities to access and manage climate finance. The GAP-CC is implementing the programme through collaboration with a number of international agencies, ASEAN Secretariat and its Member States.

4. International Rice Research Institute: Climate change poses serious challenges for rice production including: increasing temperature, both daytime and night; changes in rainfall, both total quantity and distribution throughout the growing season; extreme weather hazards, which can damage crops; and sea-level rise, especially affecting the major river deltas. Michael Sheinkman presented IRRI's current research to help rice farmers adapt to a changing climate while reducing their greenhouse gas emissions.

IRRI research on climate change adaptation includes breeding varieties of rice that are tolerant of one or more climate stresses, such as heat, drought, submergence and salinity. Other strategies include crop management practices and tools that promote efficient use of water and/or fertilizer; technologies that improve efficiencies through mechanization and reduce post-harvest losses; and facilitating agricultural insurance programs through monitoring rice cultivation using remote sensing from satellites.

Rice plants are affected by high maximum daytime and night-time temperatures, the duration of those high temperatures, and the growth stage of the plant during which they occur. Rice plants are most sensitive to high daytime temperatures during the flowering stage and to high night-time temperatures during the ripening stage, either of which can adversely affect yield and grain quality. IRRI scientists are screening improved and traditional rice varieties to identify those capable of tolerating high temperatures and drought. IRRI has identified a wild species of rice capable of flowering in early morning, when it is cooler, and of high transpiration with sufficient water, both of which are convenient traits for avoiding heat stress.

Changes in rainfall patterns affect water resource availability, with shortages and competition between agriculture and other users for water resources. AWD is a rice management practice that can reduce water use by up to 30 percent, without any reduction in yield. Continuously flooded paddy rice production emits substantial quantities of methane, contributing to global warming. Application of AWD can reduce methane emissions from irrigated rice by up to 48 percent, compared to rice under continuous flooding. One constraint to farmers adopting AWD is the loss of habitat for fish when rice fields are drained, depriving farm families of an important source of food. WorldFish developed fish rings, providing a micro-habitat for fish to survive until fields are re-flooded.

IRRI has introduced a submergence tolerant gene into popular improved rice and traditional varieties to cope with flooding associated with extreme weather events, as well as saline tolerant varieties to adapt to sea-level rise. Other research involves technologies to improve efficiencies through mechanization and to reduce post-harvest losses, including: laser levelling of fields, improving water use efficiency; straw management, which reduces GHG emissions; hermetic storage systems, mechanical dryers, and solar dryers, all of which reduce post-harvest losses. IRRI and its partners in the Remote Sensing-based Information and Insurance for Crops in Emerging Economies (RIICE) project are using satellite imagery to map and monitor rice cultivation in several countries.

5. UNEP: Dr Wyn Ellis provided a statement on UNEP's CSA for circulation. This summary is extracted from the note. In the context of the Sustainable Development Goals (SDGs) and the post-2015 development agenda, it is critical that we transition to more sustainable systems of food production that address multiple challenges through adoption of appropriate practices, through incorporation of climate change issues directly into national policies, agricultural development planning, and investment strategies. We need a dramatic increase in efforts and investment to transition from vulnerable non-sustainable systems to sustainable agriculture which achieves food security, reduces poverty, adds safeguards, and restores ecological systems. UNEP supports this effort in various ways, collaborating with other international agencies, governments and centres of excellence that include the following:

i. Through developing the knowledge base and ensure access to data, statistics and indicators for tracking natural resource use and progress towards achieving the SDGs, and to provide evidence-based information and methodologies for strengthening the science-policy interface (e.g. Massive Open Online Courses [MOOCs] in collaboration with other agencies/centres of excellence, covering CSA and a range of environmental issues).
ii. Establishment of a Regional Climate Technology Centre and Network (CTCN) in collaboration with ADB (CTNFC) to promote public-private partnerships (PPPs) in development of climate-smart technologies, building capacity and engaging private sector.
iii. Support in implementation of international protocols (e.g. refrigerant management for cold food chain under the Montreal Protocol).
iv. Capacity building programmes to support national policy and implementation plans.
v. Grass-roots programmes on sustainability, such as the Sustainable Rice Platform (www.sustainablerice.org), a global multi-stakeholder alliance which has established the world's first Standard on Sustainable Rice Cultivation.
vi. Healthy Ecosystems Key to Better Food Security – UNEP-FAO campaign to strengthen support for sustainable ecosystems and to implement a new Sustainable Food Systems Programme.

There was discussion at the end of each presentation and also a short interaction with the Workshop participants at the end of the session when the panellists made further elaborations on the many steps their organizations are currently undertaking in the area of CSA. The overall view was that while we do not yet know what would be the real nature and scale of the impact of climate change on agriculture and food security because of the uncertainties involved it is important to scale up science-backed policies and management practices in agriculture that respond to the current frontiers of knowledge. We also need more understanding of what we are now referring to as CSA. Other valuable points were raised on the need for identifying technologies with multiple wins in enhanced productivity, in dynamic adaptation and increasing mitigation, and in increased profitability as in the restoration of degraded lands and improvements of soil macro- and micro-nutrients and in proper valuation of natural resources such as water, so their management can include recovery cost and participatory management with local coordination.

VI. Session – Panel discussion: "What is needed to mainstream CSA in the Asia-Pacific region?"

Introduction

The panel discussion was organized to help participants exchange their views on possible modalities and enabling environments for mainstreaming CSA in Asia and the Pacific region. One of the main objectives of the panel discussion was to provide food for thought with the Group discussions and recommendations session scheduled shortly after the panel discussion. A total of eight panellists participated to discuss key questions on upscaling and mainstreaming CSA in the context of Asia and the Pacific reflecting upon their country experiences. They discussed diverse CSA approaches and governments' efforts to raise awareness of CSA, to enhance sustainability and replicability of CSA practices, and to remove barriers to adoption.

Names of panellists:

- Dr Yue Li, chief of climate division, Institute of Environment and Sustainable Development, Chinese Academy Of Agricultural Sciences (CAAS), China
- Dr Margaret Yoovatana, senior policy and planning specialist, Planning and Technical Division, Department of Agriculture, Thailand.
- Dr Sharavjamts Oyuntuya, associate professor/meteorologist, Mongolian University of Life Science, School of Agroecology, Mongolia
- Dr Jillur Rahman, senior scientific officer, Horticulture Research Center under the Bangladesh Agricultural Research Institute, Bangladesh
- Mr Chimi Rinzin, chief agriculture officer, Department of Agriculture, Bhutan
- Dr Ir. Catur Hermanto, head of North Sumatra Assessment Institute for Agriculture Technology, Indonesia
- Mr Heai Steven Hoko, programme manager, Rice Extension Unit of the Department of Agriculture and Livestock, Papua New Guinea
- Mr Sanjay Dhimal, agriculture officer, Ministry of Agricultural Development, Nepal

Moderator: Soojin Kim, partnership officer, FAO/RAP

The panellists were asked to respond to the following five key questions during the discussion:

i. In your view, what is the awareness level of CSA in your country, who are aware, and what do they know about CSA? How did they come to realize benefits of CSA?
ii. What kinds of CSA approaches are being implemented in your country, and which of them are well adopted? Give examples.
iii. There are many ongoing pilots on CSA but how long such interventions would be sustained is a challenging question. How do you think one can ensure sustainability and replicability of CSA practices?
iv. What are the major barriers of adopting CSA? Please share innovative ideas to enhance the adoption rate in your country.
v. Are there any ongoing or planned initiatives, efforts, and/or laws/regulations/policies by the government for scaling-up of CSA?

In responding to the above questions, Dr Yue Li (China) discussed China's focus on enhancing land use, water and nitrogen efficiency. According to her, Chinese agriculture, currently contributing to 10 percent of GDP, is facing serious challenges mainly due to limited arable land available, decrease in yield driven by extreme weather events, and increase in input to boost yields. In response to climate change, China introduced specific measures including the following four approaches: i) land use rights transfer, ii) formula fertilization by soil testing, iii) biogas for households and livestock farms, and iv) water saving irrigation and farming techniques. Such approaches included innovative measures such as utilizing traditional knowledge in water management and strengthening capacity of extension system with research and development. Subsidies for positive externalities in order to encourage adoption of CSA practices have been introduced. Dr Li suggested that for ensuring an enabling environment for CSA, conflicting subsidies such as fertilizer subsidy should be reduced, and our understanding of the complex relationships between mitigation and adaptation must be enhanced by taking into account social and economic impacts of CSA practices and policy measures.

Second discussant Dr Sharavjamts Oyuntuya (Mongolia) pointed out that the Government of Mongolia introduced the National Action Plan for Climate Change (NAPCC) consisting of national policy and strategy to tackle the adverse impacts of climate change and to mitigate GHG emissions. However, setting the budget for each action item is a serious challenge. In addition, implementing the NAPCC with local level administration is another challenge due to lack of corresponding offices responsible for climate change. As such, Mongolia is putting its efforts together in building institutional capacity and coordination. She also discussed the importance of education and training as prerequisites for mainstreaming climate change in agriculture. At present, the awareness of the general public about climate change is rather low; however, the Government recognizes the importance of climate education to enhance public awareness. A series of trainings and seminars are currently taking place in provinces and districts including teachers' training. However, recognizing that education requires long-term investment for change, Mongolia has plans to establish and implement the legal framework for providing incentives to herders and farmers who are practicing climate compatible production. In addition, strategic zoning to establish clear boundaries between pastoral animal husbandry and intensive farming is being developed and more populated city boundaries will be equipped with intensive farming to enhance food security. The livestock insurance system will be improved by incorporating climate policy. Several projects are currently implemented to enhance adaptation to climate change and improve rural livelihood of livestock herders and farmers.

The third panellist Dr Margaret Yoovatana (Thailand) emphasized Thailand's potential in mainstreaming CSA owing to the strategic directions provided by H.M. the King. Thailand recognizes the importance of natural resources conservation, traditional knowledge and wisdom for agriculture. Royal initiative projects have been implemented at the community level, which are location specific, with application of appropriate technologies in order to enhance production efficiency. Diversification and integrated farming methods are encouraged under the initiative.

Although Thailand is not yet a member of GACSA, it has made a public commitment and showed leadership in climate change in conjunction with agriculture. Also, Thailand signed the regional declaration "ASEAN Joint Statement on Climate Change 2014" in order to promote climate resilience in the region. Thailand is the leading country in the ASEAN-Climate Resilience Network (ASEAN-CRN) in up-scaling of climate resilient agricultural practices.

Dr Yoovatana emphasized that CSA mainstreaming requires inter-ministry agreement as Ministry of Agriculture and Cooperatives (MOACs) are not focal points for environment-related issues and often climate change is categorized under environmental issues. In conclusion, Dr Yoovatana suggested that CSA practices should be promoted as part of a national programme, and not on a project basis. In order to do so, knowledge products to enhance awareness must be further developed and FAO could take the lead in that. Next, promoting CSA in regional and sub-regional cooperation is much needed and a regional alliance could be established for CSA. Mainstreaming of CSA can be further strengthened though an active exchange of expertise.

The fourth discussant Dr Jillur Rahman (Bangladesh) demonstrated that there is a clear trend of transformation in Bangladesh agriculture towards CSA. Climate change is a major threat to Bangladesh from achieving its core national strategies including self-sufficiency in food production and food security. Bangladesh's agriculture is significantly challenged by sea level rise and salinity intrusion as well as increasing intensity of drought/flood and pest infestation. Several CSA measures were put in place in order to address these challenges. They include: introducing fallows in the salinity area with compensation for farmers' losses, creation of intermediate income sources from livestock grazing, salt-tolerant crops, rainwater harvesting systems, rice-fish-vegetable integrated farming, etc. Lastly, the Government of Bangladesh has engaged the private sector in implementing national policy by introducing ICTs in crop insurance and other climate information system. Mobile-based technologies that provide weather-based agro-advisories and crop insurance seem to have great potential to reach a large number of farmers in the country and could be used to scale-up climate-smart agricultural practices.

The fifth panellist Mr Sanjay Dhimal (Nepal) emphasized the major threats imposed by changing climate to the agriculture sector that makes up the largest portion of income for most Nepalese households and also the national economy. Recognizing the adverse impacts of climate change on agriculture, a variety of CSA practices have been adopted by farmers. Considering Nepal's dependence on Monsoon rainwater, construction of rainwater harvesting tanks, introduction of drought tolerant species, and drip irrigation are found to be effective these measures are accompanied by soil conservation, erosion control and nutrient management.

At the national level, Nepal has introduced the climate and agriculture reform policy and the Ministry of Agricultural Development (MOAD) is responsible for implementing the climate change adaptation programmes and projects in agriculture. In implementing the policy, Nepal has endorsed large-scale projects that establish early warning systems, and introduced an agricultural management information system (AMIS) and agro-info call centers to disseminate knowledge and information.

Next discussant Mr Chimi Rinzin (Bhutan) shared his viewpoints on their overarching national policy direction of agriculture development that is climate-smart. Based on the Gross National Happiness (GNH) principle, the Bhutanese Government is committed to transition to a carbon neutral and green economy. This has become a backbone of all Bhutanese policy and budget preparations. In addition, Bhutan has recently been promoting mitigation and adaptation measures for crop and livestock production through the national strategy on climate adaptation of the Sectoral Adaptation Plan of Action (SAPA). Although mainstreaming CSA is already on its way in Bhutan, several challenges remain to be resolved in order to ensure effective implementation of CSA practices including the following: common perception to emphasize productivity; lack of attention to socio-economic factors but only taking into account bio-physical conditions; limited knowledge and use of climate parameters; and weak research and development capacity. The above challenges must be addressed in mainstreaming CSA in Bhutan.

The seventh discussant Mr Heai Steven Hoko (Papua New Guinea) shared PNG's plan to institutionalize CSA throughout the country. Although CSA is a relatively new concept to PNG and people's awareness is rather low, PNG recognizes the importance of climate change adaptation and mitigation for agriculture development. Due to geographic and climate characteristics of PNG, most CSA interventions were customized to upland rainfed agriculture and agroforestry including soil erosion control and intercropping. Utilizing nutrients from abundant agricultural wastes and industrial crops such as coconut husks for bio fertilizer and rubber wood for biofuels have also been introduced.

Mr Hoko also pointed out that in order to ensure sustainability of CSA practices, the following policies must be climate compatible: the National Agricultural Development Policy and the National Food Security Policy (under development with assistance of FAO). To ensure replicability, extensions in 22 provinces could disseminate pilot technologies and province-to-province training and exchange programmes could be offered. In addressing barriers to adoption of CSA practices, adequate incentives must be granted to farmers including trainings, farm credits and inputs. In addition, the CSA packages must include some short-term economic returns together with long-term environmental benefits. At national level, the Office of Climate Change and Development (OCCD) has been designated to support the institutionalization of CSA.

The last speaker Dr Ir Catur Hermanto (Indonesia) demonstrated a demo version of a CSA information portal as a solution to upscaling CSA in Indonesia. The web and SMS-based information platform for CSA, the so-called "integrated cropping calendar" had been developed and introduced in Indonesia. The calendar provides a wide range of information including on: climate, planting schedule, flood and drought prone areas, possible disease outbreaks, varietal recommendations, available farm equipment and fertilizers. Due to the cultural importance of rice to Indonesians, the majority of interventions were dedicated to improved agricultural techniques for improved rice production and climate mitigation and adaptation. Dr Hermanto suggested that by disseminating innovative research results and providing simple techniques, CSA practices could be sustained and replicated. The Government of Indonesia is currently validating appropriate technologies to be scaled up and deployed to implement climate-smart agriculture.

In conclusion, the panel discussion pinpointed five requirements and/or recipes to mainstream CSA in Asia and the Pacific including the following:

i. Awareness of CSA in the general public is at the rather low to medium level, and public education and strengthening of extension services could enhance public awareness.
ii. Countries have developed and implemented location specific measures based on climate, geography, and socio-economic and cultural conditions.
iii. In order to enhance sustainability, public awareness of the benefits of CSA must be enhanced by disseminating information through simple technology and easy-to-understand messages. Inclusion of ICT has been adopted in many countries and is proven to be successful.

iv. In most cases, the key barriers to adoption of CSA practices are farmers' preference for short-term economic return and lack of incentives for switching behaviours. Adequate incentives, knowledge and information, and removal of adverse subsidies are keys to enhance adoption rates.
v. Mainstreaming CSA at a national scale requires higher-level commitment and policy directions favourable to climate change adaptation and mitigation. Clearly stated messages and priorities on agricultural development that are compatible with climate change seem to facilitate the implementation of CSA practices more broadly and comprehensively.

In addition, several participants were interested in learning more about FAO's role in supporting the mainstreaming of CSA in Asia and the Pacific with special attention on access to climate financing and technical advice for potential regional alliances. Knowledge generation and building an evidence base created quite a lot of interest. FAO is continuing to produce more innovative and cutting edge research products that are more local and context specific to assist mainstreaming of CSA in the Asia-Pacific region. This will require further effort and coordination due to lack of a sufficient evidence base in the region. However, some participants believed that there is enough knowledge products on CSA available in the region and a stocktaking exercise on a regional level might give a good picture of it. This debate requires further attention and assessment as this will determine priority actions in mainstreaming CSA in the region. Overall, the Panel discussion proved to be quite valuable, and made significant progress towards stocktaking of the elements for priority actions and enabling environment.

VII. Session – Conclusions and recommendations

The "Regional Asia-Pacific Workshop on Climate-smart agriculture: A call for action" was held on 18 to 20 June 2015, in Bangkok, Thailand, with the aim of sharing knowledge and experience on implementing CSA among stakeholders from the Asia-Pacific region. The Workshop was attended by 61 participants, of whom 27 were representatives from 21 countries in the Asia-Pacific region. During the group work, the three groups were asked to address the issues relating to: a) enabling environment for sustainable CSA; b) priority actions for mainstreaming and scaling up CSA; and c) enhancing regional collaboration and networking. The following are the conclusions and recommendations of the Workshop.

Conclusions

I. Enabling environment (policy, institutions, legal framework, finance, governance, etc.) for sustainable CSA

- Scientific knowledge to address climate change and opportunity to apply CSA
- Analysis, simulation and climate projections and trends (e.g. are we ready for sea level rise in the coastal zone? Specific trends for specific commodities)
- Policymaking: which options to choose under variable and unpredictable climate change?

II. Priority actions (implementation level) for mainstreaming and scaling up CSA

a) Present situation – Lack of awareness of CSA

   Future challenges associated with the situation – Political commitment in terms of integration of different ministries, and financing and allocation

b) Present situation – Need for mapping CSA practices, including available technology, knowledge, resources and policies

   Future challenges associated with the situation – Capacity building: i) Who is going to do what? ii) Changes in mindsets and breaking the barriers of lack of collaboration

III. Enhancing regional collaboration and networking

Current arrangements are not satisfactory. Therefore, there is a need for platforms both at the national and at the regional levels to:

- share knowledge
- facilitate collaboration and cooperation
- set joint goals
- raise awareness, both for farmers and for policymakers
- facilitate exchange of information related to resource mobilization opportunities, both for knowledge creation as well as technical assistance and implementation
- have political support
- be non-prescriptive
- find common goals

a) At the national level, a platform that:
   - has one focal point, from Ministry of Agriculture
   - has membership from wide range of stakeholders: governmental, academic, civil society, private sector, etc.

b) At regional level:
   - has rotating chair(s)
   - has a facilitating body hosted by a country
   - is composed of the focal points (country members) of the national platforms
   - core functions to be supported by the country members
   - maintains close links with existing networks, e.g. ASEAN, SAARC, SPC and NEARC groups
   - regional CSA Secretariat to be financially supported by the contribution from hosting country, participating member countries, and/or partners
   - can draw upon support from FAO/RAP for collaboration and networking

Recommendations

The Workshop made the following recommendations:

i. Through a collaborative mechanism, improve understanding of climate change in agriculture by mapping climate change effects and scenarios and incorporate them in seasonal climate outlooks.
ii. Through active community participation, increase awareness of the impacts of climate change at community level that is location specific.
iii. Enhance institutional capacity of climate-smart practices for end users, including development of common CSA tools.
iv. Develop a common SWOT analysis for countries to develop their own mechanisms that are based on their experiences, from consultation to implementation and monitoring and evaluation of CSA approaches.
v. Identify appropriate mechanisms for engaging the experiences of stakeholders, including the creation of appropriate regional platforms for listening to grassroots stakeholders.
vi. Include mainstreaming of CSA in all National Reports and communication documents.
vii. Set-up a national committee/steering committee under the auspices of the highest policymaking body of the government, through development of policy briefs and raising awareness within the government.
viii. Allocate more funds for CSA activities from the national governments by inserting them into national action plans.
ix. Pilot CSA at national level through local administrations, by including participants from farmers, governments, civil society, and community-based organizations.
x. Forge partnerships with development partners, FAO amongst others, through projects on stocktaking, mapping, inventory of technology, knowledge (including traditional knowledge), expertise, and practices.
xi. Countries to initiate the development of national CSA platforms.
xii. Viet Nam with initial support from FAO/RAP, to host a regional CSA platform.

Annex 1

Concept note

Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action
18 to 20 June 2015
Swissotel, Nai Lert Park Bangkok, Thailand

Introduction

Over the last couple of decades, the earth has begun to witness unheralded changes to its climate. Nations everywhere are beginning to experience disastrous weather events on a regular basis. The latest Intergovernmental Panel on Climate Change (IPCC) report has unequivocally concluded that this sustained alteration of climate patterns seen worldwide are the result of GHG emissions of anthropogenic origin. Climate change is beginning to bring about severe and perhaps permanent alteration of the earth's geological, biological and ecological systems. These are leading to the emergence of extreme weather, ozone depletion, increase in wildland fires, loss of biodiversity, global spread of infectious diseases, and stresses to food-production systems.

Among the various sectors, agriculture has already been significantly affected by climate change, and it is expected to worsen in the decades to come. Increase in mean temperature, changes in rainfall, frequency and increased variability in temperature and rain patterns, changes in water availability, sea level rise and other perturbations to the ecosystem will all have severe impacts on agriculture, forestry and fisheries. The problems of climate change on agriculture are further exacerbated by the fact that global population is expected to reach to about 9 billion people by 2050. With continued increase in urban growth and rising incomes in developing countries, demand for food is expected to increase substantially: FAO has estimated that food production will have to increase by 60 percent by 2050 to meet the expected needs.

The Asia-Pacific region is expected to be challenged most severely in terms of food production. Despite rapid economic growth, the region is home to 60 percent of the world's poor, and over 500 million people remain undernourished. With an expected increase of another 850 million people by 2050, combined with urbanization and improved diets, the pressure to feed the population would be enormous. Climate change in the region is expected to reduce agricultural productivity by 10 to 50 percent in the next three decades, along with dramatic impacts on stability and incomes. The region is already witnessing considerable increase in floods, droughts, and some of the most devastating storms. In addition, the region's complexity adds further difficulties to overcome. Meeting the needs of the prosperous group and the large pockets of poor in a region with limited natural resources is going to be quite complicated. This is further exacerbated by those small South Pacific islands that are already beginning to experience inundation and loss of agricultural land as a result of sea level rise. Producing enough food for the increasing population in the face of decreasing resources and changing climate would be a daunting challenge.

Best option – Climate-smart agriculture

With the realization that climate change is real, the Asia-Pacific region requires completely new approaches to address the growing food security concerns. In 2012, FAO, the World Bank and several countries organized the first Global Conference on Agriculture, Food Security and Climate Change in The Hague. The Conference sought to mobilize action for achieving CSA as a means to enhance productivity and incomes, resilience to climate change and carbon sequestration. As a follow-up, FAO has been hosting in its HQs in Rome the Facilitation Unit (FU) of the Global Alliance for Climate-Smart Agriculture (GACSA) which was launched in September 2014 at the UN Climate Summit, and FAO is supporting countries and development partners to implement and scale up CSA approaches as a matter of priority. Work on CSA is being promoted actively through GACSA, a voluntary partnership to inspire the development and dissemination of innovative, evidence-based options for CSA in different settings, and that will involve a broad range of governments and other stakeholders.

But what is the CSA concept? Briefly, it is defined as an approach that integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges through: a) sustainably increasing agricultural productivity and incomes; b) adapting and building resilience to climate change; and c) reducing and/or removing GHG emissions. CSA is an approach to developing technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. Considering climate change can have such a profound effect on agriculture, the CSA approach is designed to integrate the national agricultural planning, investments and programs to operationalize sustainable agricultural development.

Although the concept of CSA is being explored with great interest in many parts of the world, this is not fully reflected in the Asia-Pacific region. It is revealing to discover that only Japan, the Philippines and Viet Nam are members of the GACSA which seeks to adjust agricultural, forestry and fisheries practice, food systems and social policies so they can better take account of climate change and the efficient use of natural resources. Considering the situation in the region, FAO is formulating several activities to mainstream CSA in the region, this Workshop being part of it.

Objectives

The objectives of the Workshop are to share knowledge and experience on implementing CSA among public, civil society and development agencies, and promote the mainstreaming and up-scaling of CSA.

Expected outputs

Based on those objectives, the expected outputs of the Workshop are:

- Knowledge and understanding of participants on CSA enhanced;
- Good practices and case studies on CSA in different countries shared and discussed;
- Priority actions to mainstream and up-scale CSA are identified and agreed;
- A regional-level collaboration and partnership is forged for facilitating countries to promote CSA as well as to implement priority actions linking the CSA approach with agriculture-related investments, polices and measures in their transition to CSA; and
- A report summarizing the presentations and discussions at the Workshop including conclusions and recommendations (elaborated after the workshop).

Date and venue

The three-day event is scheduled on 18 to 20 June 2015, Swissotel Nai Lert Park, Bangkok. The Workshop also includes a field trip on the third day to a modern farm in Damnoen Saduak District, Ratchaburi Province, Thailand.

Participants

The expected 50 participants will include senior officials (one per member state) of Agriculture and/or Natural Resources and Environment Ministries of Asia-Pacific countries, other United Nations and International Agencies, regionally based development partners, and NGOs.

Workshop programme

The Programme of the Workshop is attached below.

Contact details

For detailed information regarding the workshop, please contact:
Mr Simmathiri Appanah (Simmathiri.Appanah@fao.org)

Workshop programme

Day 1	
Time	Activity
08.00-09.00	Registration – *FAO Secretariat*
09.00-09.30	Welcome and initial remarks: • Welcome remarks – *Mr H. Konuma, Asst. Director-General, FAO/RAP* • Opening remarks – *Dr Le Quoc Doanh, Vice Minister, Ministry of Agriculture and Rural Development, Viet Nam*
09.30-10.00	Keynote address 1: Food Security and Climate Change – *Mr Frederik Snijders, Senior Natural Resources Officer, Climate, Energy and Tenure Division, FAO*
10.00-10.30	Tea break
10.30-11.00	Keynote address 2: Food Security in a Changing Climate: How to Move to Action – *Mr Arie Veldhuizen, Netherland's Agricultural Counselor for Viet Nam and Thailand*
11.00-11.30	Keynote address 3: Why Climate-Smart Agriculture? – *Dr Suang Pheng Kam, Senior Scientist, Natural Resources Management, WorldFish Center*
11.30-13.00	Panel discussion by International and Regional Agencies: The panellists, besides introducing their agencies CSA-related work, will also address the common theme of: "What are the major challenges, and the way forward for promoting CSA in the Asia-Pacific region?": • FAO • GAP-CC/GIZ • World Bank • UNEP • IRRI
13.00-14.00	Lunch break
14.00-14.30	Invited speaker: Scaling-up Climate-Smart Agriculture in Asia-Pacific: Opportunities and Constraints – *Dr P. Aggarwal, Regional Programme Leader, CCAFS*
14.30-17.00 (with tea break)	Presentation: Seven successful CSA cases from the Asia-Pacific region
18.00-20.00	Cocktail reception
Day 2	
09.00-09.30	Invited speaker: Agriculture in UNFCCC: Paris and beyond – *Dr P. Kant, Director, Institute of Green Economy, India*
09.30-10.00	Invited speaker: State of Play: Update from the Green Climate Fund – *Mr Leo H. Park, Financial Institutions Specialist, Green Climate Fund, R. Korea*
10.00-10.30	Tea break
10.30-12.30	Panel discussion: "What is needed to mainstream CSA in the Asia-Pacific region?" (7 panellists) • Awareness of CSA in the country • What CSA approaches are being implemented? • How to sustain CSA practices? • How to attract farmers to adopt CSA practices? • Current efforts by government for scaling up CSA.
12.30.-13.30	Lunch break
13.30-15.30 (with tea break)	Group work: Making CSA work in Asia-Pacific region • Enabling environment (policy, institutions, legal framework, finance, governance, etc.) for sustainable CSA • Priority actions (implementation level) for mainstreaming and scaling up CSA • Enhancing regional collaboration and networking
15.30-16.30	Presentations by breakout groups
16.30-17.30	Concluding Session: • Conclusions and Recommendations
Day 3	
07.00-16.00	Field trip to a Thai Farm (showcasing integrated farming) in Damnoen Saduak District, Thailand

Annex 2

Welcome address
by
Hiroyuki Konuma
Assistant Director-General and
Regional Representative for Asia and the Pacific

Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action
Bangkok, Thailand 18 June 2015

His Excellency Vice Minister Dr Le Quoc Doanh

Distinguished guests

Ladies and Gentlemen,

Before I start, let me point out that Dr David Nabarro, UN Coordinator for the High Level Task Force on Global Food Security sends his regrets for not being able to join us here – he has been sent by the UN Secretary General to deal with the Ebola outbreak in Africa now.

It is a great honour for me to welcome you all to this very important event on Climate-Smart Agriculture. I think all of you will agree with me that we have reached the tipping point where we can stop talking about whether climate change is probable and start acting on it. Climate change is occurring more rapidly than we have been predicting. The increase in extreme weather events we have been experiencing in recent years alone foretells what lies ahead.

FAO, together with several other international agencies, has been leading the campaign for Zero Hunger globally. Only a week ago, the Director-General of FAO, Mr Jose Graziano highlighted the achievements. He announced that the "number of hungry people in the world has dropped to 795 million – 216 million fewer than in 1990". With 72 countries achieving the MDG target of halving the proportion of the chronically undernourished, it is an incredible achievement.

While that is true, can we sit back and bask on our laurels? I am afraid not – climate change is threatening to reverse all our achievements with reducing zero hunger. Let's rapidly review what all nations have to contend with. The world's population will continue to rise, predicted to reach 9 billion by 2050. FAO has estimated that food production will have to increase by 60 percent by then to meet the needs. Climate change, with increase in temperature, shifting rainfall patterns, heavy storms, floods, droughts, and sea level rise is definitely going to reverse all the gains made so far. But is that all that we are contending with? I have to say, our earth is tired. While agricultural productivity rose dramatically since the 1970s, it came at a huge cost in terms of degradation of natural resources. The region's cropland, grassland, woodland and forest are now severely degraded. Soils are impoverished, and besides erosion, we also face salinity, sodicity and alkalinity. Our forests, including the biodiversity are heavily degraded or disappearing. Our water resources, the life of our agricultural system, are beginning to become scarce.

With such developments overwhelming us, there is an urgent need for action. So this Workshop is setting the right tone, calling for action on Climate-Smart Agriculture. But why Climate-Smart Agriculture? That will be the entire subject of this Workshop, and so let me not remove the thunder from all the experts assembled here. While every technological advancement seems to have brought us a lot of benefits, but sooner or later it seems to have its costs too. Without having to catalogue all of them, they include climate change and the associated losses, loss of ozone layer, pollution, degradation of land, loss of forest, and biodiversity. Our solutions cannot therefore be overly reliant on technology alone. We need a more holistic solution. Climate-Smart Agriculture, or in short CSA, is an approach that attempts to address several inter-connected issues that are linked to sustainable agricultural development. First, it works at sustainably increasing agricultural productivity; second, the approach includes adapting and building resilience to climate change; and third, it goes to the extent of reducing and/or removing greenhouse gas emissions. It therefore integrates the three pillars of sustainable development, namely economic, social and environmental elements. CSA requires involvement of technical, policy and investment conditions to achieve agricultural development for food security under climate change.

The concept of CSA took off in 2012, when FAO, the World Bank and several countries organized the first Global Conference on Agriculture, Food Security and Climate Change in The Hague. The Conference sought to mobilize action for achieving CSA as a means to enhance productivity and incomes, resilience to climate change and carbon sequestration. But we in the Asia-Pacific have hardly felt its ripples. Many countries in the region have yet to incorporate the concept into their national agricultural strategies. It is revealing that only three countries in our region have become members of the Global Alliance for Climate-Smart Agriculture, or GACSA which was formed in 2014 to support countries and development partners to promote and disseminate evidence-based CSA options to governments and stakeholders.

Recognizing this deficient state in the Asia-Pacific region, FAO and other development partners have begun to step up activities to mainstream CSA in the region, this Workshop being a part of it. Assembled here are government officials from many Asia-Pacific countries, development partners, researchers, and non-governmental organizations. The Workshop's objectives are straightforward indeed, and include: enhancing knowledge and understanding of CSA, sharing good practices and case studies, identifying priority actions to mainstream and up-scale CSA, and building collaboration among us. The Workshop's effort does not end here, in fact it starts here! What follows up after this is really the test of our abilities.

Let me therefore wish you all much success with the deliberations here. Let me finally express my innermost concerns – we want to maintain our economic growth, reduce poverty and save our environment. In our past efforts, growth in one area came at a cost in another. Such development strategies cannot be sustainable. Climate change, for all its problems, has also brought home an important lesson. Sustainable development is conditional, and needs to be addressed from all fronts. Climate change has also brought home another lesson – we are all together in it. Rich and poor, big and small, developed and developing nations, we are all affected by climate change – there are no boundaries. So no country on its own can solve the problems that come with climate change. We have to work together to solve this global issue. This is the only planet we have, so let us join forces and work together for a common future.

I wish you all the best for a productive meeting.

Thank you

Annex 3

Opening remarks by H.E. Dr Le Quoc Doanh Vice Minister of Ministry of Agriculture and Rural Development of Viet Nam

Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action
18 to 20 June 2015 in Bangkok, Thailand

Mr Hiroyuki Konuma, FAO Assistant Director-General and Regional Representative for Asia and the Pacific;

Distinguished Delegates,

Ladies and Gentlemen,

It is a great pleasure for me to be with you today and to represent the Ministry of Agriculture and Rural Development of Viet Nam to share with you some thoughts on the issues of sustainable growth, climate change, agriculture including the concept of Climate-Smart Agriculture and food security. On this occasion, I would like to thank the Government of Thailand for hosting this meeting and FAO for inviting Viet Nam to attend this important workshop. I wish the meeting a great success.

Ladies and Gentlemen,

The Post-2015 Sustainable Development Agenda and the UN Zero Hunger Challenge recognize food and nutrition security and poverty alleviation as a key priority. For many years, governments and international communities have made lots of considerable efforts to address these problems and other related issues. However, the challenge remains enormous, since there are more than 1 billion people all over the world still living under the poverty line and more than 800 million people are lacking food.

Yet, as the recent 5th IPCC working group II report shows, climate change is likely to be the biggest challenge to achieving the sustainable development goals. Extreme weather events, including severe droughts and floods, and storm surges lead to crop failure and food shortages are impacting the most vulnerable populations, especially in the tropical areas.

The new and pressing situation requires us on one hand to find solutions to increase productivity and incomes, adapting to the new challenges of climate change and on the other hand to contribute to the global efforts to reduce greenhouse gas emissions. We all know that, while farmers are struggling to find solutions, adapting to climate change, there is an urgent need to assess, accelerate and scale-up the adaptation process. This may require some fundamental changes of not only our current production practices, in order to make agriculture, forestry and fisheries sustainable, while being part of the solution to climate change.

Ladies and Gentlemen,

Viet Nam is a country with limited land area, just 10.3 million out of 33 million hectares is suitable for agriculture. With the rapid urbanization, industrialization process and the bad impact caused by climate change, that include saline intrusion, soil erosion and degradation, the land area under agriculture is decreasing by a 1 000 ha annually. However, the agriculture sector has to provide enough food for over 90 million people. Moreover, we are also contributing to the region and the world food security by exporting around 7 million tons of rice annually.

In the context of globalization, we well recognize that agriculture in Viet Nam is facing two main challenges:

- Improving competitive capacity for further international economic integration; and
- Responding to climate change, Viet Nam is forecasted as one of few countries most severely affected by climate change, particularly by sea level rise. If the sea level rises 1 metre, 40 percent of the Mekong Delta, the biggest rice production area in Viet Nam will be inundated.

In order to cope with the above challenges, to maintain the development and to improve the effectiveness and sustainability of the agricultural sector, the Government of Viet Nam is carrying out the Restructuring Programmes, in which the main solutions are promoting technical and scientific application and restructuring production system towards improvement in the linkages along the value chain. Besides, the Government of Viet Nam has tried its best to implement adaptation actions. The National Strategy on Climate Change and Green Growth Strategy has been approved and implemented. In rice fields in the Mekong River Delta, farmers learn to rationally use water, fertilisers, seed and pesticides, that lead to reduced production cost and CH_4 gas emissions from the field, while at the same time ensures higher productivity. Similarly, coffee growers can reduce production cost and 50 percent of emissions from coffee fields, while increasing productivity and income by application of newly introduced fertilizer technology. The country-wide application of Biogas to treat animal husbandry waste has also brought additional benefits to farmers and at the same time to reduced emissions from livestock production.

Ladies and Gentlemen,

What Viet Nam has been doing, conceptually may be regarded partly as a Climate-Smart Agriculture. Recognizing the significant importance of the matter, we actively have joined hands with international communities to apply the CSA practice as we share the concept that CSA is a “triple win” for agriculture, climate and food security, which would lead to increased farm productivity and incomes and make agriculture more resilient to climate change, while also contributing to mitigation. A series of CSA oriented projects are being implemented in Viet Nam like low carbon agriculture, system of rice intensification (SRI) model, rice production on terrace fields, conservation innovations, etc.

As a founding member of the Global Alliance CSA, at the meeting of the Alliance, during the UNFCCC negotiations last week in Bonn, Germany, our Delegation showed our interest in carrying out case studies, and aim to share the experiences at the next Alliance’s meeting, that can add value and to bolster current efforts in CSA application.

Ladies and Gentlemen,

Our regional workshop today is the right time for us to gather a broad range of stakeholders: including central and local governments; food producers, processors and sellers; scientists, research and educational organizations; civil society and non-government organizations; multilateral and international organizations; and the private sector and introduce them into the CSA process as well as to identify priority actions to mainstream and scale-up CSA for Asia and the Pacific.

And, more importantly, I would like to emphasize that in addition to the ultimate goal of this new Alliance, more attention should be paid to a mechanism where developed countries assist developing and less and least developed countries to assure them their food and nutrition security, and then to protect the environment.

Ladies and Gentlemen,

As a UN technical Agency, FAO would play an important role to promote cooperation among member countries as well as the international community for sustainable agricultural development, food and nutrition security and reduction in greenhouse gas emissions. It is needed to call for serious consideration of governments and the international community on these issues, strongly promoting on experience sharing, technology transfer, assistance of financial resources for poor countries, and promotion and development of fair trade and investment.

Thank you very much for your kind attention.

Annex 4

Keynote Address 1: Food security and climate change
Fred Snijders, Senior Natural Resources Officer, FAO

Two weeks ago FAO presented the latest edition of the annual report "The State of Food Insecurity in the World 2015". It was reported that the number of hungry people has dropped to 12.9 percent. This is certainly good news, but at the same time, the absolute numbers are still staggering; 795 million people are still hungry today. And almost half of them are found in the Asia-Pacific region.

Undernourishment is one of the indicators to quantify food security, a concept that has many aspects. It includes food availability, production, access to food, utilization and, very importantly, stability. Here I will focus on production and stability and the need to keep the trend of reducing the number of hungry people. To this aspect we must add a new challenge, that of a changing climate and the associated impacts that are likely to affect all aspects of food security in various degrees, further complicating the already vulnerable situation in the region.

But first I would like to dedicate some words on climate-smart agriculture, the topic of this Workshop. Climate-smart agriculture is defined by FAO as an approach to help guide actions to transform and re-orient agricultural systems to effectively and sustainably support food security under the new realities of climate change. It is based on three pillars: 1) Increase, in a sustainable manner, productivity and income growth in agriculture; 2) Support adaptation across the agricultural sectors to expected climatic changes and build resilience; and 3) Reduce, where possible, the greenhouse gas emission intensity of production systems.

Let us examine each of the three pillars.

Pillar one aims at increasing agricultural productivity and income growth in a sustainable manner. This is of crucial importance as the world faces an increasing demand for agricultural products. The world population is still increasing, even though the annual rate of growth is slowing down. But not only are there more mouths to feed, people are eating more and differently. Global per capita food consumption is projected to increase from around 2 700 kcal/day to more than 3 000 kcal/day by 2050. And the world consumes more and more animal products. In particular in Asia, meat consumption has exploded, going from 10 to 130 million tons since 1960! Not only has meat consumption gone up, but fish consumption as well. World fish production has been rising constantly over the last 50 years, with aquaculture providing the bulk of the increase over the last 20 years. Asia has become the world's largest aquaculture producer. Foremost China, followed by India, Viet Nam, Indonesia and Bangladesh have become top producers.

However, the progress towards reducing the number of hungry people and the increased food availability to a large part of the population has also increased the pressure on natural resources. The amount of arable land in use per person has been gradually decreasing; globally it has reduced by half from the 1960s to now. At the same time agriculture was able to produce more and more, how was this possible? The answer is the dramatic and steady increase in yields that has been achieved through the so called green revolution. But it is also clear that there are limits to what can be achieved, the annual growth rates of, for instance, world cereal production and yields are steadily decreasing. At the same time, many of the agricultural practices put more and more pressure on the natural resources and ecosystem services. These services include not only the provision of food and fodder, but also water control, maintaining healthy and fertile soils, providing natural pest control, erosion prevention, genetic diversity, and recreation and tourism. Over-use of fertilizers or pesticides can pollute water and soils and negatively affect pollinators; extensive aquaculture production can cause salinization of soils and eutrophication of water systems; agricultural expansion is a key driver of deforestation, often with detrimental effect on hydrological cycles and resulting water scarcity. These all threaten the stability of agricultural production and the future of food security.

In addition to these developments, we introduce yet another variable, climate change. The various scenarios as developed by the Intergovernmental Panel on Climate Change (IPCC) predict changes in the nature and the geographic distribution of environmental conditions including, amongst others, air temperature, rainfall amounts and distribution, extreme weather events (droughts, storms), river flows, sea levels, ocean temperature and acidity, etc. These changes affect the growing conditions of crops, livestock, fish, trees as well as ecosystem services, and thereby the livelihood of people, often the poorest. The developing countries, mainly in the tropics, are likely to face the brunt of the negative impacts of climate change.

Many models use the IPCC scenarios to better understand the future impacts. An example of this includes the amount of fish stock in the oceans, and in particular the expected decline in stocks in coastal zones, the possible eastwards movement of the main skipjack tuna areas in the Pacific and the effect on rice yields in Asia. This is studied in more detail in the Philippines by the FAO project "Assessments of Climate Change Impacts and Mapping of Vulnerability to Food Insecurity under Climate Change." The modelled rice yields also illustrate the large amount of uncertainty of the predictions, with large variations depending on which scenario is used and the time frame. In addition, the pollinators are likely to be effected by the increase in temperatures, in particular in the tropics, thereby endangering the production of many fruits and vegetables.

This illustrates the importance of the second pillar of CSA: support adaptation across the agricultural sectors to expected climatic changes and build resilience. Adaptation is critical to secure future food security. There are many examples on how better practices and better policies can help farmers, foresters and fisher folks adapt. Agroforestry, crop diversification, conservation agriculture, improved management techniques, weather services, and availability of salt- or drought-tolerant crop varieties are just a few of them. I will not go into much more detail here now as I am certain we will hear many more examples during these two days of the workshop.

Now some words on the third pillar of CSA: reduce, where possible, the greenhouse gas emission intensity of production systems.

Agriculture is not only affected by climate change, it is also contributing to the emission of greenhouse gases. As far as global emissions from agriculture are concerned, Asia has a share of about 44 percent. In absolute terms, the emissions have been increasing over the last decades, very much in line with the increase of agricultural production in the region. Livestock, including enteric fermentation and manure, is the biggest emitter, covering about half of total agricultural emissions. This is followed by paddy rice (20%) and the emissions from synthetic fertilizers (18%).

There are ample opportunities to reduce the emission intensity of agricultural systems, that is the amount of emissions per unit of product, without reducing, or even with increasing, the productivity. Key phrases here are "resource use efficiency", "improved management" and "combining reduction of emission intensity with productivity increase". Studies do show that both in the livestock sector and in paddy rice production such reductions are possible and economically viable. One example for rice production concerns the Alternate Wetting and Drying (AWD) technique.

But introducing better, more climate-smart production system does not happen automatically. Farmers, fisherfolks and foresters need support! This includes knowledge of alternative or improved production systems and management options; local support institutions or mechanisms (extension services, cooperatives, etc.); availability of more resilient varieties (need for research and development); access to resources, both for men and women: inputs, land, financing/investment; and an enabling policy environment.

FAO, in particular through its "EPIC" programme in Malawi, Zambia and Viet Nam has developed a CSA approach with four key components:

(1) Build an evidence base: climate risk/impact assessment; identify viable CSA options and trade-offs (e.g. livestock and conservation agriculture); understand barriers to adoption; analyse and assess capacity development needs of institutions; analyse policies, strategies and development plans.
(2) Prepare policy recommendations.
(3) Support the development of investment frameworks and investment/financing proposals for upscaling CSA.
(4) Improve the CSA knowledge base and advocacy for CSA.

Finally, to bring about positive change, there is a need to create an enabling environment. For this to happen, four important principles are required:

- Turn political will into implementation/policies, investments, legal frameworks.
- Sharpen the focus of policies and programmes for climate change on food security.
- Increase the base of evidence for policymaking.
- Involve all stakeholders in decision-making.

I hope that during these days we will make progress towards real action on the way towards a transformation of agriculture into becoming more climate-smart in the Asia-Pacific region.

Thank you for your attention.

Annex 5

Keynote Address 2: Food security in a changing climate: How to move to action?

Mr Arie Veldhuizen, Agricultural Counsellor, The Netherlands

Food security in a changing climate is the theme of this Workshop. FAO is calling for action on this. In keeping with this call, attention and concrete actions would be needed in the following areas:

- increasing sustainability,
- food production,
- enhancing resilience to climate change,
- reducing greenhouse gas emissions,
- increasing food security, and
- lower global food waste and food losses.

In other words, action is needed now, instead of talk and further analyses. No doubt, there are many difficulties that will have to be overcome, but solutions are urgently needed.

For a start, just consider feeding the world's 9 billion people in 2050 – food security is indeed our top priority. And agriculture plays a crucial role in that pursuit. We must build on the strengths of all its stakeholders, from smallholders to multinational companies, to face the challenges of today, especially climate change. Feeding the world goes hand in hand with reducing the pressure on natural resources. We need innovative solutions, adapted to local conditions. Partnerships between the private sector, research institutions, civil society and governments will be crucial to sustainably nourish the world's population by 2050.

This is a year of milestones and opportunity. The Post-2015 Sustainable Development Agenda and the UN Zero Hunger Challenge recognize food and nutrition security and poverty alleviation as a key priority. Despite these major achievements, concern is welling up. As the recent 5th IPCC working group II report shows, climate change is likely to be the biggest challenge to achieving the sustainable development goals. Climate change is already affecting all four aspects of food security.

Extreme events, drought and food shortages are impacting the most vulnerable populations, especially in the tropical countries. With this in view, The Netherlands has been supporting development programmes especially with adaptation to climate change. Viet Nam, for instance is particularly exposed to climate change: floods, storms, typhoons, and longer-term sea level rise pose risks to low-lying coastal areas, including the agricultural heartland of the Mekong Delta. The Netherlands and Viet Nam, both delta countries, concluded a Strategic Partnership Agreement on Climate Change and a long-term vision on the Mekong Delta was developed in 2013. A forerunner related to the current Mekong Delta approach was the Coastal Wetlands Protection and Development Project (1999–2007). This project adopted a comprehensive, long-term approach to the protection of coastal wetlands in four Mekong provinces. As a result, pressure on coastal mangrove ecosystems has been reduced, erosion has declined and livelihoods have improved for coastal communities who have witnessed a resurgence of aquatic resources such as crabs and clams.

While farmers are already adapting to climate change, there is an urgent need to accelerate and scale-up the adaptation process. Viet Nam is still one of the forerunners in the international context. Last year The Netherlands and Viet Nam have also signed a Strategic Partnership on Sustainable Agriculture and Food Security. We are working hard together to get results, because we realize: time is running out.

But we have to continuously explore for new ideas so we can innovate upon current production practices, in order to make agriculture, forestry and fisheries sustainable, while being part of the solution to climate change. Therefore it is important and inspiring to gather here in Bangkok where people, ideas and innovations connect. In this workshop, we will share knowledge and experience on implementing Climate-Smart Agriculture among public, civil society and development agencies, and promote the mainstreaming and up-scaling of Climate-Smart Agriculture.

In The Netherlands agriculture accounts for over 40 percent of the national production of renewable energy and is innovative in developing new techniques, such as sustainable heat from geothermal sources. An example is the development of a "climate neutral" tomato, growing on renewable heat. Our innovative farmers are also adapting to future and less favourable climate conditions, by for instance growing crops adjusted to saline ("salty") conditions: vegetables, algae and, most promising, a "salty" potato (test farm scale). The next challenge is to develop a full rotation shift of salty crops.

But we have to focus together on the urgent need to increase the capacity of farmers worldwide to cope with climate change and food security. We need bold action to stop the moral outcry that almost 1 billion people still go to bed hungry every night. We need to achieve food security and to feed over 9 billion people in 2050. And we need to overcome the devastating impact of climate change.

And we know what bold action implies. We know what the solutions are to achieve global food security. We have to increase our agricultural production in a sustainable way, by at least 60 percent. And we have to double our efforts to reduce our use of finite natural resources. That is why The Netherlands have been active in putting Climate-Smart Agriculture firmly on the international agenda and why we are here today to share experience, but most of all learn from you.

Since 2009 the Government of The Netherlands has taken a leadership role, together with a close group of key partners from all regions and stakeholder groups, in bringing together the agendas for agriculture, food security and climate change. Three Global Conferences for Agriculture, Food Security and Climate Change have been organized from The Hague, Hanoi and Johannesburg. And an equal number of Science for CSA Conferences have been hosted by The Wageningen University and Research Center, UC Davis and the most recently in Montpellier, in March this year.

In 2014, the UN Secretary-General Ban Ki-moon invited world leaders, from government, finance, business and civil society to a Climate Summit in New York, to galvanize and catalyse climate action. He asked these leaders to bring bold announcements and actions to the Summit that will reduce emissions, strengthen climate resilience, and mobilize political will for a meaningful legal climate change agreement in 2015.

During this Summit the President of Niger and the Prime Minister of The Netherlands chaired a session with Action Announcements on Agriculture, which included the Chairperson of the African Union, the CEO of The Southern African Confederation of Agricultural Unions (SACAU), Walmart, McDonalds, GFAR, and Civil Society. The Global Alliance for CSA (GACSA) was formally launched by the Prime Minister of The Netherlands, and warmly welcomed by a number of speakers. More than 70 governments, organizations and companies announced their commitment to join the newly launched Global Alliance for CSA. The joint entities that have committed to the Alliance represent millions of farmers, at least a quarter of the world cereal production, 43 million undernourished people and 16 percent of total agricultural greenhouse gas emissions. It is important to insist on the focus on agriculture, food security and nutrition, and the action oriented nature of the Alliance. We need to identify initiatives and actions to tackle seriously the challenges of climate change, and to bring forward transformative changes in the practices of agriculture.

The Global Alliance for Climate-Smart Agriculture has to reach a new phase in which partners determine together their contribution to create and accelerate action on the ground. In the view of The Netherlands, the Alliance should be driven by the needs of end users, especially smallholder famers and communities. We need to ensure these stakeholder groups are adequately represented in the discussions and that the goals and actions of the Alliance support these stakeholder groups.

The Netherlands supports international initiatives that strengthen the capacity of smallholders to adapt to climate change, like IFAD's Adaptation for Smallholder Agriculture Programme and the CGIAR's Climate Change, Agriculture and Food security Programme.

An equally important issue relating to climate change is the reduction of emissions of greenhouse gases in agriculture. We therefore support the work of the Global Research Alliance on Agricultural Greenhouse Gases (GRA). The GRA's mission is to reduce the emission intensity of agricultural production by improving the efficiency and productivity of agricultural systems to meet the increasing demand for food in a sustainable manner. Being a global collaboration of 45 member countries who link their efforts in research and capacity building, the GRA forms a valuable partner-alliance.

With a great variety of partners we build on another initiative, coming from last year's Global Oceans Action Summit for Blue Growth and Food Security, in the area of sustainable fisheries: a Voluntary Global Network for Action on Blue Growth and Food Security. The Government of Grenada will organize a conference in early 2016 to create and accelerate new actions and partnerships in this area.

Further, another very important priority of us all should be to reduce food losses and waste, which was also put forward as one of the priority areas coming from Montpellier's 3rd Global Science for CSA meeting. Worldwide one-third of our food is lost or wasted. In developing countries most is lost before it even reaches the consumer, for example in production and post-harvest stages. In contrast, in developed countries such as The Netherlands, most food is wasted by consumers, retailers and the hospitality sector. Reducing food losses and waste is a key priority for The Netherlands. We have expertise in efficient agro-logistics in food supply chains – linking farmers to markets and post-harvest quality management, for example in fresh fruit and vegetables. A promising initiative in this respect is the Postharvest Network that aims to unite companies, research institutions and governmental organizations to work together to reduce postharvest losses. That is why this week the Government of The Netherlands is hosting the Global "No More Food to Waste" Conference in The Hague, in close cooperation with the Government of Viet Nam, FAO, UNEP, and the African Union Commission, and supported by the Global Forum for Agricultural Research (GFAR) and Wageningen University and Research Center. It brings together a wide range of relevant stakeholders to share experiences and demonstrate combined action in partnerships in the food chain. The Conference, which includes a High Level segment, will look for new ways to craft an ambitious and action-oriented agenda, which integrates food losses and waste to establish cross-sectoral alliances and concrete commitments to reduce food loss and waste across the value chain by 2030.

Recently, the Agricultural Minister of The Netherlands, Ms Sharon Dijksma said in Paris: "*Food security is fertile ground for stability*". At a time when climate change undermines food systems and the threat of conflicts and deadly epidemics are more real than ever, we cannot afford to underestimate the importance of our commitments to food security. The Netherlands aim to contribute to worldwide sustainable economic development in the agricultural sector, as an engine for fair income and productive employment, thereby producing enough and safe food for 9 billion people in 2050.

This is a year of opportunity – with upcoming agreements on climate change and sustainable development: CoP21 and the Post-2015 Development Agenda, and beyond. I am hoping this Workshop is merely a start in the region towards making agriculture climate-smart.

But let's make sure the steps we take today are fair, innovative and sustainable.

Thank you for your attention.

Annex 6

Keynote Address 3: Why climate-smart agriculture?

Suan-Pheng Kam, WorldFish Center

Climate change threatens to undo years of progress achieved in agricultural development towards enhancing livelihoods and food security, with the most severe consequences falling on developing countries and the poor. Reducing this threat requires that agriculture must be practiced in climate-smart ways so that the goal of achieving agricultural development and national food security is not compromised. The three pillars of Climate-Smart Agriculture are sustainable improvements in productivity, building resilience (through adaptation), and reducing and removing greenhouse gases (mitigation).

The Asia-Pacific is an enormously diverse region, widely ranging in eco-physiography, nation size, population densities and economic development. Given its sheer population size and considering that about half of the people live in the coastal zone, large populations are exposed to sea level rise and greater risks of extreme coastal events besides increasing vagaries of weather as direct impacts of climate change. Demand for agricultural products – food, fibre and fuel – continues to increase due to population growth, changes in diet as per capital income increases, and the need for alternative energy sources. Agriculture in the Asia-Pacific thus needs to produce more on dwindling land and water resources and be more resilient to risks associated with extreme weather events.

Climate change simulation models vary considerably in projected results. Broad trends suggest a warmer, wetter climate with more marked seasonality, and more unpredictable weather events that affect agriculture, directly and indirectly, through multiple pathways. Risks associated with climate change vary across the Asia-Pacific region; the ultimate effect is on destabilizing livelihoods and food security through impacts on terrestrial and aquatic systems. More intensive rainfall exacerbates flooding while prolonged and more severe droughts cause greater vegetation water stress and water shortages for irrigation and aquaculture in terrestrial systems. Ocean warming and acidification are already showing impacts on marine and coastal ecosystems.

Climate change is affecting crop yields. Results from multiple global gridded crop models (GGCMs) indicate strong negative effects from climate change, especially at higher levels of warming and at low latitudes. The slight increase in crop productivity at mid to high latitude would be offset by increased occurrence of frosts, heat waves and heavy rainfall. Climate change is affecting nutritional quality of food. C_3 grains and legumes grown at the elevated CO_2 concentrations have lower levels of zinc and iron, which are important dietary sources of these elements for many people.

Climate change impacts on meat and fish production will also affect human nutritional balance. Fish accounts for significant proportions of protein (over 50%) in the diets of many Asia-Pacific countries, where per capita fish consumption rates are comparable with those of the developed world. Climate change is affecting marine fisheries. Marine species are gradually moving away from the equator into cooler waters, resulting in reduced catch in the tropics. The projected longitudinal pattern of ocean warming in the Pacific also suggests a likely eastward shift of tuna that would result in declining tuna fisheries in the western Pacific countries. Climate change is expected to affect existing plans in these countries aimed at deriving more livelihoods from fisheries and aquaculture resources. Climate change is affecting livestock production. By 2020, 30 to 40 percent of global milk and meat production is expected to be produced in Asia. Livestock production in the Asia-Pacific is predominantly pastoral or mixed farming systems and hence is highly dependent on pasture productivity which is impacted in the same way as crops by climate change. Warming temperatures also impair animal productivity (growth, meat and milk yield and quality, egg yield, weight, and quality) and reproductive performance, metabolic and health status, and immune response.

Climate change impacts are most severely felt by the poor. Given the large population in the Asia-Pacific and a region-wide poverty rate of about 20 percent, the number of poor people remains high – estimated at 743 million people in 2011. Recent history has shown that food price spikes can cause instability and social revolt. The Arab Spring unrest of 2011 has been linked with the sharp rise in wheat prices following extreme weather events in Asia and Australia. Shortage of rice in 2008 caused rice price to spike in 2008, with repercussions of food riots occurring as far away as Haiti. There is therefore a compelling need for agriculture to be climate-smart to avoid social and political destabilization that will adversely impact the economy and security of affected nations.

An array of agricultural interventions for adaptation to and mitigation of climate change have been tested and promoted; successes achieved demonstrate the diversity of potential options across different regions, agricultural systems and thematic aspects including improved crop varieties, farm-level techniques, better weather forecasting and risk insurance. Specific adaptation measures responding to climate change include:

- using improved crop varieties and livestock and fish breeds that are better adapted to changed climatic conditions;
- simple adjustments to land, crop and livestock management such as optimizing cropping and husbandry schedules;
- more efficient use (including multiple use and re-use where possible) of water and energy in the food production and supply chains;
- better weather forecasting and timely provision of data and information to farmers;
- risk insurance; and
- sustaining the ecosystem services of forests and water sources for combating climate change impacts, e.g. shoreline protection function of mangroves which are also important breeding and feeding grounds for fish.

Direct GHG emissions from the agriculture sector and associated land use changes are low relative to other urban-based sectors. Notwithstanding that, mitigation of GHG emissions reduces the impact of agriculture on climate change. Sequestering carbon in the soils of croplands and grazing lands offers agriculture's highest potential for climate change mitigation, followed by improved fertilizer management (particularly nitrogen fertilizer) which also increases fertilizer use efficiency and reduces production costs. Methane produced from cattle enteric fermentation is another source of agricultural GHG emission that can be mitigated.

Climate-smart management, even within a sector, encompasses a range of options that synergistically contribute to adaptive and mitigative outcomes. As illustrated by the livestock sector, being climate-smart entails integrating various aspects of stock breeding and selection, animal health and disease management, grassland and feed management and manure management; while ensuring the build-up and flow of knowledge from experimentation to piloting to scaling out best practices across the value chain. Integration that extends beyond the farm to landscape and coordination across agricultural sectors (with crops and fish) would further capitalize on potential synergies and optimize the use of natural resources and ecosystem services.

Climate-smart management is applicable across a range of spatial scales from farm to landscape and catchments, as well as across the scale of governance hierarchy from local to national and regional institutions and policies. Practicing CSA is often considered a "no-regrets" strategy in that its benefits of sustainable improvements in agriculture will accrue even if climate change impacts turn out not to happen or be as severe as expected. While "no-regrets" may be a persuasive argument for the initial steps of adaptation in the immediate to short term, it should not preclude longer-term solutions for sustained resilience that call for more difficult choices and trade-offs and, associated with that, heavier financial and human capacity investments.

It is important to consider climate-smart management of agriculture within a broad socio-ecological context, recognizing that climate change is one of many drivers of change influencing the agricultural sector. Responses to shorter-term perturbations (markets, prices, land conversions, etc.) often take priority over adaptation to a slow variable like climate change. Technological solutions for climate change adaptation and mitigation must be supported by enabling policies and institutional and financial arrangements and be based on an understanding of the socio-cultural-economic contexts that provides insights about barriers to adoption – behavioural or otherwise – and ways of overcoming them.

Climate-smart agriculture already features in several international fora and development agenda. CSA is central to the development plans of international bodies (e.g. FAO, IFAD, World Bank) and touted as the sustainable and food secure pathway in various United Nations fora on sustainable development and on agriculture and food security. The recent Intergovernmental Panel on Climate Change Meeting on Climate Change, Food and Agriculture in May 2015 articulated the need to situate climate issues in wider sustainable agriculture development agenda, with emphasis on multi-functionality of agriculture linking across adaptation and mitigation – in essence climate-smart agriculture.

The CGIAR Research Program (CRP) on Climate Change, Agriculture and Food Security (CCAFS), through its research projects of piloting climate-smart villages in various countries across the continents, attempts to deal with climate change response in agriculture in a more holistic manner. Interventions deemed to be weather-smart, water-smart, carbon-smart, nitrogen-smart, energy-smart and knowledge-smart are identified with target communities and other stakeholders, tried out and evaluated. Successes are beginning to emerge; the challenge remains for scaling out to other villages and scaling up beyond the village level to encompass larger landscapes where different sets of sustainability issues might emerge and broader-level management, institutional and policy interventions would come into play.

As the CGIAR moves into a second 15-year phase of CRPs in 2016 a major rethinking emerges that recognizes climate change as a cross-cutting issue to be addressed in meeting the challenges of reducing poverty, improving food and nutrition security for health, and improving natural resource systems and ecosystem services. A new CRP structure is expected to have climate change research embedded into a number of CRPs on food systems for the major food types, rather than constituting a separate research program as presently configured. This will foster climate-smart thinking and integrate climate change management actions into the food-systems research programs aimed at sustainable improvements in agriculture while enhancing the ecosystem services of the natural resources that it depends on. Designing and implementing an integrated framework of research programs such as this is challenging and is being pursued.

Climate change is global, and response to its impacts must be universal. While countries grapple with national action plans to deal with climate change, including climate-smart agriculture, regional initiatives to foster collaboration on common themes could be undertaken to tackle common issues related to climate change management that transcend national boundaries. Such an initiative has already emerged in Africa, where alliances (such as the Africa Climate-Smart Agriculture Alliance) and partnerships (such as the Climate-Smart Agricultural Partnership for Africa) have been established. Would this be a model for the Asia-Pacific?

I started with a question, and end with one. But research is all about asking appropriate questions, and finding solutions. I feel optimistic that we will find the solutions for agricultural adaptation in the face of climate change.

Thank you for your attention.

Annex 7

Scaling-out climate-smart agriculture in Asia-Pacific: Opportunities and constraints

Pramod Aggarwal
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Asia-Pacific comes across as amongst the most vulnerable regions to climate change in the Fifth Assessment Report of the Intergovernment Panel on Climate Change (IPCC) which was released a year ago, and in other similar reports. Climate change in the region is manifested by depleting glaciers, increasing coastal erosion, frequent heat waves, rising sea level, frequent floods and droughts, and varying rainfall patterns. It is now evident that Asian climate is already changing and the impacts are already being felt. As a largely agrarian economy, this vulnerability is compounded by the fact that almost 1 000 million people's livelihoods depend on agriculture directly influenced by changes in climate.

Although the Asia-Pacific region has seen robust economic growth over the past 20 years, the region is still home to a large number of hungry people. In South Asia alone, we have more than a quarter of the world's hungry and 40 percent of the world's malnourished children and women. As populations continue to rise and the demand for food grows, the question is: how will this increase in demand be met and where will all this food be grown? With stiff competition for land from the non-farm sector, expanding farmlands is not an option. Climate change will further exacerbate the existing pressures on land and water resources. Numerous studies including IPCC reviews have shown that the productivity of crops, fish and livestock in the Asia-Pacific region would decline even in the short-term with significant effects later in the century if corrective actions are not taken now to increase our adaptive capacity. For example, even with the benefits of carbon fertilization (which could anyway be negatively affected by increases in surface ozone concentration) India stands to lose nearly 4 to 5 tonnes of wheat with every rise in temperature of 1°C. Dependence on global supplies is not an option because of increasing volatility of supplies and prices. If the Sustainable Development Goal of ending poverty, achieving food security and promoting sustainable agriculture is to be realized, climate change adaptation and mitigation technologies, practices, services and policies will need to be implemented in earnest.

What are our options at this stage? The following section provides brief details of six key action points to promote CSA to enhance adaptation to climate change.

1. Make full use of untapped potential of currently available technologies

There are large yield gaps in almost all crops in most Asia-Pacific regions. These gaps provide huge opportunities for increasing food production even in the face of climate change, especially in short- to medium-term. In South Asia for example, bridging these yield gaps could almost double food production. For this to happen, investments in land and water management, infrastructure, and research accompanied by enabling policies, sustained regional cooperation and robust institutions is crucial.

2. Use the power of ICT and insurance for managing current climatic risks

Increased production variability could perhaps be the most significant impact of climate change in Asian countries. Short-term changes in weather extremes, which are still not very predictable in most countries of the region, pose huge challenges. Some recent examples are the drought in 2014, the floods in Pakistan in 2010, floods in India, Nepal and Bangladesh in 2007, and the heat-stress experiences in India in 2004 which resulted in fluctuating yields, food price volatility and threatened food security and incomes. To ensure future food security in climate change scenarios, investment in managing and stabilizing the existing irrigated potential while exploring options to expand this potential is the need of the hour.

Scaling out climate-smart agriculture: Opportunities in Asia-Pacific

1. Make full use of untapped potential of currently available technologies
2. Use the power of ICT and insurance for managing current climatic risks
3. Identify and exploit potential benefits of climate change
4. Use science and technology for improved targeting of CSA technologies and policies
5. Adopt climate-smart village approach for integrated solutions leading to higher income, resilience, adaptation and mitigation
6. Address simultaneously poverty, governance, institutions, and human capital which limit agriculture growth even today

There has been great progress in the ICT and crop insurance sectors in many countries yet their potential is only partially exploited in the Asia-Pacific. India has almost 3 million farmers who are receiving today weather forecasts and related agro-advisories through their mobile phone. But in other countries there has been limited success. Even in India there is a large dropout rate because of the generic nature of advice. There is a need to tailor this information to village/community/individual farmer level. Ready availability of cheap android smartphones, modelling techniques, and progress in big data, crowdsourcing, cloud computing and decision support systems (DSS) could make this happen rapidly while also increasing the effectiveness of information provided and thus facilitating scaling-out.

Both yield and rainfall index-based insurance schemes provide risk management options and enhance the resilience of farmers in an environment of increasing climatic risks. Today almost 30 to 35 million farmers have access to crop insurance in the Asia-Pacific region but the distribution is highly skewed with India alone having the majority of beneficiaries. There is a need for site-specific indices. CCAFS has made tremendous progress in designing improved insurance products and PPP schemes that are currently being tested in India and Nigeria. Lessons from these could quickly enable other governments and industries to scale-out similar products in other countries.

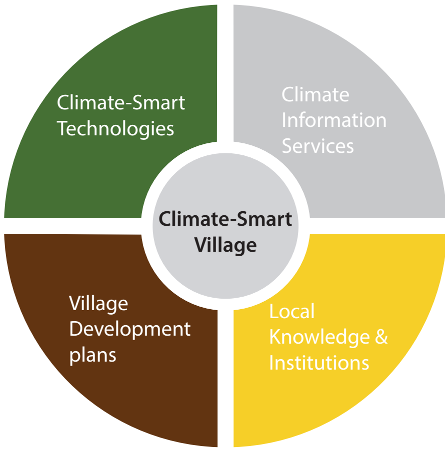
3. Identify and exploit potential benefits of climate change

In general we always talk about the negative impacts of climate change. In several parts of the world including Asia-Pacific, however, climate change could provide some opportunities as well. Somehow, there has not been much consideration of this in the region. Asia-Pacific has almost all agro-climates, all crops, several seasons, and large diversity in diets. This wide-spectrum could provide several opportunities, if properly researched and tried even though these may not outweigh the negative impacts. Some regions could become conducive for alternate crops and their varieties in the changed climate. Change in temperature invariably reduces crop duration for most species and thus sometimes could become more suitable for shorter-duration crops/varieties. For example, farmers in the upper regions of Himachal Pradesh in India have taken to growing apples because temperatures in the lower regions became too warm for its growth. The shift in cultivation brought new opportunities and high incomes for these farmers while their counterparts in the south switched to cultivating vegetables. Similarly large coastline and aquaculture systems could provide opportunities for alternate fish species. Research on alternate land-use systems for various regions needs to be accelerated to enhance our capacity to adapt to climate change.

4. Use science and technology for improved targeting of CSA technologies and policies

Climate-smart interventions have varying costs and environmental and economic impacts, and their implementation requires appropriate investment decisions by national/sub-national policy makers that are relevant in current as well as future scenarios of climate and economic development for all farmers and other stakeholders. Investment plans are being prepared by national and international agencies in scaling out CSA. Hence, there is a big need to identify which intervention is suitable for what region and its associated costs: benefits to promote CSA as well as to prevent maladaptation. Our recent unpublished analysis has shown for example that investment in large-scale seed banks to manage early rainfall failures is not useful in much of South Asia. CCAFS has also developed a CSA prioritization toolkit: household typologies and gender toolkits that can support investment decisions in CSA technologies and policies for a region.

5. Adopt Climate-smart village approach for integrated solutions leading to higher income, resilience, adaptation and mitigation



Several technological, institutional and policy interventions have been proposed that can help us adapt to climate change as well as to current and future weather variability. Similarly options have been proposed that can recue GHG emissions from agriculture. We need to maximize synergies among these interventions as well as minimize trade-offs. CCAFS, in collaboration with national programs, is partnering with rural communities to develop Climate-Smart Villages (CSVs) as models of local actions that ensure food security, promote adaptation and build resilience to climatic stresses. Researchers, local partners, farmers' groups and policy makers collaborate to select the most appropriate technological and institutional interventions based on global knowledge and local conditions to enhance productivity, increase incomes, achieve climate resilience and enable climate mitigation. Climate information is an important part of CSVs and consideration is always given to integrating village developmental and adaptation plans together with local knowledge and institutions into the project. There is no fixed package of interventions or a one-size-fits-all approach.[1]

Initial field and modelling results suggest a large scope of CSV approaches for significant increase in production and farmer's income, climatic resilience, adaptation to longer-term climatic change and to some extent mitigation of GHGs over the long-term and thus to maximize synergies among different interventions in order to scale out CSA. Much work needs to be done to expand the evidence base of CSVs with regard to targeting the approach in different agro-climates, the cost-benefit analysis in terms of investment and returns, and the institutional and policy changes that are needed to promote CSA.

6. Address simultaneously poverty, governance, institutions and human capital which limit agriculture growth even today

In several parts of the Asia-Pacific region, problems of widespread poverty, poor governance, weak institutions and human capital limit agricultural growth today. It is critical to simultaneously address these political and socio-economic constraints if the full potential of CSA is to be realized for farmers and the region as a whole.

[1] For more details:

- Aggarwal P., Zougmoré R., & Kinyangi J. "Climate-Smart Villages: a community approach to sustainable agricultural development," CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS, 2013). Available online at: www.ccafs.cgiar.org.
- Jat, R.K., Sapkota, T.B., Singh, R.G., Jat, M.L., Kumar, M., & Gupta, R.K. 2014. Seven years of conservation agriculture in a rice–wheat rotation of Eastern Gangetic Plains of South Asia: Yield trends and economic profitability. *Field Crop Research* (available online), http://dx.doi.org/10.1016/j.fcr.2014.04.015.

Annex 8

Agriculture at UNFCCC: Paris and beyond

Promode Kant, Institute of Green Economy, India

Food security, and hence agriculture, has been at the centre of the global climate negotiations from the very beginning and was in fact the reason why 160 countries of the world agreed to meet at Rio de Janeiro in 1992 to negotiate the first framework convention on the possible ways to deal with arguably the most serious self-created problem the global community has ever faced. The ultimate objective of this Convention is limiting the concentration of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system within a time frame that ensures the food production is not threatened. There was a clear recognition that the warming climate due to uncontrolled use of fossil fuels was threatening agriculture and all countries made commitments to develop, make available, and use technologies and processes that reduce greenhouse gases emissions in agriculture, and to cooperate in preparing for adaptation to the changing climate, particularly in areas affected by drought, desertification and floods.

Under the Kyoto Protocol signed in 1997 the developed countries agreed to promote, while meeting their emission reduction targets, sustainable forms of agriculture, and undertake reforms to progressively phase out of market imperfections in all greenhouse gas emitting sectors caused by fiscal incentives like tax exemptions and subsidies that run counter to the objective of the Convention (Article 2). The inclusion of emissions and reductions by agricultural sources and sinks is optional under Article 3.4 of the Protocol and only very few countries have chosen to do so. Also, all countries are required to formulate and implement national programs to mitigate climate change and to adapt to it in the field of agriculture in order to achieve sustainable development subject to their common but differentiated responsibilities and national priorities and circumstances (Article 10). The Annex A to the Kyoto Protocol lists enteric fermentation, manure management, rice cultivation, agricultural soils, prescribed burning of savannas and field burning of agricultural residues as the main mitigation opportunities in agriculture.

Performance of the agriculture sector under Clean Development Mechanism (CDM) has been very modest with just 213 of the total 7 645 registered projects – less than 3 percent – falling under this sector. Of these, 61 are large-scale projects which are exclusively animal waste management related while the rest, the 152 in small-scale category, are mostly for biomass based energy generation.

In 2007 the Ad-Hoc Working Group on Long-Term Cooperative Action (AWG-LCA), a subsidiary body under the UNFCCC, was launched under the Bali Action Plan. This Action Plan has five main components of shared long-term vision for action on climate change, mitigation, adaptation, technology and financing. The mandate to bring agriculture into these negotiations comes from the Bali Action Plan's paragraph 1(b)(iv) calling for cooperative sectoral approaches and sector-specific actions for enhanced implementation of the provisions of Article 4, paragraph 1(c) of the Convention which pointedly demands cooperation in the development and diffusion of technologies to reduce emissions in the agriculture sector.

Negotiations on agriculture continued at Copenhagen and a draft text on agriculture was developed which had the following key components:

- "Decides that all Parties . . . should promote and cooperate in the research, development, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases, particularly those that improve the efficiency and productivity of agricultural systems in a sustainable manner and those that could support adaptation to the adverse effects of climate change, thereby contributing to safeguarding food security and livelihoods"
- "Requests the Subsidiary Body for Scientific and Technological Advice (SBSTA) to establish a programme of work on agriculture"

This draft text was carried over to Cancun but there was no agreement on it. Then in the AWG-LCA meeting held in April 2011 in Bangkok, agriculture was proposed as a standalone item separated from other sectors under the Bali Action Plan para 1 (b)(iv) that did not have much in common with this sector but was opposed by developing country parties. Again in the June 2011 session of SBSTA in Bonn agriculture was sought to be included in the SBSTA agenda but in the absence of any agreement agriculture continued to be discussed under the cooperative sectoral approaches as before.

A major breakthrough happened at Durban in 2012 when the Convention managed (Decision 2/CP17) to separate agriculture from other sectors and asking SBSTA to consider issues related to agriculture with the aim of exchanging views and enabling a decision on this matter at the next CoP even while continuing the consideration of a general framework for cooperative sectoral approaches and sector-specific actions. Countries were invited to submit their views to SBSTA and the following views emerged from important groups of countries.

The European Union stated that in parallel to the need for adaptation, there are large opportunities for mitigation in the sector without affecting the food security and livelihood. Many mitigation actions, like restoration of degraded lands and enhancement of soil organic matter also build resilience. There should be recognition of the wide diversity of agricultural systems, development priorities, objectives and circumstances. There are synergistic opportunities in the three conventions of climate change, desertification and biodiversity which should be fully explored. The SBSTA should deliberate on the state of scientific knowledge on the impacts of climate change, on the measurement of emissions and removals, on scientific, technical, environmental and socio-economic aspects of adaptation and mitigation in agriculture and their synergies and trade-offs, identification of sustainable agricultural technologies for adaptation and mitigation and transfer to farm level and on approaches to enhance international cooperation in research and development and capacity-building of all relevant stakeholders in agriculture.

The LDC group drew attention to the overwhelming dependence of their economies on agriculture and the high vulnerability of the sector to climate change and said they were concerned about article 4.1(c) of the Convention which lays stress on mitigation whereas the priority of the LDCs is adaptation. Their interest lay in the Work Program on Loss and Damages and while they welcomed the inclusion of agriculture in the agenda of SBSTA they were apprehensive of any new commitment on mitigation. They wanted SBSTA to deliberate on measurement and methodological issues, on the state of knowledge relevant to agriculture and examine existing pilot projects on adaptation in developing countries to learn from the experience.

The Group of African States stated that their priority is to ensure food security, enhance socio-economic development, and secure livelihood with special attention to smallholder and marginal farmers through adaptation. For them the priority issues for agriculture under SBSTA were compilation of a knowledge base and its expansion through research, identification of technologies and practices suited for transfer to countries that need them, measurement of emissions and other methodological issues, and assessment of capacity development of all stakeholders.

The Environmental Integrity Group, consisting of the Republic of Korea, Mexico, Switzerland, Liechtenstein, and Monaco, stated that agriculture has both potential for mitigation and a considerable ability for adaptation, and should thus form a core part of the global strategy to deal with climate change. The Group proposed a work programme under SBSTA aiming at increasing the adaptive capacity of the agriculture sector, minimizing its emissions and improving food security, reducing poverty and increasing agro-ecosystems services.

Among individual nations the views of The United States of America, China and Japan are presented here. The United States of America stated that in relation to agriculture also SBSTA should work within its mandate under the article 9 of the Convention and may address the broad fields of adaptation and mitigation synergies; improved efficiency, productivity, and resilience; and safeguarding food security and livelihoods, capacity building, research needs and technology transfer.

China stated that the discussion on the agricultural sector should focus on how developed countries provide support to the developing countries adapt to the changing climate and that SBSTA should initiate a dialogue on how technology could be transferred to them.

SBSTA initiated discussion on the subject which continued at the next session in December 2012 and in June 2013 without developing any consensus. One significant decision at its June 2013 meeting was to invite countries to submit their views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts with no mention of mitigation. These were discussed in a SBSTA workshop the report of which came up for discussion in it session in June 2014 when it was concluded that SBSTA would undertake scientific and technical work, in the areas of:

(a) Development of early warning systems and contingency plans in relation to extreme weather events;
(b) Assessment of risk and vulnerability under different climate change scenarios;
(c) Identification of adaptation measures, indigenous knowledge systems, co-benefits and sharing experiences; and
(d) Identification and assessment of practices and technologies to enhance productivity sustainably in different agro-ecological zones and farming systems.

The SBSTA also invited views on the issues mentioned above the first two of which were to be discussed in June 2015 and the last two in June 2016. Only five countries and the European Union submitted their views. R. Korea, the only one from the Asia-Pacific, stated that the agro-meteorological Early Warning System should be built on accurate and site-specific-agricultural information, and be able to integrate the effects of several weather elements and not merely temperature and rainfall, which is lacking now and the National Academy of Agricultural Science in the Republic of Korea has designed a risk management solution which could address this shortcoming. The SBSTA deliberated on the issues related to agriculture but there was no conclusion and it was decided to continue with the discussions. Two in-session SBSTA workshops on early warning systems and assessment of risk and vulnerability were held on June 2 to 3, 2015 at Bonn, the report of which shall be discussed in the SBSTA meeting to be held in December this year.

Could NAMA and NAPA bring agriculture substantively within the zone of intense action? Agriculture does find a place in the National Adaptation Plans of Action of most LDCs prominently, and to a much smaller extent, under NAMAs but agriculture is too widely spread, both geographically and in terms of extent of population involved, for these measures to be of any significance going by the current scales of finances available for these activities.

At Paris the Intended Nationally Determined Contributions (INDCs) are likely to form the centre of the negotiating plank for the climate architecture beyond 2020. So far only ten countries and the European Union have submitted their INDCs. Agriculture is included in the sectors in which these countries, including The United States of America and the European Union, intend on achieving emission reductions but no separate target for this sector has been fixed by any country.

In conclusion one could say that while agriculture has a good potential for mitigation of climate change, and is the prime candidate for adaptive action, there is as yet no progress forward in giving this sector the prominence it requires in dealing with the problems that lie just around the corner. The hope however lies in the fact that negotiations on issues related to agriculture have turned more intense in the recent few years than ever in the past. These discussions, and the fast paced developments in technologies, may just provide the spark that is needed.

Annex 9

State of play: Update from the Green Climate Fund

Leo Park, Financial Institutions Specialist, Private Sector Facility, Green Climate Fund

Introduction

The GCF is an operating entity of the financial mechanism of the UNFCCC established in 2010 and considered to be the centerpiece of long-term climate finance. The GCF's headquarters opened in December 2013 in Songdo, in the Republic of Korea.

To date, 33 countries have pledged US$10.2 billion to invest in the green economies of developing countries. The GCF's mandate is twofold: it aims to combat climate change while at the same time giving equal weight to economic development and job creation in a green economy.

The Fund is currently moving towards full operations and has achieved several important milestones, the most recent one being the accreditation of seven entities at the end of March 2015. At the next board meeting in July 2015, further entities are expected to obtain accreditation. The Fund is also in the process of converting at least 50 percent of the initial pledges into actual contributions. As of May 21, 2015, GCF achieved a conversion of 58.5 percent or US$5.5 billion of the total pledges into contribution agreements with countries such as Germany, France, Japan, United Kingdom, Sweden and Republic of Korea.

Readiness programme

The readiness programme supports countries in building capacity of their Focal Points/National Designated Authorities (NDAs), developing strategic frameworks, identifying and supporting local implementing entities to be accredited with the Fund and develop project pipelines, and host events to share information and knowledge. The first country readiness programme will soon be initiated. Within its readiness programme, the GCF will disburse up to US$1 million per year and per country. More than 50 readiness requests have been received by the Fund so far. In order for requests to be approved, it is essential that a very detailed and specific description of the envisaged programme is provided.

Funding areas

The GCF has two funding windows for mitigation (50%) and adaptation (50%). The adaptation window will include a disaster risk element and investment in infrastructure to make it more climate resilient. With regard to its allocation framework, the GCF strives towards achieving a geographical balance, allocating sufficient resources for vulnerable regions and to the Private Sector Facility (PSF).

The GCF has identified several strategic impact-results areas within its two funding windows.

Mitigation:

- Low-emission energy access and power generation
- Low-emission modes of transport
- Buildings, cities, industries and appliances
- Land use, deforestation, forest degradation, and sustainable management of forests and conservation and enhancement of forest carbon stocks

Adaptation:

- Livelihoods of people, communities and regions
- Health and well-being of people, food and water security
- Infrastructure and built environment
- Ecosystems and ecosystem services

Project proposals

The Fund is currently receiving funding proposals from various accredited entities around the globe and it is expected that the first projects will be approved in October this year.

Project proposals will be assessed against the following investment criteria:

- Impact Potential: Potential to achieve the Fund's objectives and result areas
- Paradigm Shift Potential: Potential to catalyse impacts beyond a one-off project or programme investment
- Sustainable Development Potential: Potential to provide wider benefits and priorities such as creation of jobs and contribution to gender equality
- Needs of Recipient: Vulnerability and financing needs of the beneficiary country
- Country Ownership: Beneficiary country ownership of and capacity to implement funded activities
- Efficiency and Effectiveness: Economic and, if appropriate, financial soundness of the programme/project

The approval process of project proposals is still being finalized. Project proposals can only be submitted by accredited entities of the Fund. The National Designated Authorities (NDAs) of the country are required to send a non-objection letter to the GCF. The Fund aims to approve or decline projects within three months from the date of project proposal submission.

Accreditation

Accreditation to the GCF is open to all entities, including international, regional, national, sub-national and public and private entities, through one of two modes of access:

- Direct access track: for regional, national and sub-national entities
- International access track: for international entities, including United Nations agencies, multilateral development banks, international financial institutions and regional institutions

Intermediaries and Implementing Entities need to meet the GCF's fiduciary standards and environmental and social safeguards (ESSs) which are based on the International Finance Corporation's (IFC) performance standards.

If entities are accredited by GEF, AF or EU DEVCO, they may be eligible to apply under the fast-track accreditation process. The fast-track process allows for eligible entities to focus their application on those GCF accreditation requirements that have not been assessed during other accreditation processes.

No quota system is in place and accreditation works on a first-come-first-serve basis.

Private sector facility (PSF)

The GCF is a climate fund with the mandate to work with the private sector. The PSF was created as a mainstream component of the Fund to maximize private sector investment engagement with climate finance in developing countries. The PSF aims at creating synergies among public and private stakeholders to support the development of adequate national climate change strategies that address key investment barriers, and at leveraging the existing financial ecosystem by working with financial intermediaries that have the necessary experience and pipeline of investments.

It is important to note that the GCF will provide concessional investments where private finance is near feasible. Four types of instruments will be applied by the Fund, namely grants (e.g. for risk assessments), debt (e.g. to cover high upfront costs), equity (e.g. in the riskier early stages of projects) and guarantees (e.g. to mitigate project specific risks).

Areas of priority for the PSF are public transportation, waste and water management, and energy smart buildings, companies and cities in the case of urban projects, and agriculture and forestry for rural projects. Water and on- and off-grid low emission energy are considered cross-cutting sectors.

Accredited intermediaries can submit funding proposals spontaneously or through responding to a Request for Proposals issued by the Fund.

Annex 10

Climate-smart agriculture success stories from Asia

Introduction

In 1992, when countries across the globe joined an international treaty on climate change, their primary concern was with food security. It was becoming apparent that global warming will set back all the advances we have achieved in agriculture. This concern pales against the likelihood that the earth's population is projected to reach 9 billion by the year 2050. FAO estimates that food production must increase by 60 percent to meet the needs of such population growth. In such a scenario, the agriculture sector must transform itself to be far more productive while being simultaneously resilient to the impacts of climate change.

In the face of such challenges, agriculture must be transformed into a "climate-smart" system to continue feeding the world in a sustainable manner. FAO developed such a concept, called Climate-Smart Agriculture (CSA) as part of the background document prepared for the 2010 Hague Conference on Food Security, Agriculture and Climate Change. CSA is an approach, using appropriate technical, policy and investment conditions, to achieve sustainable agricultural development for food security under climate change. CSA's approach has three objectives: i) sustainably increase agricultural productivity and incomes; ii) adapt and build resilience to climate change; and iii) reduce and/or remove GHG emissions where possible.

When the concept of CSA began to capture much interest, there was the impression that CSA constitutes a new approach. But upon further reflection, it is possible to recognize many low-carbon approaches have been in practice in the Asia-Pacific region for millennia. It must also be realized that agriculture has been continuously facing climate change, and farmers in the region have been adapting their practices to accommodate such forces of nature. They have been innovating new technologies without any or much external support. Many of the traditional practices are pre-adapted to climate change, are low-carbon approaches which are sustainable, cost effective, and bring higher yields or more income. Considering they are already in use, it infers that they can be easily adopted by communities elsewhere in the region. So, instead of looking for new technologies, it is equally important to promote these traditional practices to farming communities across the region. With this in mind, FAO looked at a number of such low-carbon climate-smart practices, and decided to capture briefly a selection of those practices for this publication. The following case studies were selected:

i. Aquasilviculture: An environmentally friendly mariculture system in Viet Nam
ii. Seaweed farming: A community-based adaptation to climate change in the Philippines
iii. The New Theory of Agriculture: A Thai farmer's climate-smart pathway
iv. Floating gardens: Spreading the tradition
v. India's traditional water harvesting systems: Age-old, climate-smart agriculture
vi. Leasehold forestry in Nepal: A new lease of life for rural communities and forests
vii. Vertical farming: An innovative agriculture system for producing food in urban areas

It is the desire of FAO to showcase these case studies that demonstrate farming practices that are built on traditional knowledge, cheap and renewable material, and with practically no external inputs. They represent some of the most sustainable practices and activities that hardly result in GHG emissions, but more often are working to mitigate climate change. This work also is a dedication to the farmers who have continuously improved their practices, with little external support, and yet have achieved practices that are clearly adaptations to the impacts of climate change.

FAO contracted out the studies to various experts in the region. In some cases, the reports were undertaken by FAO officers themselves. The studies were selected based on their low-carbon approach in their design and outcomes, and represent adaptation and resilience to climate change, sustainability, contribution to livelihoods and incomes, and mitigation/ reduction of GHG emissions.

Case 1
Aquasilviculture: An environmentally friendly mariculture system in Viet Nam[1]

Introduction

Ca Mau Province has the largest area for aquasilviculture in Viet Nam. In 2013, the total area of aquasilviculture was around 60 000 ha (Tuan et al. 2013). This aquasilvilculture system is unique in Viet Nam for the production of certified organic shrimp. Since 2002, the Ca Mau frozen seafood processing import-export corporation (Camimex) has been certified to supply organic shrimp by IMO (Institute for Marketecology), Switzerland based on Naturland standard of Germany. Camimex has exported approximately 350 to 390 tons of organic shrimp annually to the Coop in Switzerland (Ha et al. 2010). Until 2013, Camimex had an organic shrimp certificate area of over 700 households in Nam Can and Ngoc Hien districts (Tuan et al. 2013). Recently, Minh Phu group has also received a certificate of organic shrimp for 741 households in Ngoc Hien district, Ca Mau Province.

Basically, the aquasilviculure model has been introduced as an environmentally friendly mariculture system to adapt to climate change. A series of programmes have been conducted in this area to enhance this system, in particular, the project "Mangroves and Markets" (MAM) being carried out by SNV Viet Nam. This project has applied three approaches, including increasing yield, reducing cost and obtaining a premium price to improve livelihood, food security, and adaptation of climate change for farmers living at Nhung Mien hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province.

This case study conducted a cost-benefit analysis of economic returns, livelihood and food security issues, usage of natural resources, and low carbon agricultural practices. This study also indicated how the new practices enhanced the current practices with extreme weather. Thirteen households living within the MAM project were selected for interviews in this study. Farming practices, production value chain, cost, income and a status of organic shrimp certificate were documented and assessed.

Technology/Practice

This study was carried out at Nhung Mien hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province, Viet Nam in May 2015. All farm owners have a green book land use right certificate issued by Nhung Mien Forestry Management Board (FMB), and all activities such as selling, leasing and redesigning of the farm must be approved by the FMB.

This aquasivilculture system was designed to be as simple as possible. Farm sizes varied from 3.1 to 5.5 ha and water surface areas ranged from 1.1 to 2.4 ha. Mangrove forest area represented around 40 percent of the farm area (Table 1).

Table 1. General information of the aquasilviculture farms in Nhung Mien hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province, Viet Nam

Parameters	Mean ± STDEV (n=13)
Farm size (ha)	4.0±0.8
Water surface (ha)	1.8±0.4
Ratio between mangrove forest and total areas (%)	39.8±5.1
Black tiger shrimp stocking density (PLs/m^2/year)	26.5± 6.7
Mud crab stocking density (crablets/ha/year)	3 966±1 874

Note: PLs = post larvae

[1] Prepared by Dr Vu-Anh Tuan, Project Leader, Research Institute for Aquaculture, Ho Chi Minh City, Viet Nam.

Each farm had three components including: 1) mangrove forest area; 2) water surface area for aquaculture; and 3) the remaining land for other trees and crops (Figure 1). Farms were surrounded by a larger outer canal of more than 1.2 m in depth and 6.0 m in width, with many smaller and shallower inner canals dissecting the mangrove forest, which was more elevated than the canal water surface. The farm usually had one big water gate for water exchange, which is netted for harvesting shrimp.

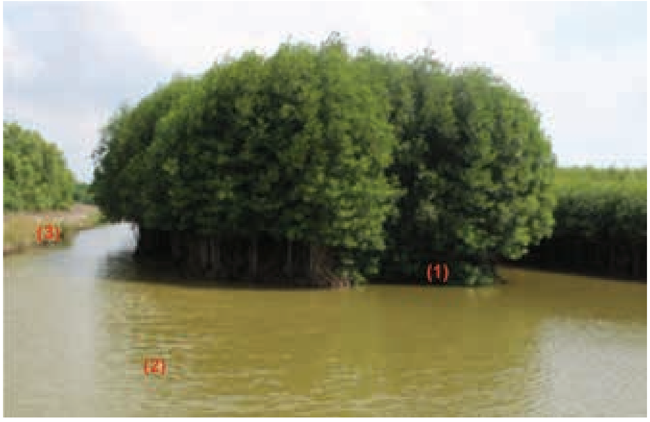


Figure 1. Aquasivicuture in Nhung Mien Hamlet, Vien An Dong Commune, Ngoc Hien district (Photo sourced by Tuan Anh Vu, 2015)

Based on the lunar calendar, post larvae (PLs) of black tiger shrimp (*Penaeus monodon*) were stocked in October or November every year, followed by supplemental monthly stocking until December. Some farms were stocked continuously until April or May. The stocking densities fell from the beginning to the end of crop, with an average density of around 27 PLs per m^2 per year. During the post larval stocking period, mud crablets were also released into the pond. Most farmers used crab seed produced from hatcheries, though some used seed from wild crablet collectors.

No feed, chemicals or antibiotics were used in this system, although some farmers used small amounts of lime to reduce turbidity and increase pH. Prior to stocking PLs, farmers also used saponin to kill predatory wild fish in the pond. In this system, shrimp and mud crab depended only on natural food. After four months from the first socking, the biggest shrimp and mud crab were initially harvested. Harvest times of shrimp were based on the moon cycle, with two harvest periods per month (middle and end of month). Shrimps were usually harvested at the sluice gate at night by partially draining the pond, although some were also caught using the "against water current" netting technique. Mud crabs were mainly harvested by hand net and line-hook.

The harvested shrimps were usually bigger than shrimp produced from intensive ponds (15 to 20 pieces make a kg). In 2014, the farm gate price was around VND300 000 per kg for larger shrimp sized at 17 pieces per kg. Most farmers sold their shrimps to middlemen rather than a wholesale buyer or companies because of their small volume and distance from markets. The value chain analysis of black tiger shrimp in Ngoc Hien district, Ca Mau Province is described as below (Figure 2).

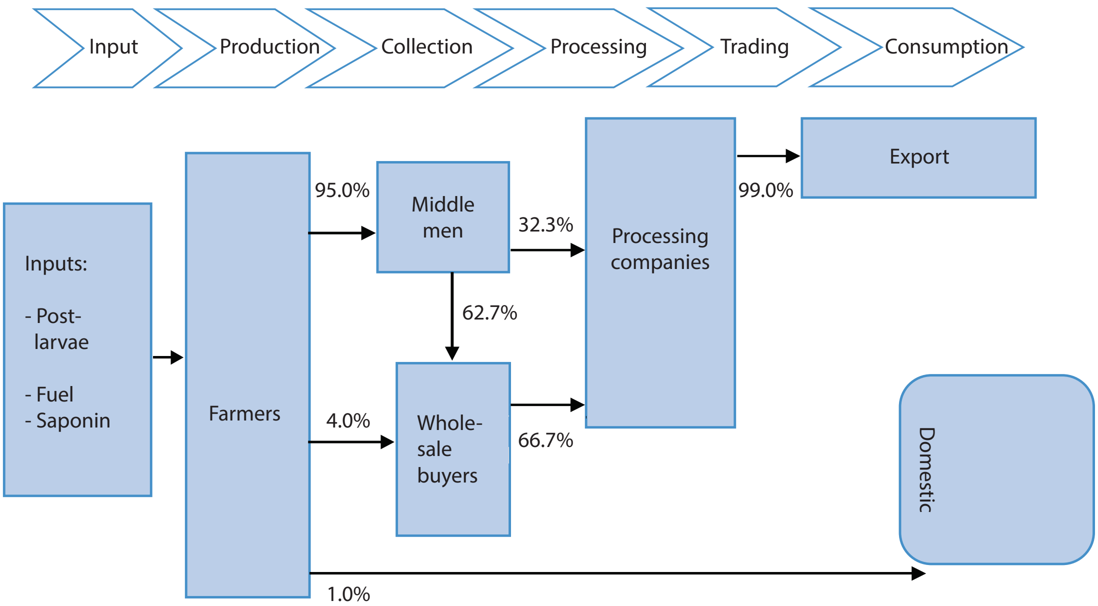


Figure 2. Value chain for non-certified and certified organic shrimps at Ngoc Hien district, Ca Mau Province, Viet Nam (Tuan et al. 2013)

Results

a. Case study findings

Shrimp sizes and prices

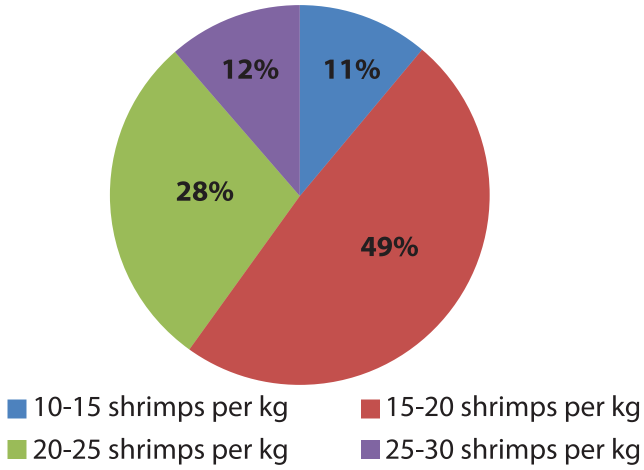


Figure 3. Ratio among four size classes of black tiger shrimp in Nhung Mien hamlet, Vien An Dong Commune, Ngoc Hien district, Ca Mau Province in 2014

The highest proportion of the harvested shrimp sizes was around 15 to 20 pieces per kg (Figure 3). In 2014, prices ranged from VND280 000 to 330 000 for sizes in a range of 15 to 20 pieces per kg, respectively. Similarly, the highest price was from VND350 000 to 400 000 for sizes in a range of 10 to 15 pieces per kg. *(Note: Exchange rate was US$1= VND21 500).*

Yield, survival rate, income, cost and profit

The yield of black tiger shrimp was low and varied from farm to farm. In particular, survival rate was very low (about 1.9%) despite the relatively high stocking densities and farmers spent a lot of money to buy PLs. They could recoup more of this initial outlay if the survival rate could be increased. The total income and income per hectare in Table 2 represents income from all sources, namely black tiger shrimp, wild shrimp, mud crab, wild fish and fruit trees.

Table 2. Yield of black tiger shrimp, survival rate, total income and income per hectare

Parameters	Mean ± STDEV
Yield of black tiger shrimp (kg/ha/year)	213±104
Survival rate of black tiger shrimp (%)	1.9± 1.1
Total income (US$/household/year)	7 026±2 278
Income per hectare (US$/ha/year)	4 115±1 761

Table 3 shows fixed and variable costs of the interviewed farms. The fixed cost included 50 percent of net, 20 percent of boat, and 10 percent of sluice gate cost. The variable cost consisted of farm preparation, PLs, mud crablets, saponin, lime/zeolite, bank interest rate of 10 percent, and labour (one person per farm) for year 2014.

Table 3. Fixed cost, variable cost, total cost per hectare, total profit and profit per hectare of the aquasilviculture model at Nhung Mien hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province, Viet Nam in 2014

Parameters	Mean ± Stdev, n=13
Total fixed cost (US$)	98±12
Total variable cost (US$)	2 857±762
Total cost per ha (US$)	1 702±487
Total profit (US$/year)	4 072±2 020
Profit per ha (US$/ha/year)	2 414±1 458

The average profit was US$2 414 per ha per year. To compare with the profits of other models in Ca Mau in 2012, this income was as similar as the previous finding for the certified organic shrimp farm but it was higher than that of the uncertified aquasilviculture, the rice-shrimp farms, and the traditional extensive shrimp farm. According to Tuan et al. (2013), the profit of the certified aquasilviculture was around US$2 356 per ha per year at Nam Can district. The profits for uncertified aquasilviculture, rice-shrimp, and traditional extensive shrimp farms in Ca Mau were US$1 849, 1 415 and 1 180 per ha per year, respectively. In general, this income was adequate to meet their needs and keep operating their farm. However, the profit did not take into account the loan they were paying the bank for purchasing the farm. *(Note: exchange rate: US$1 = VND20 500 in 2012)*

b. Implication for low carbon agriculture, biodiversity conservation, water saving, and forest regeneration

Trees absorb CO_2 from the atmosphere. According to Vu Tan Phuong and Nguyen Viet Xuan (2013), *Rhizophora* trees could absorb approximately 136.6 tons/ha of CO_2 and the value was VND3.3 million or US$154 per ha per year. Each aquasilviculture farm contained around 1.6 ha of mangrove area, and the main mangrove tree species is *Rhizophora apiculata*. Therefore, each aquasilviculture farm could absorb approximately 219 tons CO_2 and the value of carbon sequestration comes up to US$246 per year.

In addition to the mangroves, this system also has other trees. Although land area in this study has been known to have low pH and salty soil, pineapple, mango, dragon fruit, and coconut trees have been raised in this area (Figure 4). Many kinds of vegetables such as Kankun (*Ipomoea aqua*tic) and Gotukola (*Centella asiatica*) have also been cultivated.

Figure 4. Diversification of trees in Nhung Mien Hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province, Viet Nam (Photo: Tuan Anh Vu, 2015)

In particular, the aquasilviculture system has a low carbon demand since it is mostly based on natural conditions. According to Figure 5, the cost structure shows that the labour was a major cost of this system. No feed, chemical or antibiotic was used, although some farmers used small amounts of lime and saponin. On the other hand, farm preparation cost was the second biggest item of expenditure for this system. The machine to clean the channel bottom consumes fuel. However, farm preparation is carried out only once a year, so carbon emissions from fuel consumption are somewhat lower than that associated with intensive shrimp culture.

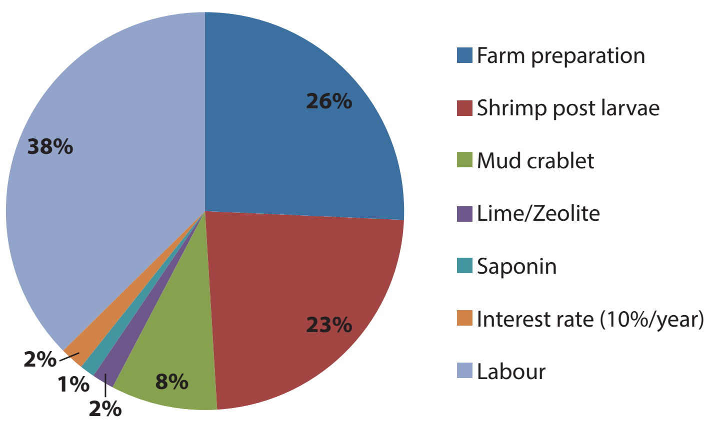


Figure 5. Cost structure in 2014 for aquasilviculture aquasilviculture at Nhung Mien hamlet, Vien An Dong commune, Ngoc Hien district, Ca Mau Province, Viet Nam

Water management has not been considered in this model yet. The traditional habit of harvesting shrimp by draining involves considerable water and increases the risk of disease transfer between farms. In fact, water exchange is one of the main factors responsible for the outbreak of widespread shrimp disease in Ca Mau Province. Therefore, the MAM project is using probiotics in some farm trials in this area to save water and to prevent disease. Hopefully, this technique will be successful and help farmers in the near future.

Forest management and regeneration is one of the main targets of this system. Many programmes have been introduced and training provided for farmers to replant their mangrove area. All mangrove seeds and techniques have been given freely by Nhung Mien FMB. To encourage farmers to look after and protect the mangroves, the FMB has signed a contract with farmers to share benefits when the mangrove forest is harvested. Accordingly, the farmers will receive 95 percent value of harvested mangrove trees. Additionally, farmers will have an opportunity to obtain a 10 percent premium on the payment for shrimp when they increase mangrove area in the farm to meet the requirement of Naturland standard for organic shrimp.

c. Implication on livelihoods and food security

The farmers living in the study area have a diversified source of income – from black tiger shrimp, wild shrimp, mud crab, wild fish and fruit trees (Figure 6). The main income was from black tiger shrimp (70%) while that from fruit trees was approximately 1 percent overall, since only one farm owner received VND15 million from pineapple in 2014. Some chicken, duck and fresh water fish (snakehead, catfish and tilapia) have been raised as well. These provide food sources for the farmer's family and diversification of their sources of income.

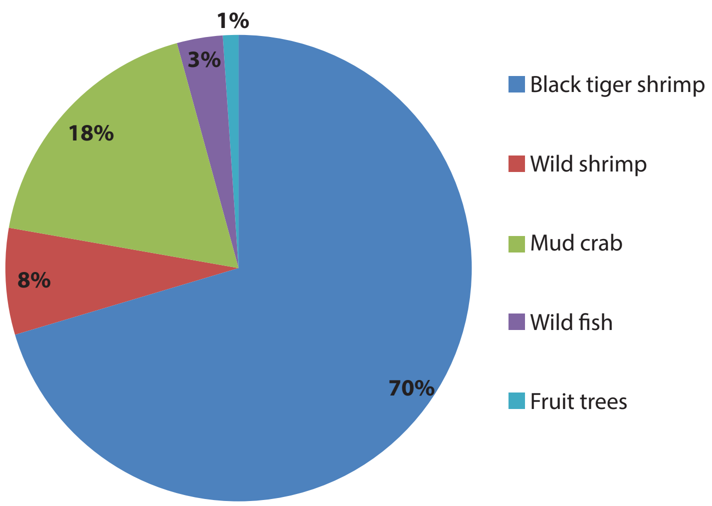


Figure 6. Diversified income structure of aquasilviculture in 2014 at the case study site

Farm owners have signed long-term contracts with the Nhung Mien Forestry Management Board on sharing benefits of timber from mangrove forests planted initially at 10 000 trees per hectare and harvested at 10 to 15 years of age. Mangrove forests in this study are presently around five to eight years old, so farm owners will have to wait another five to seven years before they derive income from harvesting their mangroves.

A payment of premium price for organic aquatic products is another means to increase income for farmers in this area. The Camimex company has paid a premium price of 6 percent higher than the conventional prices (Tuan, et al. 2013), while Minh Phu group has agreed to pay 10 percent. The households that have been certified for organic shrimp are having a chance to increase their livelihoods with the premium price.

Improving livelihoods of farmers in the Nhung Mien hamlet was conducted by MAM project managed by SNV Viet Nam. The MAM project has been studying ways to increase incomes for farmers by raising the survival rate and yield of shrimp and reducing variable costs and increasing premium price of shrimp. Therefore, the activities of the MAM project has helped the Minh Phu group to obtain the organic certificate from Naturland which has committed to paying a premium price which is 10 percent higher than the conventional price for organic shrimp.

For further food security and livelihood enhancement, a policy for payments for forest environmental services (PFES) should be considered in this area. This would help farmers in this area to improve their livelihoods by planting and protecting the mangroves.

Conclusions

The current practice of aquasilviculture approach using simple techniques and low cost inputs nevertheless provides stable incomes. The system does not only have a low carbon footprint without feed, chemicals and antibiotics but also absorbs carbon dioxide from the atmosphere. Biodiversity conservation was established by planting other vegetables and fruit trees, raising terrestrial animals and fresh water fish. The mangrove forest has been reforested under a contract which allows the farmer to earn up to 95 percent of the harvest value while simultaneously obtaining a certificate for organic shrimp.

Livelihoods and food security were stabilized and improved based on diversified income from aquatic animals and other sources such as vegetables, fruit trees, terrestrial animals and even fresh water fish. New practices from the MAM project include determining an optimal stocking density to reduce the cost of PLs, applying probiotics to increase survival rate, yield and reduce the risk of disease outbreaks, and certifying organic shrimp to gain a premium price that is 10 percent higher than the regular price.

However, some management issues still need to be addressed. These include low survival rates of the shrimps, harvesting techniques, and water management to reduce the risk of disease transmission. Therefore, the following recommendations are made: 1) Further studies on suitable methods to improve survival rate and harvesting technique and reduction of risk from disease; and 2) Implement a payment for environmental services (PES) for protection of the mangrove forest.

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Case 2
Seaweed farming: A community-based adaptation to climate change in the Philippines[1]

Introduction

What agricultural commodity is versatile, can be grown without land preparation, does not need fertilizer inputs, is resilient against drought and heavy rain, can be harvested in 45 days, and is nutritious and fit for human consumption right after harvest? Seaweeds! Seaweed has many other advantages. Demand for seaweed and seaweed products are increasing, it is not perishable and can be dried and stored for two months or more. And with hard work and determination, you can start your own seaweed farm with US$500 or even less. Seaweed, specifically of the genus *Eucheuma*, and its extracts, Iota carrageenan (for Spinosum) and Kappa carrageenan (for Cottonii) are used as follows (Table 1):

Table 1. Common uses of seaweed

Common uses of seaweeds	
Product application	**Finished product impact**
Meat extenders	• Enhances texture and water retention • Stabilizes fat-protein emulsion in meat
Dairy product stabilizer	• Allows homogeneity and smooth dispersion of ingredients
Pet-food binder	• Allows stable form and homogeneous appearance
Beer	• Allows for easy filtration
Pharmaceuticals	• Used in hard and soft gel capsules
Technical applications	• Used in technical beauty and other personal care products
Other applications	• Food stabilizers and thickeners for canned products

Aside from providing food and nutrition, seaweeds photosynthesize and draw off CO_2 from the atmosphere, which is a mitigation action against climate change.

Site selection for seaweed farming

Ideal sites for the setting up of seaweed farms are areas located between islands where current flow is moderate allowing nutrients to reach the plants and drawing away waste material produced by the plants (Figures 1 & 2). These areas also provide protection from strong winds and waves during inclement weather. They should also be deep enough by at least one metre during low tide and away from rivers or possible sources of freshwater run-off. The site should also be taking into consideration the presence of farms or fishponds that may release pesticides or chemicals before or during their crop cycles.

[1] Prepared by Mr J. Piscano, Business Manager, Center for Empowerment and Resource Development Inc. Hinatuan, Surigao del Sur, the Philippines.

Figure 1. Site Selection – Choose sites with moderate current flow and allow protection from winds and waves

Figure 2. Seaweed Farms and fish cages often look for the same site criteria

Planting method

Seaweed farmers select the method most suitable to their areas and species cultivated. Shallow areas are preferred by *Spinosum* growers while Cottonii (*Eucheuma cottonii*) farmers prefer deeper areas and use the hanging method more. Deeper areas allow greater leeway in management during extremes in weather such as storms and high temperature.

While contacting your seedling plant supplier, you may begin to set up your lines. Lines are usually 20 to 50 metres in length secured at both ends by bamboo stakes or stone anchors (Figure 3). There are no strict rules in layout of farms, but rather conform to topography and current flow. Below is an example of a layout used in Barangay Salog.

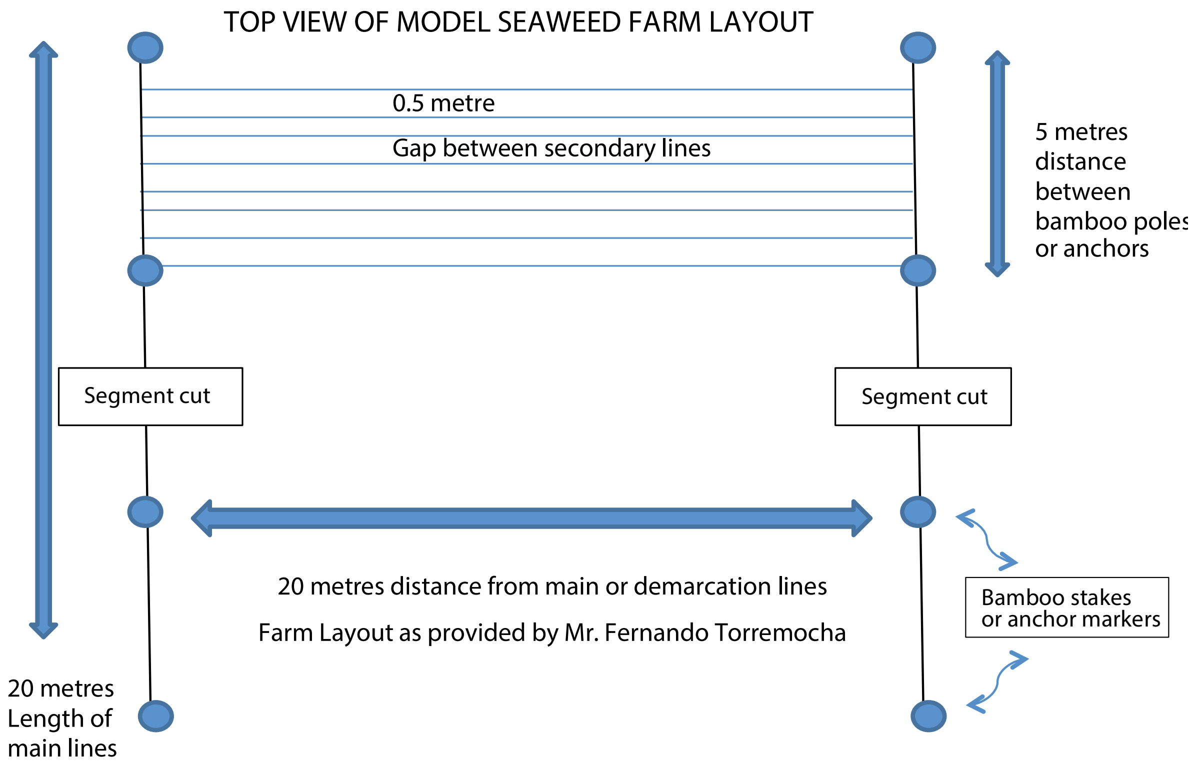

Figure 3. Layout of seaweed farm used in Barangay Salog

Floats are spaced at 0.5 metres apart, and may be reduced or increased as required. They can be made from styropore or empty PET bottles or even bamboo. PET bottles, though unsightly, appear to be the most cost-effective and with the least environmental impact. Styropore tends to breakdown over time and scatter into bits that are hazardous to fish and small marine animals. The tie lines used to hold the seedling plants are spaced 8 to 10 cm apart (Figures 4 & 5). Most farmers prefer to plant on the prepared lines set on the sea which reduces stress on the plants. On the day of planting, seed stock is placed in net enclosures to ensure sufficient water movement around the plants.

Figure 4. Seedling plant enclosure where seed stock is placed and checked just before transfer to the lines

Figure 5. Seedling plants being examined before distribution

Plants are then tied securely to the lines. About 150 to 200 grams of seed material are tied at intervals (Figures 6 & 7). The plants are allowed to grow for the next 45 to 60 days.

Figure 6. Seaweed harvested to be sold as seed plant. Note distance of straw ties on nylon line

Figure 7. Epiphytes growing on harvested line

Farm management

Inspect the farm regularly for signs of potential problems. Shake the lines if necessary to remove debris and other foreign matter after storms or floods. Check for disease and grazing by fish which can be serious if left unchecked. Reduce the number of floats during hot weather to further submerge the plants away from the surface. Also reduce the floats during storms as wave action is stronger at the water surface than within the water column.

Check for epiphytes and other plants that adhere to your lines and compete for space and often reduce the value of your crop. These need to be removed on a regular basis

Fish tend to congregate under the seaweed and can cause serious damage. Place gillnets near areas where fish congregate to be able to collect the fish for yourself, and avoid fishermen coming over to check out your lines.

Harvesting and drying

Seaweeds may be harvested after 45 days but it is preferable to wait for 60 days or more. This allows the plants to mature and produce more carrageenan and brings in a better price. Farmers harvest by either stripping the lines at sea or bringing the whole line to shore and stripping seaweed on the beach.

It is best to immediately dry the seaweed after harvest. The best method of drying is air drying the seaweed. This allows for cleaner seaweeds. Most farmers, however, sun dry their seaweeds by placing them over tarpaulins or net material. One of the common problems for farmers is finding drying locations and drying facilities.

Storage

Dried seaweed is best stored in an enclosed warehouse. Inspect the dried seaweed regularly and roll them over periodically. Keep your warehouse clean and prevent animals and pests from entering. Make sure your warehouse and stock is protected from rain and well secured against theft. When you are ready to sell, you may pack your seaweed in recycled bags of feed or rice. Rice sacks can be packed with up to 70 kg of dried seaweed.

Marketing

Prices of seaweed go up or down depending on supply and demand. Normally, however, buyers compute their price offers based on your distance from the nearest port and processing plant. This reflects their own costs for freight and handling as well as incidental fees like transport permits. Unlike fish and other perishables, dried seaweed can be stored and producers may stockpile seaweed and wait for good prices.

Seaweed will continue to be a valued commodity in the market. It is the largest component of Philippine aquaculture production comprising 69 percent of total production. The Philippines is the third largest exporter of seaweed products in the world (Philippine Rural Development Program [PRDP] 2014) producing 1 751 kg of carrageenan in 2012. Despite this, however, it imported both dried seaweed and carrageenan bulk from China and Indonesia (Table 2).

Table 2. Import of seaweed products into the Philippines

Import of Seaweed Products Based on Issued SPS/Import Permits		
YEAR	**DRIED SEAWEED (tons)**	**CARRAGEENAN (tons)**
2011	4 299	0
2012	2 071	0
2013	1 717	668
2014	3 148	1 205
Total	11 235	1 873

This indicates that there is a strong local demand for seaweed and carrageenan. Changing lifestyles and food preferences will further push the demand for carrageenan upwards.

Benefits provided by seaweed and seaweed farming

Most seaweed farmers produce seaweed to augment income from their main livelihood. Work in seaweed farms, like in most agricultural activities, is seasonal and can be done by most people. A farmer together with family members can tend a small farm that can provide extra income as follows (Table 3).

Table 3. Income from a seaweed farm typically managed by a farmer

Cost and return estimate for	Per crop		Per year
5 lines of *Eucheuma* farm using hanging line method ((Fresh to dry ratio (kg) 7:1))	Price per (Pesos)		3 crops (Pesos)
	Kg	Ton	
Sales for 1 000 kg dried seaweed/crop cycle	40	40 000	120 000
Less cost of sales			
Seedling plants 1 000 @20/kg	20	20 000	60 000
Cost for drying seaweed/kg	3	3 000	9 000
Subtotal	23	23 000	69 000
Gross margin	17	17 000	51 000
Less operating expenses			
Amortization of initial investment (nylon lines, sacks, straw, netting with a lifespan of 2 years or 6 crop cycles) = P12 000	2	4 000	12 000
Replacement floats, straw ties		1 000	
Subtotal OPEX	2	5 000	15 000
Net income	15	12 000	36 000

While no records or statistics are available on the impact on the economic well being of residents brought on by seaweed farming, many people, especially the farmers themselves say that seaweed farming has brought material benefits to them. In Barangay Tulang, 40 percent of its 426 households report an improvement in economic status. They point to the increased number of motorized boats, which are the main mode of transport in coastal and island areas. They point to an increase in the number of families that have been able to send their children to schools. Further, many farmers have been able to sustain farming from income derived from seaweed.

The farming of seaweed has also brought on an unexpected benefit: an increase in number and diversity of fish that shelter under the plants, attracting bigger fish that provide both food and income to seaweed farmers. Also, another valuable contribution of seaweed is its absorption of carbon dioxide from the environment. Carbon dioxide is one major GHG contributing to global warming. Seaweeds take in CO_2 and mitigate the effects of global warming. A study by George and Rao (2012) estimated CO_2 in the atmosphere at 373 parts per million (ppm). They also estimated that *Kappaphycus* (*Eucheuma*) can utilize CO_2 up to 185 ppm. This means a kilo of seaweed can take 185 milligrams of CO_2 and hold it until it is harvested. The more seaweed we plant, the more we will benefit not only financially but also environmentally.

The focus on the production of dried seaweed, unfortunately, has made people ignore the other by-products of seaweed. Not one farmer has mentioned making use of the drippings from seaweed, which can be processed into fertilizer and plant nutrients. Some people produce seaweed chips, which is processed seaweed mixed with other ingredients to produce potato-string style chips on a limited scale. The relative high value of dried seaweed eliminates its use as biofuel.

Regarding its impact on livelihood, seaweed farming is essentially a supplemental activity to either fishing or farming. It has proven, however, to be capable of serving as a reliable safety net when the main livelihoods are threatened or unable to deliver. Further, it taps the services of all family members as work revolves around manual dexterity and keen observation rather than physical strength.

Conclusions

There are many positives with seaweed farming. Seaweed farming provides an alternative livelihood for farmers – they are able not only to diversify their income, but supplement it as well. While the profits from seaweed farming are still at the low end, higher profits will certainly encourage more farmers to take up this practice. However, seaweed farming certainly contributes to food security and improvement of the communities' livelihoods.

Socially, seaweed farming has positively transformed communities. It has provided a creative outlet for women and the youth. People who used to while away their time are now engaged in discussing weather conditions, prices and school concerns. The team-style nature of seaweed farming from seeding to harvesting has allowed many families to have more time shared during work resulting in closer knit families and children highly appreciative of the efforts of their parents in supporting their families and the education of their children. The learning process is heightened as well – farmers have been able to identify, observe and respond to its challenges. Farmers now respond by planting deeper, optimizing locations and selecting the best planting times of the year.

While the contribution of seaweed farming is generally observed in economic terms, its environmental benefits may be higher still. Seaweed farming requires no chemicals such as fertilizers and pesticides that are common with land-based farming. Some seaweeds have been known to absorb some of the nitrogen-based fertilizers that seep into the waters from the land-based farming activities, thereby removing these potentially toxic substances from the environment. In addition, seaweed farming is a renewable source of food, which can be harvested continuously with no depletion of minerals, which is the norm with soil-based farming. This is an important contribution in our approaches to develop CSA – seaweed farming does not contribute to CO_2 emissions, but instead is potentially able to remove those gases from the atmosphere. If seaweed farming can be expanded, this can become a significant positive contribution to global environment. The farms also appear to improve the environment for fish, and their populations seem to grow around the area.

Finally, there is a need to strengthen the seaweed farming system. The effort of the seaweed farmers has made the Philippines the third largest seaweed exporter in the world. Yet, the farmers have done this largely on their own initiative. The current approach of providing funding, but no marketing and capacity building support results in many discouraged farmers who fall out, and this detracts from the overall success of seaweed farming. The seaweed sector must provide farmers not only a fair price but social protection, health protection, crop insurance and security of tenure of the farm. Seaweed farming must become profitable to attract investors and more farmers. A paradigm shift from treating small seaweed farmers as mere producers to partners in a greater endeavour is needed.

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Seaweed Farming: Interview Matrix (22 to 26 May 2015)

Name of Interviewee		Gil Leonor	Fernando Torremocha	Lucio Baguio	Remy Regacho	Alex Ceredulla	Meniranda Alcantar	Aniceto Cuatro	Rito Tesorio	Elizabeth Cortez
Location		Poblacion, Tubigon	Salog, Jetafe	Tulang, Jetafe	Tagbilaran City	Jetafe	Tagbilaran City	Calape	Catmonan, Calape	Poblacion, Calape
Occupation		Seaweed farmer/ Entrepreneur	Seaweed farmer/ set gillnet Fisherman/Rice farmer	Seaweed farmer/ ex-Village chief, fish farmer for 15 years	PAO	Aquatechnician	City Fishery Coordinator	Seaweed farmer/ Fisherman	Seaweed farmer/ Land farmer	MAO of Calape
Species		*Caulerpa*	*E. spinosum* – fast growth/cottonii	*E. spinosum*	*Eucheuma* sp.	*Eucheuma spinosum*	*Eucheuma* sp.	*Eucheuma* sp.	*Eucheuma*	*Spinosum & Cottonii*
Site selection		Close system	Open Water; protected from strong waves; away from freshwater sources; sandy bottom	Open water	Open	Open	Open	Open	Open	Open
Planting method		Bottom	Hanging	Hanging	Bottom & hanging	Hanging	Hanging	Hanging	Hanging	
Grow out		30 days	120 days	45 days	45 days	45 days	45 days	60 days	30–45 days	
Harvest		Partial	partial	Partial	Partial	Partial	Partial	Partial	Partial	
Marketing		Buyers come to farm and buy stocks	Harvest sun dried, packed in sacks and brought to consolidators	Harvest dried and brought to consolidators in Talibon	Harvest dried and brought to consolidators	Harvest sun dried, packed in sacks and brought to consolidators	Harvest sun dried, packed in sacks and brought to consolidators	Harvest sun dried, packed in sacks and brought to consolidators	Harvest is dried and sold to consolidators	Harvest dried and sold to consolidators
Pricing (Pesos)	sp	Different species	Low of 10; high of 40	15	17	17		15	15 (fresh)	
	cot		Low of 30; high of 70	40 - 60	36	38		40	25–30 (dried)	
How communities benefit from Guso Farming	Economic	Substantial income	Supplemental income has allowed maintenance of living standards	Has allowed parents to send children to school, 40% of residents have improved their economic standing through seaweed farming	Increase in income; Documented success stories from seaweed farming	Long time and persistent growers have attained better living standards	Increase in income	Visible impact of government initiatives	Visible impact of government initiatives	150 heads of families engaged in seaweed farming able to sell 50 kilos of fresh seaweed and estimated 1 ton of dried seaweed at PHP 28/kg
	Environmental	Low input, nature-dependent operation	Increase in the number of fish and other organisms around seaweed farms	Low waste, materials used are recycled and reused; perceived increase in fish and other marine animals	Noticeable increase in fish population but no science base		Noticeable increase in fish population	Waters appear to be cleaner or clearer, with seaweed taking up nutrients that may instead be used for algal blooms; Seaweed farms are expected to improve fish populations	Seaweed prone to toxins released into the environment	Seaweed farming limited to areas with favorable coastline
Seaweed by-products		No seaweed by-product	No seaweed by-product	No seaweed by-product	No seaweed by-products	No by-products	No seaweed by-product	No seaweed by-product	Seaweeds processed into food chips (value adding)	Seaweeds processed into food chips (value adding)

Name of Interviewee		Gil Leonor	Fernando Torremocha	Lucio Baguio	Remy Regacho	Alex Ceredulla	Meniranda Alcantar	Aniceto Cuatro	Rito Tesorio	Elizabeth Cortez
Respondent		**Gil Leonor**	**Fernando Torremocha**	**Lucio Baguio**	**Remy Regacho**	**Alex Ceredulla**	**Meniranda Alcantar**	**Aniceto Cuatro**	**Rito Tesorio**	**Elizabeth Cortez**
Livelihood improvement		Allowed recovery from typhoon damage	Have allowed investment in fishing gear	Farmers have been able to upgrade to motorized boats, buy household appliances	Funds to improve houses and move into other activities	Funds to expand farms	Supplemental income, secondary to other activities (tourism or selling)	Supplemental income allowing crossover work from fishing to seaweed farming	Recovery from loss of estimated 2 tons of seaweed affected by toxin release	Supplemental income generated
Climate change adaptation		Largely unaffected, high temperatures make stock prone to diseases, but mitigated by increasing water level	Time of planting to coincide with better part of the year; Reduce number of floats during hot weather	Time of planting to coincide with better part of the year. Seaweed is resilient against climate change	Contributes to temperature stability	Planting depending on availability of seed plant	Relatively new activity in Tagbilaran; high temperature increases risk of diseases	Strong winds becoming regular; Increased temperature makes plants prone to disease (ice-ice) Early attempts to farm seaweed negated by disease	Seaweed appears resilient to natural events but not to toxic agents	Effects or impact of climate change not so defined in the area
How seaweed farming offers families opportunities to unite and work together		Workers often work with family members and relatives	Family members assist and alternate in tending the seaweed farm	Family members assist and alternate in tending the seaweed farm	Positive use of time. Seaweed farmers usually work as family groups	Family members assist and alternate in tending the seaweed farm	Women normally take their children to work on simple tasks on seaweed drying, etc.	Seaweed work allows participation of small children, providing opportunities for bonding and appreciation of farm work		Seaweed farming involves father, mother and children, especially during school breaks
Social benefits		Workers have become empowered, working more as contractors rather than paid labour	Focus on livelihood, people are inspired to work and are more industrious	Focus on livelihood, less time for gambling; Improvement in living conditions for 40% of 426 households.	Productive use of time, less gossip and gambling	Interest in alternative income source by other fisherfolk	Avenue for improved productivity for women; Productive use of time, leaving behind mah-jong and card games	Interest in alternative income source by other fisherfolk		Extra income allows parents to enrol children in school
Social issues and concerns		Right of way to and out of farm	Damage from shellfish gatherers particularly in shallow areas	Theft and poaching of seaweed stock; innovations in poaching have also been noted	Theft and poaching	Seaweed farming ideal for small holdings	Theft & poaching; possible conflict with tourism activities and income generation	Theft, destruction of seaweed stock due to suspected release of toxic chemicals into the farm environment; Resistance of fishers to register with LGU	Seaweed farming ideal for small holdings	Blast fishers encouraged to desist from this practice
Gender contribution		All male crew, with women assisting in recording and domestic chores	Wife and daughter assist in farming	Wife has adapted to seaweed farming activities	Increased engagement of women		Tagbilaran project all women initiative. 29 women have come together to form a seaweed growers cooperative	Participation of women and children apparent	No comment on gender	MAO is female

Case 3
The New Theory of Agriculture: A Thai farmer's climate-smart pathway[1]

Introduction

FAO has recently stated that the world's population is expected to reach 9 billion by 2050. At the same time, the world is facing the challenge of climate change. With such challenges, there is a need for major improvements in agriculture to achieve food security globally. In view of this, FAO is promoting CSA, an approach that fosters adaptation to climate change while achieving sustainable production of adequate food supplies. The three objectives of CSA are to: i) sustainably increase agricultural productivity and incomes; ii) adapt and build resilience to climate change; and iii) reduce and/or remove GHG emissions where possible. The CSA employs an array of technical, policy and investment measures to achieve sustainable agricultural development. The CSA principles to increase agricultural productivity while maintaining the natural resource base are closely related to His Majesty King Bhumibol Adulyadej's Sufficiency Economy philosophy and the New Theory of Agriculture.

In Thailand, the concept of Sufficiency Economy philosophy developed by His Majesty King Bhumibol Adulyadej was first introduced in 1974. However, it gained greater attention in 1997 when Thailand faced a financial crisis. The "Sufficiency Economy" focuses on three components, namely moderation, reasonableness and self-immunity based on knowledge and right living. The "Sufficiency Economy" has been adopted by the farmers in their farming practice: adopting the concept of moderation would lead them to abandon monocultures in favour of multi-cropping practices; reasonableness requires due consideration of farmers to the risks of concentrating all resources into one commodity; and the adoption of the principle of self-immunity means planning for price fluctuations in the markets by producing enough to maintain food security as a priority and only then selling any surplus.

Under the Philosophy of Sufficiency Economy, His Majesty has developed a specific application consisting of the system of integrated and sustainable agriculture called the New Theory of Agriculture (or The New Theory). It encourages self-reliance and addresses food security issues. The New Theory consists of three phases:

Phase 1: Farm households are encouraged to divide the farmland into well-defined parts so that farmers receive optimum benefits and achieve efficient land use. This is to enable farmers to achieve self-sufficiency (be able to support themselves).

According to this theory, the land is divided into four parts with an approximate ratio of 30:30:30:10 (Figure 1). Based on this formula, 30 percent is set aside for pond and fish culture, 30 percent for rice cultivation, 30 percent for growing fruit and perennial trees and the remaining 10 percent for housing, livestock and other activities. However, the approximate ratio of 30:30:30:10 is indicative rather than prescriptive. Therefore, it could be adjusted based on the geographical area of each farm. For example, in areas where rainfall is more abundant (i.e. the southern part of Thailand), the dimension of the pond can be reduced and land area could be used for other farming activities.

[1] Prepared by Ms Wirya Khim (JPO, FAO) with advice from Mr S. Appanah (Climate Change Officer, FAO) and Ms N. Chalermpao (AFAOR [Programme]), and support from Mr Patphong Mongkholkachanakhun, farm owner, Sisawath District, Kanchanaburi, Thailand.

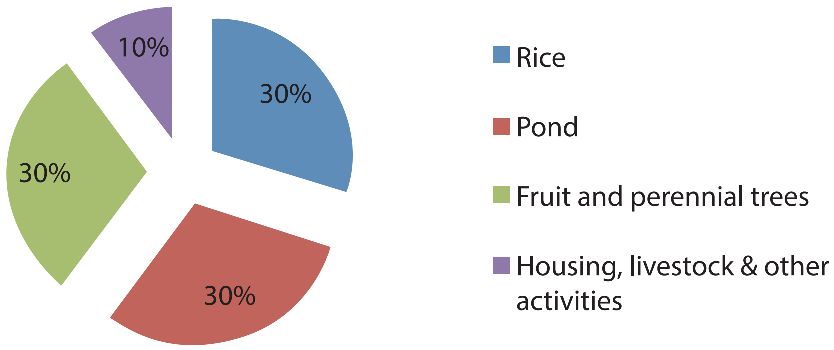

Figure 1. The New Theory of Agriculture

Phase 2: To enable farmers to work together and form a cooperative group to handle production, marketing, management and educational welfare and social development.

Phase 3: To enable farmers to build up connections with various cooperative groups and expand their businesses with the private sector, in order to assist the farmers in the areas of investment marketing, production, management and information management.

The Sufficiency Economy Philosophy has greatly influenced Thailand's agricultural development and further led to implementation of integrated farming, organic farming, natural farming and agroforestry. The New Theory aims at promoting diversified farming techniques for small-scale agriculture. This practice allows co-managing and co-existence of multiple subsystems (i.e. multi-crop production, livestock, forest trees and aquaculture). While each subsystem can function independently, the New Theory approach ensures that the resource (usually referred to as waste) from one subsystem becomes an input to the next subsystem, resulting in greater efficiency and synergy among the subsystems, and a higher total output of desired products.

The benefits of the New Theory are two-fold. First, it provides a steady and more stable income, and second, it can result in a better agro-ecological equilibrium through the reduction of the build-up of pests and diseases through natural cropping system management and reduction in the use of chemical fertilizers and pesticides. Specifically, the New Theory approach brought about many positive developments: i) improves space utilization and increases productivity; ii) provides diversified products; iii) improves soil fertility and physical structure from appropriate crop rotation and usage of cover crops and organic compost; iv) reduces weeds, insect pests and diseases through appropriate crop rotation and simple mowing techniques; v) utilizes crop residues and livestock wastes; and vi) relies less on outside inputs – fertilizers, agrochemicals, feeds and energy. As result of the integration, the New Theory has generally brought higher net returns. The concepts associated with the New Theory are practiced by numerous farmers in Thailand.

In order to gain a better understanding of how CSA principles, and the New Theory of Agriculture in particular, are implemented in Thailand, a case study of a small-scale farmer in Sisawath District, Kanchanaburi was conducted.

The New Theory of Agriculture in practice

Mr Patphong owns 39 rai (6.24 ha) of farmland in Sisawath District, Kanchanaburi, Thailand (250 Km WNW from Bangkok) (Figure 2). Initially, due to extremely high production costs and severe soil infertility, he could not make ends meet. In 2006, Mr Patphong was introduced to the concept of Sufficiency Economy and the New Theory of Agriculture and decided to change his farming practice from monoculture (i.e. focusing only on monocrop practices for sweet corn or chilli) to integrated farming. His farm income and production have improved since then. According to Mr Patphong, his farm income has steadily increased from US$19 773 in 2011, US$20 640 in 2012, US$35 700 in 2013 and US$47 217 in 2014 (with a total net income US$26 113).

"Because I could no longer feed my family, I decided to change my farming system from the monoculture to the New Theory"- Mr Patphong Mongkholkachanakhun, Kanchanaburi, Thailand.

Figure 2. Mr Patphong Mongkholkachanakhun, Khim/FAO (2015)

Mr Patphong's adaptation of the New Theory includes a multi-cropping system, fish culture, animal-raising (e.g. pigs, cows, ducks and chicken) along with soil improvement techniques through the use of green manure, green mulching and organic matter, crop rotation, mowing, using cover crops for weed reduction, water saving methods using a nozzle spray sprinkler irrigation system, bio-liquid fertilizer, and biogas from animals for household use. The New Theory is different from conventional farming as it requires an area and resource analysis to determine production direction and farming activities. At Mr Patphong's farm, the land is divided systematically for various farming activities (Figure 3). Mr Patphong adjusted the land division ratio slightly to maximize farm production.

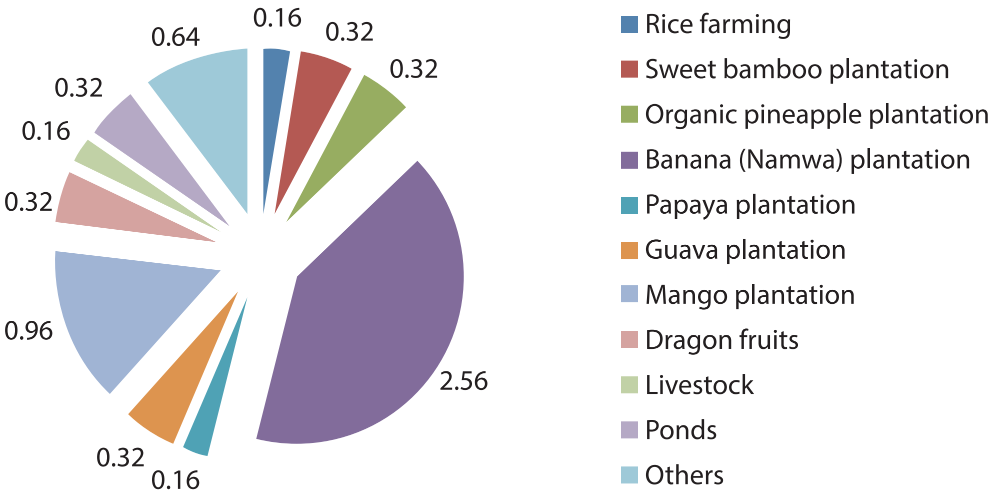

Figure 3. Land division for farming activities

A clear farm management plan was prepared to guide his farming practices (i.e. to manage farm inputs, labour, capital, timing of farm activities, processing for value addition, and marketing). He also carries out other supporting activities in the production chain such as using surplus produce as animal feed, and growing herbs for insect repellent. To reduce the input cost, he uses native plants from his farm to feed fish and cure diarrhoea in pigs.

In addition, he makes use of farm waste to make bio-liquid fertilizers and compost, and uses animal manure to generate biogas for household use. The effluent from biogas production is used to fertilize the paddy field and feed the fish. Instead of using chemical products to control weeds, mowing is introduced along with cover crops such as citronella grass to reduce weed and retain soil moisture. Mr Patphong has begun to introduce organic farming methods into his integrated farm practices. He has introduced practices to maintain/improve soil condition through the use of compost, animal manure and green manure, reduced tillage, and use of natural pesticides. He has eliminated the use of artificial fertilizers and pesticides. As a result, he is now able to sell organic produce for local and international markets.

Results

The flow of resources (also referred to as waste) from one subsystem to another is schematically shown in Figure 4. Current farming practices include multi-cropping, livestock and fish culture. To maintain and improve soil conditions for cropping, Sunn-hemp grass is planted in the infertile soil, and following its flowering the soil is turned over to cover the grass which then acts as green manure. Only green manure, animal manure, compost and bio-liquid fertilizers are used. Vetiver grass is planted around ponds and slope land to protect the soil from erosion. The leaves are piled for mulching around the trees' root zone which later breaks down into natural fertilizer. Sustainable weed control techniques include mowing instead of spraying chemical substances and by planting cover crops such as citronella grass to retain moisture and as an insect repellent. A sprinkler irrigation system (Figure 5) was installed in the farm (it costed US$240 for the whole farm). The installation was done in 2006 and it is still working well in 2015.

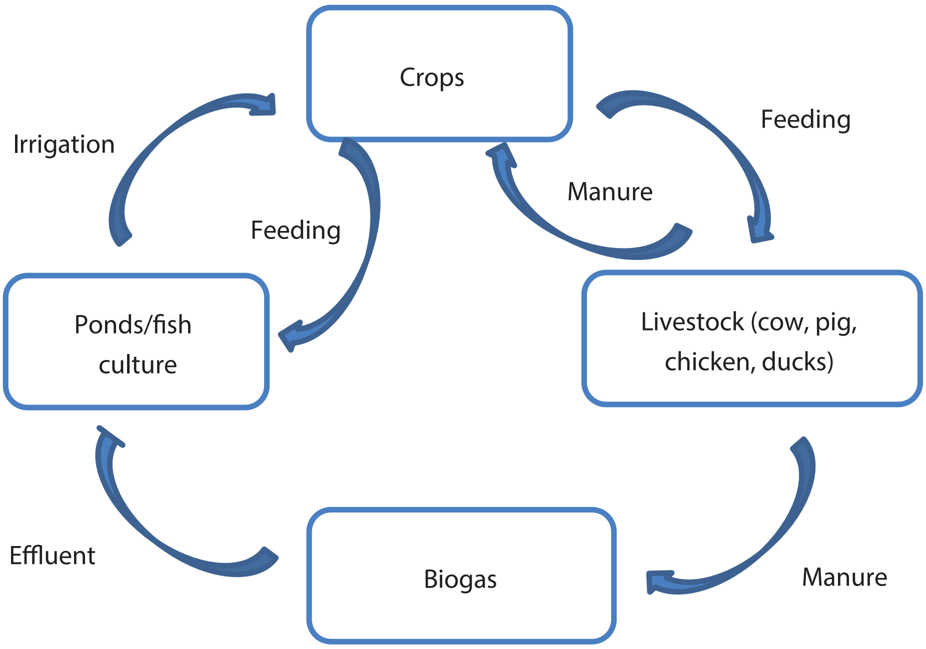

Figure 4. Integrated farming approach based on the New Theory of Agriculture at Mr Patphong's farm

Figure 5. Sprinkler irrigation system in pineapple plantation at Mr Patphong's farm, Khim/FAO, (2015)

Multi-cropping systems at Mr Patphong's farm include:

1. Rice (berry) covers 0.16 ha, and is mainly for family consumption. After harvesting, vetiver grass and sunn-hemp grass (Por Thieng) are grown in the field to improve soil quality.
2. Bamboo plantation covers an area of 0.32 ha. The sweet bamboo shoots are sold in the local market, and the bamboo is used as multi-purpose wood in his farm (e.g. supporting plants, building nursery, leaves for feeding pigs).
3. Organic pineapple plantation covers an area of 0.32 ha.
4. Banana plantation covers an area of 1.60 ha. Intercrops such as mango, rambutan, mangosteen, kaffir lime, forest trees for vegetables such as *Melientha suavis*, citronella grass and vetiver grass surround the plantation to retain soil moisture.
5. Papaya plantation covers an area of 0.16 ha. The side-venner grafting technique and air layering are used to produce a healthy varietal.
6. Mango plantation covers an area of 0.96 ha.
7. Guava plantation covers an area of 0.32 ha. It is mixed-grown with papaya.
8. Dragon fruit plantation (started in 2015) covers an area of 0.32 ha.
9. Vegetable garden: mixed herbs and vegetables are grown as intercrops between the plots of major crops for home consumption and sale in the community.
10. Forest trees grown in the farm include Siamese rosewood, teak, and others.

The crops are sold in both local and international markets. The production surplus is for household consumption, animals and fish feed as well as for compost and bio-liquid fertilizer (Figure 6).

Figure 6. Bio-liquid fertilizer production, Khim/FAO (2015)

Livestock production includes cows, pigs and poultry (chicken, ducks and Thai native chicken) (Figures 7, 8 & 9). Waste from livestock (animal manure) is used for **biogas production** (Figure 10) – it produces up to 10 kilograms of gas per month while previously the family paid approximately US$12 to 15 for purchasing gas. Waste from biogas (effluent) is then used to fertilize the paddy field and to feed the fish.

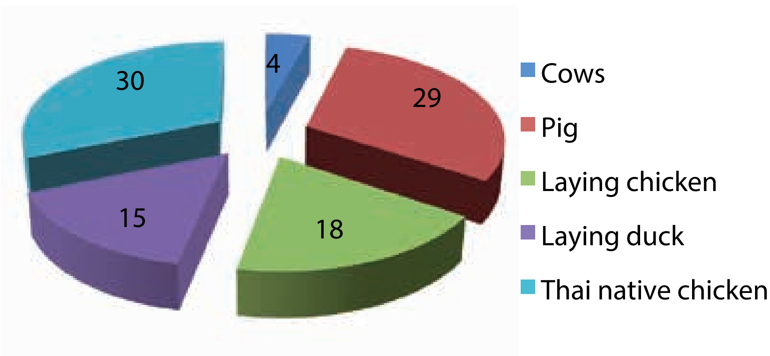

Figure 7. Composition of livestock at Mr Patphong's farm

Figure 8. Cows are raised in banana plantation, Khim/FAO (2015)

Figure 9. Pigs fed left-over organic fruit at Mr Patphong's farm, Khim/FAO (2015)

Fish culture: Two fish ponds were established in the farm, covering a total area of 0.32 ha (Figure 11). The fish species include tilapia, silver barb and giant gourami. Left over organic fruits are used as fish feed together with effluent from biogas production. The ponds hold sufficient water, and are used to irrigate the crops all year round.

Figure 10. Biogas production system at Mr Patphong's farm, Khim/FAO (2015)

Figure 11. Fish pond at Mr Patphong's farm, Khim/FAO (2015)

Implications of Mr Patphong's farming practices for food, economic and energy security

The New Theory has enabled Mr Patphong to diversify his agricultural products, which allows him to maintain a steady production all year round. This, in return, generates a constant flow of daily income (from vegetable, mushroom and eggs), monthly income (from banana, papaya), and yearly income (from pig, fish, native chicken, ducks and mango). Papaya is the main source of farm income accounting for 62.19 percent of total net income, followed by others[2] (19.88%), banana (9.15%), and rice (8.78%) (Figure 12). The New Theory also helps his family to maintain a healthy diet based on a variety of food and other farm produce.

[2] Others include mango, guava, oyster mushroom, pineapple, garden vegetable, sweet bamboo, poultry and pig farming.

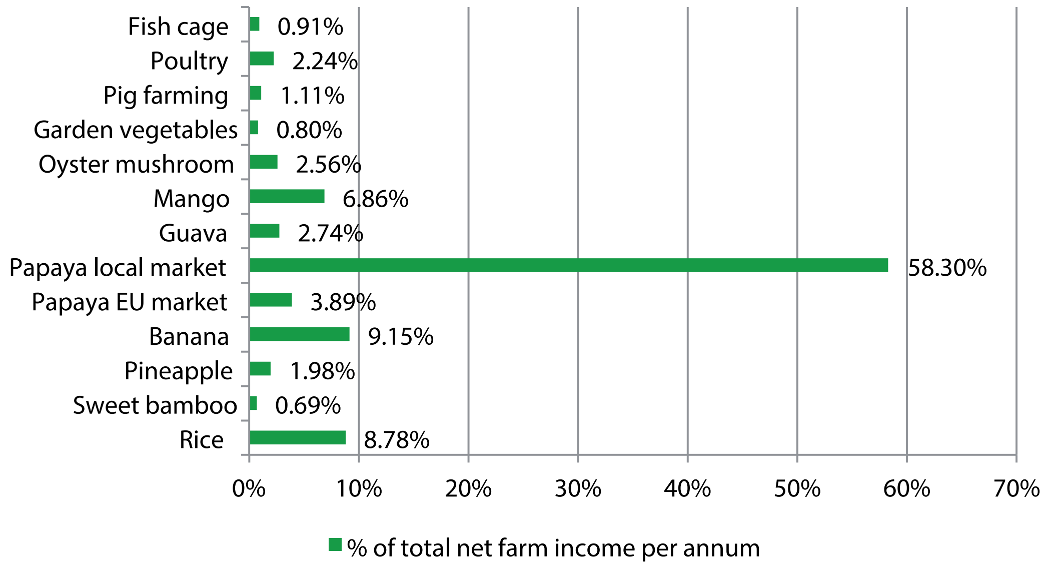

Figure 12. Farm income diversification based on the New Theory

According to Mr Patphong's estimation, the current net farm income per hectare (US$4 184) is about three times higher than the income under the monoculture practice when he focused only on sweet corn or chilli (US$1 500). The rise in farm income under the New Theory is reflected in products that are preferred by the markets locally and internationally. He has kept his costs down by avoiding use of industrial fertilizers and pesticides. And with other sustainable practices he has succeeded in maintaining the soil fertility, irrigation and lowered energy inputs. With additional innovation, he has even introduced biogas production using animal manure, and he no longer pays for cooking gas. In addition, by using low-cost technologies such as nozzle spray sprinklers and elephant burglar alarms, crops are well irrigated and protected from animals, respectively.

Implications of Mr Patphong's farming practices for ecosystem enhancement

The benefits of the New Theory for ecosystem enhancement based on Mr Patphong's farming practices are many. Firstly, it helps to conserve water through the application of low-cost water saving technology (i.e. low-emitter sprinklers). Secondly, the soil fertility is improved through green mulching, cover crops and grasses. Thirdly, it saves energy through the production of biogas from animal manure. The use of biogas and reduction of industrial fertilizers and pesticides also result in lower GHG emissions.

Knowledge sharing and replication

Mr Patphong shares his knowledge and skills with other farmers through his Sufficiency Economy Learning Center at his farm. He also hosts many study tours for participants coming from government agencies, NGOs and civil society organizations (CSOs) to learn about the integrated farming practices. He advises his fellow farmers that to become a successful farmer, "There is a strong and urgent need to reduce the high production costs, stop practicing the monoculture system and stop using chemical products. We need to restore the environment and ecosystem conditions first before they can provide us fertile soil and enabling conditions to farm".

Conclusions

This study highlights the importance of the His Majesty King Bhumibol Adulyadej's Sufficiency Economy philosophy and the New Theory in promoting sustainable agriculture practices and poverty reduction in Thailand. It shows that a farming system as carried out by Mr Patphong clearly presents the concepts and principles of CSA which are in line with the New Theory of Agriculture. His practice has shown the critical role of the New Theory in: i) improving soil conditions and nutrient recycling through the use of green manure, green mulching and green weed control techniques; ii) reducing GHG emissions by introducing trees, using biogas production from animal manures, and switching away from industrial fertilizers and pest control chemicals; iii) providing better crop yields and better financial returns; and iv) promoting environmental sustainability. Based on a decade of implementing the New Theory, a sustainable farming practice was achieved by Mr Patphong. Such developments provide valuable lessons, and can even be replicated in other countries in the region with appropriate adjustments to suit the local context.

In conclusion, the New Theory of Agriculture practiced by Mr Patphong demonstrates a clear pathway towards climate-smart agriculture. It could prove to be an important development to the problems of food insecurity and climate change. In this system nothing is wasted, the by-product of one system becomes the input for another. Moreover, the system helps small-scale farmers to diversify their farm production and reduce risks, increase cash income, and improve the quality and quantity of food production. However, farmers need to have sufficient access to knowledge, assets and inputs to manage this system in a way that is economically and environmentally sustainable over the long term.

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Case 4
Floating gardens: Spreading the tradition[1]

Introduction

The impact of climate change is seen vividly in Bangladesh. The cumulative effect of heavy rains, frequent storms and sea level rise is severe flooding. With continuous water logging conditions, crops are often lost and land for agriculture is becoming scarce. Evidence is that wetland areas face more flooding/water logging for a longer duration.

The low-lying areas of the southern coastal areas of Bangladesh remain submerged for long periods (generally from the month of June to December) every year, especially during the monsoon season. As a result, no crop cultivation is possible in this land naturally. The detrimental impacts of changing climate may intensify these situations in the future. In these circumstances, location-specific adaptation measures to climate change should be taken on a priority basis for improving the food security of the vulnerable people.

The flooded lowland condition in Bangladesh is converted into opportunity – farmers are turning to floating gardens, known locally as *dhap* or *baira* for their livelihood. These are floating plots made from local material on which diversified vegetables are grown or seedlings are raised for marketing. These plots resting on mats of plant material and bamboo can rise and fall with the river water levels, and are not washed away no matter how long the floods last. The floating agriculture is based on local knowledge, and is helping people to achieve sustainable livelihoods despite the adverse impacts of climate change. As one farmer said, "This has made a great difference to my life. Now I have enough food in the floods and I can give some to help my relatives as well."

This unique system of floating gardens for vegetable and spice production prevails in the deeply flooded wetlands of the south central districts of Gopalgonj, Pirojpur and Barisal, primarily in low-lying areas where land is submerged most of the year. While this farming practice grew in the area as an alternative form of livelihood, it is now being replicated in other regions with similar ecology. The practice varies from place to place in the region in shape and size as well production system.

"Soil-less agriculture evolved through people's initiative for adaptation to an adverse environment," said researchers. It is said that the productivity of this farming system is much higher than traditional land-based agricultural production. The practice attracted the attention of policymakers and scientists recently from a number of angles. It clearly represents an adaptation to climate change, and has contributed to food security and livelihoods of vulnerable people in the region. The practice itself, with no or less agro-chemicals for plant nutrition and pest control, can be regarded as environmentally friendly with minimal GHG emissions. Initially, it was practiced mainly for meeting household needs, but now commercialization has begun. The practice is now seen in other parts of the country.

Floating gardens can clearly be classified as a CSA practice. Since it is receiving a lot of attention currently, and has the potential for replication elsewhere, FAO undertook a rapid study in terms of how floating gardens are constructed, their produce, contribution to livelihoods of the community, and their environmental value.

A rapid survey

The field visits were made to the remote southern region of the country (Bisharkandi union of Banaripara Upazila and Botiagata of Najirpur Upazila) of Barisal and Pirojpur districts, where no direct communication is possible (Figure 1). Localities are around 280 km from Dhaka. From Barisal HQs, it takes about three hours by road, and then by mechanized boat (Harta river) where about 15 000 farm families are involved with floating bed culture. The area (Ganges non-saline tidal floodplain) is under the influence of tide within large and small rivers; mostly low to medium low land of flood plain and water-based transportation is widely used.

[1] Prepared by Mr Wais Kabir, Team Leader, Mapping Exercise on Water Logging in SWB, FAO, Bangladesh.

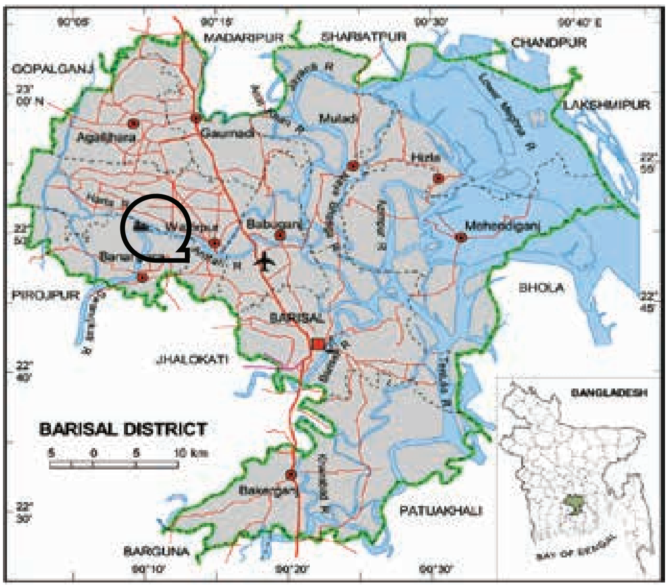

Figure 1. Study site (black circle)

The study was conducted at three floating vegetable cultivating districts of Pirojpur, Barisal and Gopalgonj. The practitioners, local extension providers, input suppliers and local government officials were consulted. Both practitioners from floating vegetable farms and the plains were consulted.

Constructing floating gardens

There are few studies which elaborate the floating gardens production system. The plant bed is built using several layers of water hyacinth and bamboo frames and the raft is overlaid with hyacinth to give it thickness. These beds are typically 15 to 60 m in length, 1.5 to 3 m wide and 0.6 to 0.9 m thick (Figure 2). Traditionally the farmers stack the water hyacinths on water in 2 to 4 layers at 8 to 10 days interval. When the stacked plants are partially decomposed, another layer of water hyacinth is put on to the previous stack. Then Dulalilata (*Hygroryza aristata*) and Topapana (*Pistia stratiotes*) are laid on top to facilitate germination and growth of crops. Semi-decomposed aquatic plants are then added to the mix and left to sit for several days before it is ready to be seeded. The beds can be prepared in any depth of water. Farmers can stand on some of them or manoeuvre around them in boats (Figures 3–5). The farmers prepare the beds during June-July and sow/transplant seeds/seedlings after eight to ten days of last stacking. General shape of the beds is rectangular. Materials like coconut husk are spread over the floating bed to add additional height.

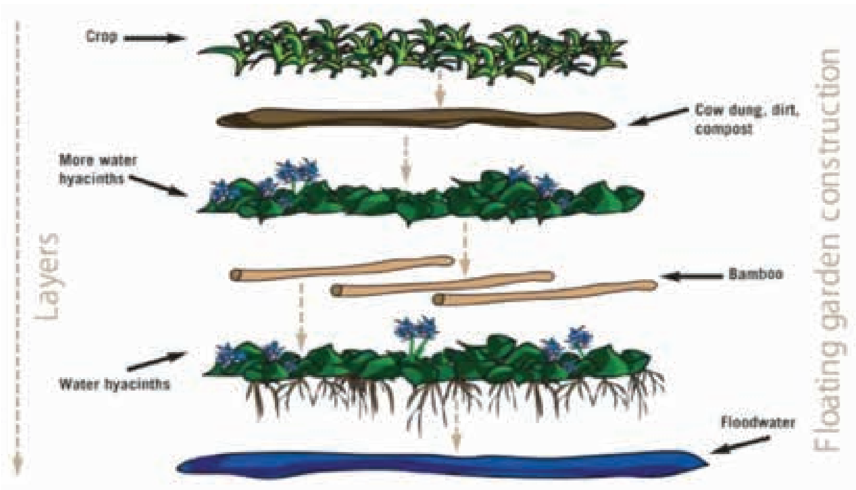

Figure 2. Plant bed construction (Source: *Practicalaction.org*)

The size and shape of the bed is not fixed. Farmers make the bed to their desired size and shape which varies from area to area. Farmers of Barisal and Pirojpur district make longer beds than the farmers of Gopalgonj district. The distance between beds depends on length of land. The narrow strip shaped bed is constructed so that gathering water hyacinths and harvesting of crops is convenient.

Figure 3. Floating farm (source: http://www.irinnews.org/report/90002/bangladesh)

Figure 4. Farmer walking over layered bed of aquatic plants

Figure 5. Beds of different sizes; note boat used to manoeuvre around

Around 30 species of vegetables, spices and other crops or seedlings are grown in the water based production system. The major vegetable crops are okra, ribbed gourd, Indian spinach, brinjal, cucumber, red amaranth, stem amaranth, wax gourd, and in winter turnip, papaya, cabbage, cauliflower, tomato and red amaranth. Among the spices, turmeric and chili are grown. Mixed intercropping is the most prevalent system. In Gopalgong farmers mainly grow vegetables while the Barisal farmers prefer to raise vegetable seedlings (six to seven cycles of seedlings per bed per season) (Figure 6–7).

Figure 6. Raising seedlings

Figure 7. Marketing seedlings from a boat

An important part of the practice is recycling. With recession of floodwater, decomposed beds are used as compost on the ground to grow winter crops. The production system is almost organic in nature. Family members, especially women, are involved in: (i) nursing and intercultural operations of vegetables, (ii) making *tema*, a ball type devise for raising seedlings, (ii) nursing the bed, (iii) harvest and post-harvest operations, and (iv) seed processing and preservation (Figure 8). The main cost includes labour for preparing the bed, sowing and harvesting. Cost of fertilizer (urea) and pesticides, if applied is minimal. Present transportation and marketing is indigenous. Organic production of vegetables is of importance for both local, urban and export markets. Besides, there is scope of improving productivity, profitability, marketing and opportunities for value addition through research and development programs.

Figure 8. Woman engaged in ball preparation for seeding (right)

The farmers

The community here is impoverished, with about 90 percent of them engaged in agriculture alone with no or few livelihood options during the monsoon. Some of the responding farmers were also involved in other business and services. The farm size varied from 0.6 to 0.88 ha with an average of 0.75 ha. Average holding of floating beds is five.

Problems in floating vegetables cultivation

The farmers continue to face some problems in production and marketing of floating vegetables. The interviews brought out several issues, primarily lack of credit facility, low seed quality, high cost of inputs, and problem of heavy rainfall, lack of water hyacinth and other aquatic plants due to salinity.

Cost of the practice

Costs are the expenses incurred for organizing and carrying out the production process. The cost of production includes different variable cost items like labour, seed, materials (includes bamboo, different elements required for preparation of seed ball [*tema*/mada], fertilizers and insecticides). Both cash expenditure and imputed value of family supplied labour are included in the analysis. As sizes vary from place to place, for the purpose of calculation, 100 m^2 of floating bed was used. Floating bed vegetable cultivation was high labour intensive. The highest cost was incurred for human labour (79%) followed by material cost (9%) and seedling cost (7%). Highest labour was used for seedling raising as farmers raised seedlings for 5 to 6 times each season. Women are involved in seed ball (mada/*tema*) preparation, nursing, harvesting, i.e women are contributing to increase income of their family.

Profitability of vegetable cultivation

Farmers get gross return of Tk.33 540, gross margin of Tk.26 544 and net return of Tk.18 418 in vegetable seedling growing. BCR on total cost is found to be 2.22 and 4.79 on variable cost from bitter gourd seedling growing which is higher than any other seedling growing at Barisal district. Farmers get gross return of Tk.26 489, gross margin of Tk.20 373 and net return of Tk.15 113 from country bean seedling. BCR on total cost is 2.33 and 4.33 on variable cost from country bean seedling raising which is higher than any other seedling raising at Pirojpur district. On average farmers get gross return of Tk.25 093, gross margin of Tk.18 836 and net return of Tk.13 810 while BCR on total cost is 2.23 and 4.0 on variable cost.

Considering all areas (districts) together for 100 m^2 area, farmers get gross return of Tk.22 404 and net return of Tk.11 356. BCR on total cost is 2.07 and 5.16 on variable cost from seedling raising and vegetable cultivation together. In comparison, cropping on plain land, on average farmers get gross return of Tk.2 640 and net return of Tk.869 and BCR on total cost is 1.54 and 2.72 on variable cost, which is lower than the floating bed vegetable cultivation technique. It is clear from the analysis that the floating bed vegetable cultivation technique is more profitable than the plain land vegetable cultivation. While the farmers cultivating floating gardens incurred higher cost, their returns were higher than the plain land vegetable farmers. During field visits it has been observed that commercial cultivation and marketing of hyacinth and other aquatic material has started to support floating cultivation (Figures 9–10).

Figure 9. Trading coconut husk (left) and aquatic plant (right) by boat for *dhap* making

Figure 10. Trading of aquatic plants for bed making

The study also showed that the income from floating vegetables reached 60 to 70 percent of family income, with 20 to 30 percent from paddy, and the remaining from trading or any other off-farm activities. However, this varies considerably from place to place.

Future research and development agenda for replication

Organized system based research program has not been started. However, some documentation, demonstration and training have been made by the Department of Extension and other NGOs. There is a huge scope to further improve the system and make it more efficient and profitable. Some researchable issues include management of fertilizer, pests and diseases, organization of the business model, shortening crop life cycles, and development of integrated crop-fish culture in the floating bed.

Social, economic and environmental benefit

In Bangladesh most of the lowlands remain waterlogged or under submergence year-round or at least 6 to 8 months. Floating gardening has several advantages: 1) the fallow waterlogged area can be cultivated and the total cultivable area increased, 2) area under floating cultivation is more fertile compared with the plain land, 3) no or less fertilizer and manure are required unlike in the conventional agricultural system, 4) after cultivation, the biomass generated can be used as organic fertilizer in the field, 5) it conserves the environment, 6) during the floods it can be used as a shelter for poultry and cattle, and 7) fishermen can cultivate crops and fish at the same time. There are additional advantages: the crops never wash away; and the platforms, made from plants are practically free, recyclable, and do not pollute. All the activities of the practice are environment friendly, while contributing to food security and nutrition under the impacts of climate change.

Conclusion

Though the practice began long ago, it has not attracted the notice of the researchers until very recently. Base line survey and in depth studies are needed to develop location specific improved practices. About 3.0 million ha of medium low to very low lands exist all over Bangladesh, which cover about 21 percent of the total country. The low-lying lands of these areas remain fallow especially during the monsoon season due to flooding or submergence. The potential for floating gardens to improve the quality of the life of agriculture-dependent communities is very high. Even though the floating garden technology was developed out of necessity, the poor have the capacity to adapt to tough conditions posed by climate change. The floating garden approach uses local skills and knowledge in adapting to the impacts of climate change, and fosters the self-reliance, drive and commitment to meet the challenges from climate change.

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Case 5
India's traditional water harvesting systems: Age-old, climate-smart agriculture[1]

Introduction

With its unique diversity and history – environmental as well as cultural – India offers a rich range of references in humankind's efforts to deal with climate change. India has 15 distinct agro-ecological zones. An aerial journey of only about 850 km can take you from sea level in the city of Bhubaneswar to the mighty Kanchenjunga in the Himalaya, which peaks at an altitude of 8 586 masl. Cherrapunji in the northeast is among the wettest places in the world, while the Thar in the west is among the world's driest areas. Some regions in the states of Assam and Bihar face fierce annual floods; some others in central and western India are accustomed to several, consecutive years of drought. And some of the islands and coastal regions bear resemblance with Southeast Asia.

Yet if there is one element that unites India despite its mind-boggling diversity, it has to be the Southwest Monsoon. Since pre-historic times, residents of the Indian subcontinent have made efforts to understand the hydrological cycle, of how the Monsoon brings water-bearing clouds from the ocean, and how that water flows back to the seas through rivers. The oldest textual reference to this is in the *Chhandogya* Upanishad, a Sanskrit text some scholars have dated to more than 3 000 years ago.

India's numerous calendars are all centred around the Monsoon. The term for year in Sanskrit is *varsh*, which originates from *varsha*, the term for rainfall. Time has been measured in drops of rain. Figure 1, a method to measure water level using statues of elephants and horses used to measure water level, is an example of how engineering was steeped in culture, and not in impersonal units and measurements. About 70 to 90 percent of India's total rainfall occurs in a few days during the three-month Monsoon period: from June to August. Even then, the amount and timing of rainfall varies a lot from year to year and from place to place.

Figure 1. The water level in Amarsagar pond, Rajasthan, was built in the fifteenth century. The water level is measured by the statues of elephants and horses

[1] Anupam Mishra & Sopan Joshi, Head and Fellow respectively, of Natural Resource Management (NRM), Gandhi Peace Foundation, New Delhi, India.

Water harvesting: An indigenous way of life

The key to survival in India has been to build systems to harvest this seasonal bounty, so that water remains available over the remaining nine months. Such systems date to prehistoric times, and references to their role in irrigation[2] and agriculture[3] can be found in ancient texts and treatises. Perhaps the most ubiquitous structure like this is the *taal* or *talaab* (pond or lake, depending on size) (Figure 2). It can still be found across India, even if a bulk of such water bodies has now fallen into disrepair.

Questions remain as to who built them and how they were maintained over time. Some answers can be found in folk narratives, songs and descriptions.[4] People simply got together to do what was required for their survival and prosperity (Figure 3). These water bodies were built with community effort, with a festive spirit, as all efforts related to water-works were tied up with the agricultural and religious calendars. One term often used in some Indian languages for such congregations is *goth*, which simply means a get-together to shoot the breeze, combined with a feast and collective labours for building and maintaining water bodies. People knew how to design and build water-harvesting structures, and the knowledge was passed from generation to generation. An example is the famous stepwell (Figure 4) of the Toda Rai Singh Baodi in Tonk District, Rajasthan. The stepwells are some of the oldest designs of waterworks across India . Over the centuries, the physical proliferation of such systems became so widespread that they became omnipresent. When the first enumeration was carried out by the colonial British administration in the mid-nineteenth century across India, they found about 3 million water bodies in about 500 000 villages. In a variety of ways – and over centuries – communities in India have fashioned systems that provide a predictable supply of water, despite the unpredictable nature of the Monsoon. At a time when weather patterns are changing rapidly due to climate change, such systems are examples of dealing with unpredictable rainfall for both drinking water and irrigation.

Figure 2. A view of Jaisalmer's Gadsisar pond, an international tourist attraction that shows the beauty that was associated with all traditional waterworks engineering in India

[2] Anon. 1965. *Irrigation in India through the ages.* Central Board of Irrigation and Power, New Delhi, India.

[3] Anon. 1964. *Agriculture in ancient India*. Indian Council of Agricultural Research, New Delhi, India. pp 113-133.

[4] Anupam Mishra. 1993. *Aaj Bhi Khare Hain Talab (Hindi)*. Gandhi Peace Foundation, New Delhi, India.

Figure 3. Village folks surveying an embankment of a pond they built, in order to carry out maintenance work

Figure 4. The Toda Rai Singh Ki Baodi, one of the oldest and most famous step-well in Tonk District, Rajasthan. The step-well was built not just to provide potable water around the year, but is constructed with great architectural beauty

Lessons from the driest region – local knowledge and local material

About 30 million ha of the Thar Desert lie in the western state of Rajasthan. In its western reaches, annual average rainfall is about 100 mm or even lower. The temperature during the peak of summer rises to just under 50°C. The groundwater in several regions of western Rajasthan is so saline it is unfit for consumption. Despite the hostile environmental conditions, the Thar is often counted among the most populated deserts in the world, both with people and livestock. Lacking sources of water from the Himalayan glacial melt, they found it in other natural sources such as the layers of gypsum under the desert sand. Rainwater does not percolate into the saline groundwater deep beneath the sands because the gypsum forms an impermeable layer, leaving water trapped in the sand above. This changes the nature of the vegetation on the ground as plant roots can tap this moisture. By observing the vegetation, people have learned to tap water from the ground.

In the district of Jaisalmer, where annual average rainfall is around 160 mm, people have been cultivating wheat without any irrigation for over 800 years (Figure 5). They use a system called *khadin* in areas where the gypsum layer is not too deep. Embankments of sand are built to create a physical barrier for water running down the natural slope of the gypsum belt. The embankment is built by first accumulating dry, thorny bushes along its length, usually east-to-west, against the northwards direction of the wind. The obstruction of the thorny bushes collects and deposits sand along its length. The amount of this sand increases with time, thus the embankment rises naturally. It is then compacted. This obstruction traps the runoff from rainfall that runs down the slope of the gypsum layer. In the Monsoon season, this creates a pond in some places. In the winter season, this water turns to soil moisture, and is used to grow the winter crops of wheat and chickpea, without any irrigation.

Figure 5. Villager next to his *khadin* with wheat crop in the background, grown only with soil moisture

"The crop output of a *khadin* is better than it would be in a patch of land irrigated by a canal or even a bore-well," says Girdhari Singh, a social activist in the region, working with Sambhaav, a civil society organisation. The runoff brings to the *khadin* lots of biomass that results from pastoralism on higher ground – animals' droppings and other plant material add nutrients and replenish the sandy soil, giving it texture, which in turn increases its capacity to retain water. "Farmers do not need to apply fertilizers purchased from the market in *khadins*. Its sands are fertile," Singh observes. The *khadin's* soil fertility actually accrues over time, as the organic matter accumulates year on year, creating a topsoil even in the desert conditions, he points out. "Using local knowledge and material, the estimated annual cost of maintenance would be about US$31 to 78," says Singh. However, one acre of winter crop of wheat or chickpea can yield between US$392 and $471.

How to survive consecutive years of drought

Ponds are also built above the gypsum layer. Two such ponds exist near Ramgarh town of Jaisalmer. The 2014 Monsoon failed this area, resulting in an acute drought. One of the ponds dried up, yet there was enough drinking water for nearby villages. This is down to a structure called a *kui* or a *beri*, which means a small well (Figure 6). A *kui* is lined with stones, or even with tree branches. The walls of this well are porous, going down to the gypsum layer. Sand water trickles in slowly into these shallow wells, which are narrow at the top, getting wider with depth (Figure 7). This maximizes the surface area for the sand water to trickle in, minimizing the surface available for evaporation losses from the desert heat. In the Ramgarh area, *kuis* have seen them through the current drought. Such low-cost methods, from labour to technology to the material and maintenance, come without money changing hands (Figure 8). In contrast, the desert towns that have water tankers to deliver water pay as much as INR1 000 (US$15) per tanker.

Figure 6. *Kui* or small well

Figure 7. Diagram showing a *kui* going down to gypsum layer

Singh's organization has developed a system of making *kuis* with reinforced cement concrete; it has built about 200 such narrow wells, based on the old concept, but using modern materials. The cost of this seldom goes beyond INR6 500 and INR10 000 (US$102 and $157) for each well. Some cities of Rajasthan are being served by the Indira Gandhi Canal, built from the 1960s to bring water from Punjab. But the feeder system to supply smaller settlements is often found in a state of disrepair, with sand flowing in the canal network, instead of water. Some of the areas served by the canal have serious problems with water logging and salinity. The high concentrations of salt in the desert sand and groundwater gradually make surface water unfit for drinking or irrigation.

The modern apathy to time-tested systems

Another structure that became ubiquitous is the *tanka* or *tanki*, which is the etymological origin of the English word "tank" (Figure 9). It is an enclosed structure to harvest rainwater for drinking. Such structures were as common in cities as they were in villages and pastures and were even found by the roadside; they were the only source of potable water in regions where the groundwater is saline. An average-sized tank seldom costs more than INR50 000 (US$785). Singh has built one recently which can store 10 000 litres of water, and it fills up with rainwater at least twice a year, sometimes thrice. If this structure is filled with water fetched by a tanker, it would require three tankers and cost INR3 000 (US$47). If the *tanka* was to be filled by tankers, it would cost the owner up to INR9 000 (US$141) each year. This means the cost of construction will be recovered in four to six years; after that, the tank will provide rainwater for free. Such structures, once built, have provided water for generations. Their cost of cultivation becomes ridiculously small when seen over time.

Another natural resource that the desert folk have used is a rare rock called *habur*, found in only one village of western Rajasthan. Geologists say this unique, red-coloured, shiny rock was formed during the early Cretaceous period, more than 100 million years ago. It contains calciferous deposits like shells of marine creatures. It has variable porosity, filtering water by taking out its impurities. So people come from far and wide to get this stone and use it in all their waterworks. Nobody can say how old this practice is. But it reflects how carefully traditional societies have observed their environment, the resources it offers, and how they have used every possible method to conserve water. Where water was too scarce for any kind of agriculture, people relied on livestock and pastoralism, converting the nutritious desert grasses into milk and butter (Figure 10).

The good sense of pastoralists

In the dry and saline district of Kutch, Gujarat, traditional nomadic pastoralists called the Maldhari have engineered a system called *virda* – shallow wells that separate freshwater from saline. These are built in depressions in the vast, arid flatland, where chances of rainwater collection are high. The Maldhari must have noticed that rainwater stays above the saline groundwater due to the difference in density; salt makes the water denser, so it stays beneath fresh water, until the two dissolve.

Figure 8. Shallow well – workman digging a *kui*

Figure 9. A *tanka* or *tanki* (also called a *kund* in some places). This image is of a 250-year old *kund* in Churu District, Rajasthan. It is for harvesting rainwater in a region where the groundwater is saline

Figure 10. Pastoralists in Rajasthan have played a role in water conservation – where land is not fit for cultivation, pastoralists have relied on livestock to convert desert grasses into milk and butter

So the pastoralists began the practice of digging their wells only till the depth of about a metre above the groundwater. When it rains, the water level rises. But only the freshwater above the saline groundwater gets inside the *virda*. This system relies on maintaining an optimum vegetative cover in the surrounding areas, so the Maldhari learned to not allow their animals to overgraze. To survive in difficult environmental conditions, engineering must go hand in hand with social and environmental regulation.[5]

Far from this region, in the coastal plains of the southern state of Tamil Nadu, farmers had evolved the *eri*, a system of tank irrigation that made possible paddy cultivation in this region. An *eri* traps the rainwater running down the eastward slope to the coast. These were maintained by village communities themselves, with officials appointed informally to distribute water equitably. *Eris* also provided soil conservation and flood control.

The *eri* system suffered a great deal when the colonial British Government tried to control this economic resource by centralizing it in the mid-nineteenth century. This alienated the communities. Efforts to revive the system after India achieved independence have not adequately recognized the role of community ownership and management. Across India – and through the history of the land – water management systems that provided water during drought and also functioned as flood control measures were built and controlled by communities.

Signs of revival

While traditionally the ruling class and the State contributed to them in varying ways, every part of society was responsible for water management in its own field. Sensible water management was regarded essential for farming – and for surviving the vagaries of the Monsoon. Advances in modern engineering over the past century have taken the spotlight away from such systems. In some quarters, they are described as vestiges of the past, with no place in the future. But the limitations of modern engineering have revived popular interest in traditional systems. Dams and canal projects have not delivered the results they promised. With the effects of climate change becoming clear with time, there are efforts to retrieve the good sense of traditional systems.

In two parts of the central province of Madhya Pradesh, farmers have invested their money and effort into reviving old systems of irrigation and water conservation. Mahoba district, in the parched northern region of Bundelkhand, saw a turnaround in March 2013.[6] At the initiative of a CSO, farmers began a "Build Your Own Tank Campaign". While the district administration was supportive and even offered funds, the farmers said they were doing this for their benefit so they did not need assistance.

Most of these tanks got filled up during the Monsoon rains, and several retained water till March 2014.[7] Seeing the results, several farmers in the area built tanks before the 2014 Monsoon. Some 400 were built and they provided vital support for farmers in the weak monsoon that year.

An even more dramatic turnaround has happened in the State's south. The Malwa plateau was traditionally considered water rich, with innumerable tanks. Rampant withdrawal of groundwater since the 1960s took the city of Dewas and surrounding areas to a point where drinking water was being supplied by train. The groundwater table sank to depths of over 400 feet in some areas, putting a great burden on even the electric pumps for water withdrawal.

5 Agarwal, Anil & Narain, Sunita (eds.). 1997. *Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems*. Centre for Science and Environment, New Delhi, India. p. 146.

6 Bhaduri, Amita & Jha, Prabhat. 2014. "Princely" Private Ponds. (available at www.IndiaWater.Portal.org)

7 Khandekar, Nivedita. 2014. For more than 20 years, a slim book has helped Indian farmers become self-reliant in water. (available at www.Scroll.in).

Over the past decade or so, some progressive farmers decided to revert to the traditional tanks to harvest rainwater and improve water availability, rather than sinking ever-deeper bore-wells to mine groundwater. Since then, more than 6 000 tanks – small and big – have been built by farmers. Dhaturia village of about 120 households, for example, has 154 tanks now. As a consequence, the water table in some parts of the region has risen so much that water is now available at 40 feet. It has recharged the bore-wells and dug-wells of several farmers. Several tracts of land that were lying fallow earlier due to lack of irrigation are now productive. The water conservation efforts of the district won it the "Water for Life" UN-Water Best Practices Award[8] in 2012. One or two academic evaluations[9] have spelled out the economic potential of the waterworks carried out.[10]

The cultural aspect of dealing with climate change

Discussions of combating climate change and sustainable development often tackle the social, economic and environmental dimensions of water management for food and agriculture. There is also a cultural aspect of such efforts. Since time immemorial, societies in India have dealt with erratic rainfall and weather extremes by creating a culture of water harvesting, which intrinsically accounted for socio-economic and environmental factors.

This value system materialized the potential of natural resources for food and agriculture in trying circumstances. The core institution was that of society, of people acknowledging that their survival and well-being was tied with the well-being of the natural resources. The names of cities and villages were often based on their water bodies. This value system gave the natural world a cultural respect, a sense of gratitude, which made collective action easier. Systems created by societies in India to deal with the caprices of the Monsoon are a valuable resource for humankind's efforts to deal with a changing climate regime due to global warming.

8 Anon. 2012. "Water for Life" UN-Water Best Practices Award: 2012 edition: Finalists. (available at www.un.org).

9 Malik, R.P.S., Giordano, M., & Sharma, V. 2014. Examining farm-level perceptions, costs, and benefits of small water harvesting structures in Dewas, Madhya Pradesh. *Agricultural Water Management*, Vol. 131, pp. 204–211.

10 Anon. 2011. Miracle achieved by the joint efforts of a local community and a government administration: An economy of water by a visionary crusader Umakant Umrao, (available at www.thegroundreportindia.com).

Case 6
Leasehold forestry of Nepal: A new lease of life for rural communities and forests[1]

Introduction

Landlocked Nepal remains a poor country, with over 80 percent of its 26 million people living in rural areas. These rural communities, with very small land holdings, are heavily dependent on forests to supplement their daily needs. Figure 1 displays how rural livelihoods are dependent on forests. Forest resources have been dwindling for decades as a result of land use conversion and over-harvesting of trees and other products. Deforestation, land degradation and soil erosion took their toll on the rural populations. As forests declined, people – especially women – spent much more time to collect fodder and fuelwood, which resulted in lower agricultural production and decreased food security.

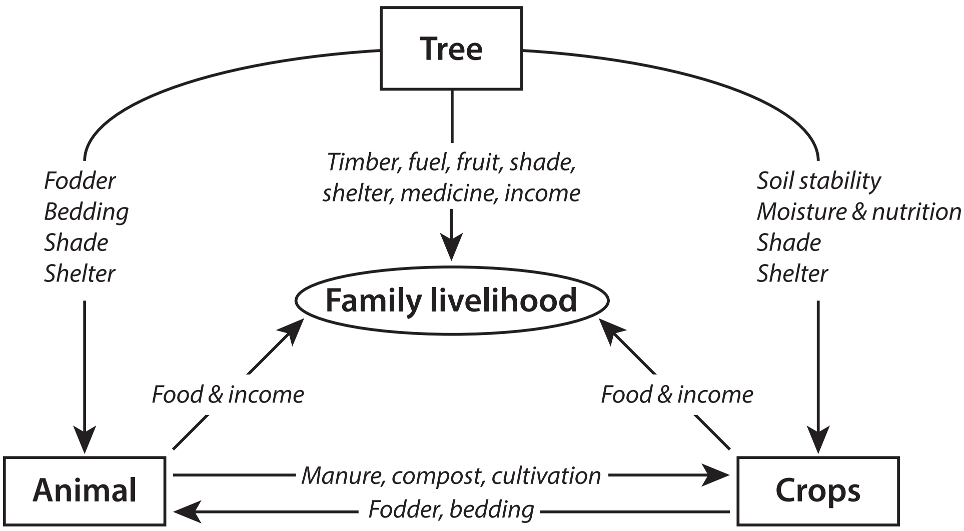

Figure 1. The link between tree-animal-crop farming system in Nepal

To address the situation, in 1978 the Government of Nepal initiated Community Forestry schemes, whereby the nation's forests were handed over to local communities (*panchayats*) to manage them. Currently, about 1.7 million ha of forests are managed as Community Forests which has benefitted about 2.2 million households so far. In essence the Community Forestry with its base as common-property forest, primarily met the basic needs of communities from forests while improving the forest conditions.

However, the resource-poor households and socially marginalized people such as women and low caste groups benefited little from the community-based forest lands as the benefits tended to accrue to the influential and well-off households. Recognizing this flaw, the Leasehold Forestry (LF) was developed to address poverty of marginalized groups. The term leasehold, which is not instantly associated with community forestry, is due to the Forest Act of 1993 which permits forest tenures for forest-based industries and private individuals. The Government of Nepal utilized the Forest Act to lease out forest land to marginalized households. Under the guidance of the Forest Regulation of 1995, community-based LF was specially provisioned for the poor. The LF of Nepal is a pioneering approach to reverse deforestation and land degradation while involving and benefitting underprivileged rural communities. Currently, Nepal has some 40 000 ha under LF for nearly 66 000 households.

[1] Prepared by Mr Simmathiri Appanah (FAO Climate Change and Bioenergy Officer, FAO) & Mr Kenichi Shono (FAO Forestry Resources Officer).

Leasehold forestry – an agroforestry approach

Only households living below the poverty line and owning less than 0.5 ha of land are eligible to become Leasehold Forestry User Groups (LFUGs) (Figure 2). Each household receives about 1 hectare of state forest land for a lease of 40 years, with a provision for extension. These lands are usually extremely degraded, even barren. The LFUGs are required to protect the forest lands against degradation so natural regeneration of trees, shrubs and grass can take place. Since the land is deemed forest, the user groups are allowed to cultivate economically valuable perennial plants such as non-timber forest products (NTFPs) and fodder. Open grazing has been disallowed, and has been replaced with stall feeding. Technical advice, training, and basic material are provided to start planting and generating other income-producing activities. The concept of LF was further expanded by including livestock (mainly goats), and was called the Leasehold Forestry and Livestock Programme (LFLP).

Figure 2. User groups tending to their Leasehold Forestry plots (Photo: Department of Forests, Nepal)

Forestry is usually a long-term economic activity, which is unrealistic for the poor who have no agricultural land for raising food crops. In order to create short-term revenue flow on degraded forest lands, the households initially raised broom grass (*Thysanchaena maxima*) and other fodder species. The fodder was for raising livestock, which established income over the short term. The livestock initially included goats, but over time cows and buffaloes were added. The milk and meat from them not only improved the nutritional levels of the households, but the surplus was sold for instant cash. A market for broom grass has also grown in the region. A number of other high-value NTFPs such as bay leaf (*Cinnamomum tamala*), Nepal pepper (*Zanthoxylum armatum*), cardamom (*Amomum subulatum*) and Nepalese paperbush (*Edgeworthia gardneri*) were raised. Existing timber species from seedlings and coppice growth were protected. Additional plantings generally included Himalayan Ash (*Fraxinus floribunda*), *Garuga pinnata*, *Ficus* spp., *Acacia catechu*, *Schima wallichii* and *Castanopsis indica*. These were interplanted among the fodder species or in completely barren sites. The NTFPs and timber species provided longer-term income generation, while restoring the degraded forest lands.

This integration of forestry, agriculture and livestock provided the income and material resources for subsistence in some of the extremely poor mid-hill regions of Nepal. Through a participatory approach, the LFUGs were encouraged to determine the activities that provided both incomes as well the restoration of productive landscape for meeting their social, economic and environmental requirements for the future.

The link between LF and CSA is clear cut. LF achieves two goals (Figure 3). LF as an agroforestry system starts with degraded forests or low-productivity sites which are gradually turned into regenerated forests. Recovery of many of the environmental values of forests and their biodiversity follow. The LFs, with planting of fodder and NTFPs, are geared towards improving the livelihoods of poor households. When the LFs are linked with livestock (LFLP), they enhance the food security of the users (Figure 4). Inherent in the system is the potential for LF to be climate resilient by improving the environmental conditions for sustainable farming. This report examines briefly LF in terms of environmental, economic and social values.

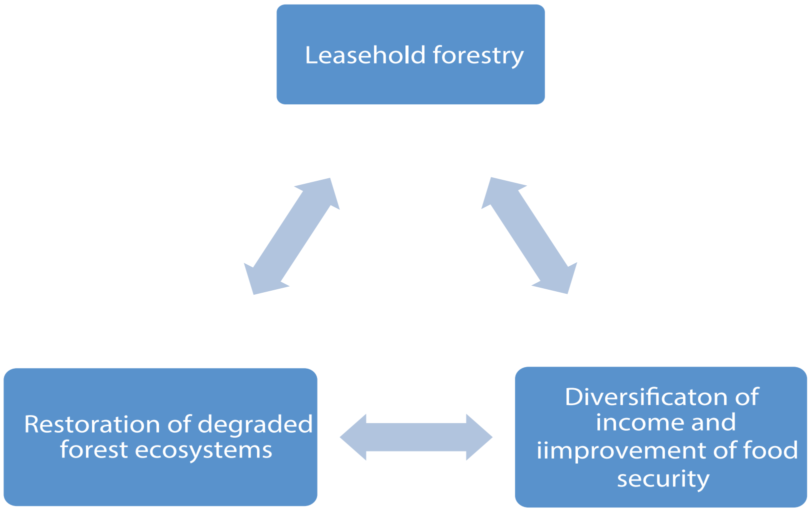

Figure 3: Dual goals of Leasehold Forestry

Figure 4. Livestock incorporated into Leasehold Forestry to form the Leasehold Forestry and Livestock Programme (Photo: Shono)

Outcome of Leasehold Forestry

The findings here are based mainly on two FAO studies: a) two LFs with 1 500 LFUGs in Chitripani and Bhagawathisthan districts (1994-2000); and b) four LFs with 352 LFUGs in Palpa, Nawalparasi, Gulmi and Syangja districts (2010-2013). Data from other studies, where available, are used to augment the findings of LF implementation.

Socio-economic development

Overall, there was a clear trend in the proportion of the poorest households participating in the LF programme – their numbers, based on economic categorization, declined from 41 percent in 2006 to 19 percent in 2013 (Figure 5). The programme appears to have contributed to the reduction in poverty.

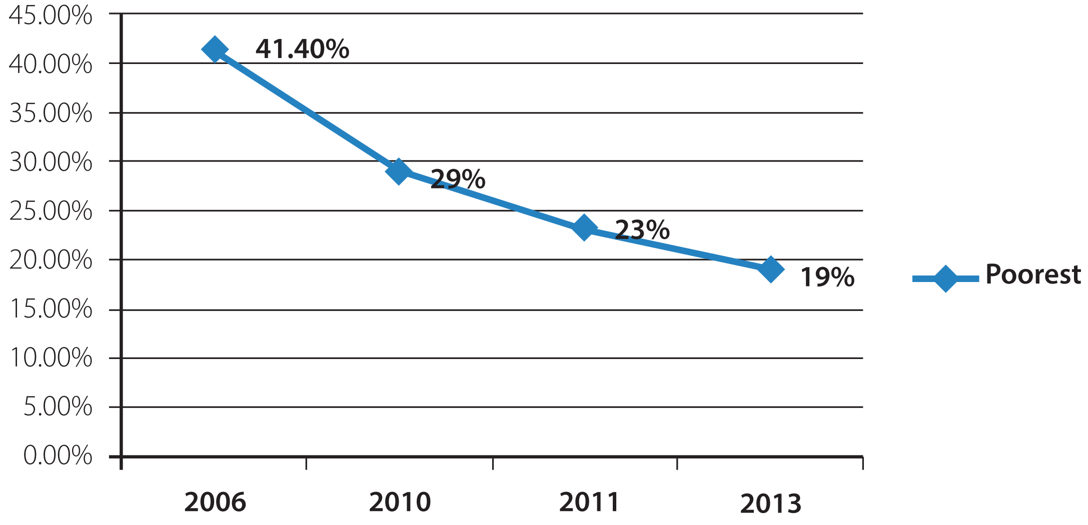

Figure 5. Trend in poor household numbers in the Leasehold Forestry Programme (FAO 2013)

Once the forest lands came under LF management, grazing and fire were controlled, and the forest productivity increased, as measured from fodder and fuelwood. As shown in Figure 6, households receiving less than three months of fuelwood decreased, and the proportion of households receiving up to six, nine and more months increased during the period. The supply of fuelwood from LFs gradually increased.

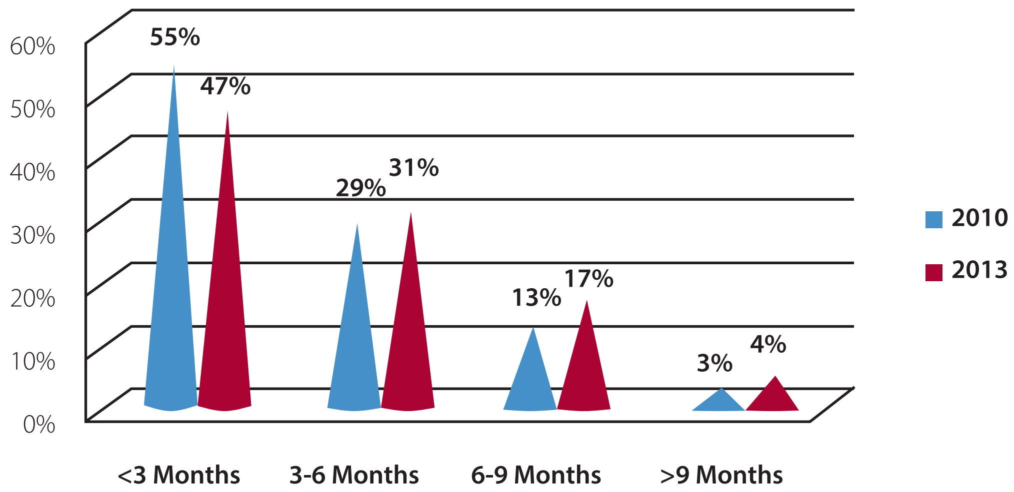

Figure 6. Percentage of households receiving fuelwood from Leasehold Forests (FAO 2013)

The LFs became a vital source of income for the LFUGs. With the increase in fodder, the LFUGs were able to raise goats and maintain buffalos for milk production. There was a diversification of income from the sale of goats and buffalo milk, and even fodder. The percentage of income from the sale of such produce increased steadily over the six years that data were collected (Figure 7). LF made it possible for almost 90 percent of the households to earn cash income, an increase of 40 percent in six years.

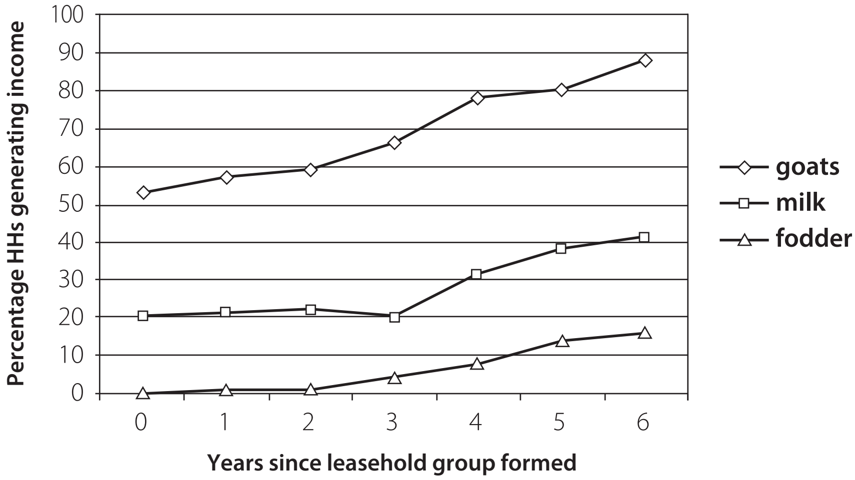

Figure 7. Percentage of Leasehold Forestry User Groups earning income from sale of fodder, milk and goats (Ohler 2000)

The impact of LF can also be seen in the number of hours women devoted to collecting fodder. Before the LF Programme women spent almost four hours daily to the task, whereas with the LF, this was reduced to 1.4 hours a day (Figure 8). As a result, the women folk could devote their time to other vital tasks.

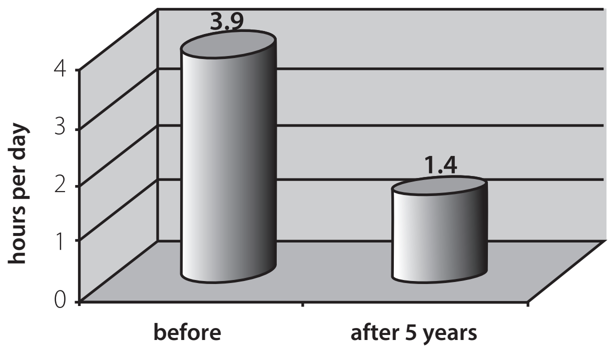

Figure 8. Time women from leasehold forestry households need to collect fodder (Ohler 2000)

Environmental change

To start with, only degraded forests with less that 20 percent crown cover can be handed over as LFs. An analysis of forest cover based on perception by the User Groups is shown in Figure 9. At handover, on average 53 percent of the LFs had low forest cover (<25%). A survey three years following LF management, only 15 pecent of the LFs were in the <25 percent category. Almost half of the LFs had green cover of 25 to 50 percent. This is an excellent achievement in comparison to the almost barren lands at the handover to the LFUGs.

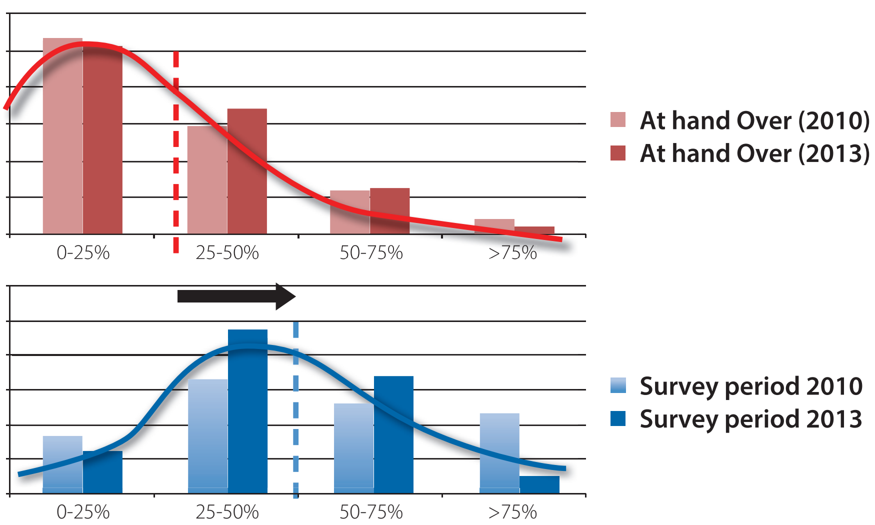

Figure 9. Change in land cover in Leasehold Forests from handover to survey (sampling based on feedback from LFUGs) (FAO 2013)

Besides planted fodder grasses, NTFPs and timber trees, the establishment and growth of natural regeneration accelerated in most of the LF sites. Another FAO study in Makwanpur and Kavrepalanchok showed rapid increase in vegetation ground cover of the sites from an initial 32 to 50 percent after one full growing season, and reached over 80 percent seven years later (between 1994 and 2000) (Figure 10).

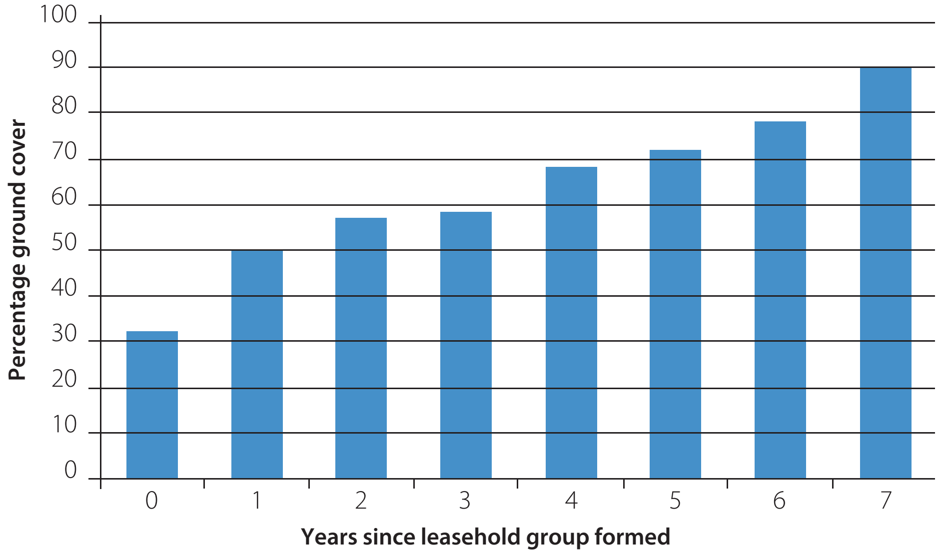

Figure 10. Percentage of ground cover following management as Leasehold Forest plots (Ohler 2000)

Based on an assessment, LFUGs perceived significant enhancement in forest conditions and environmental services following LF management, with improvements in overall green cover, access to forest resources, availability of fodder, and plant diversity (Figure 11). However, the groups perceived no change in water sources.

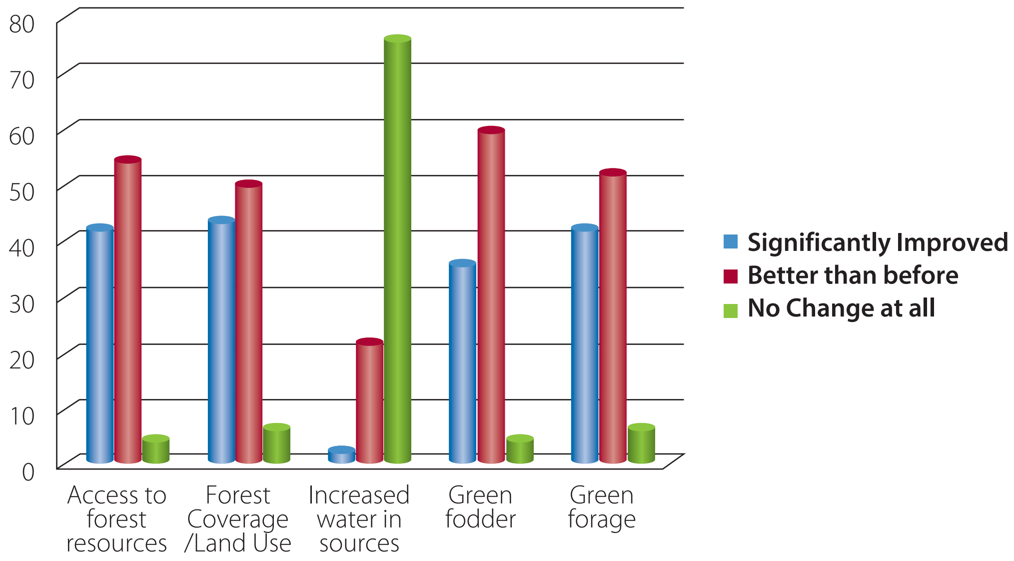

Figure 11. Perceived improvements in environmental services (FAO 2013)

Considering most LFs were barren or low in vegetation cover at time of transfer, once grazing was stopped, rapid natural regeneration of herbs, grasses and trees took place. Many trees regenerated from stumps. Further, with the active introduction of plants, the overall rehabilitation was impressive, resulting even in multi-layered forest. The biodiversity, based on LFs in two study sites, increased by 57 and 86 percent (Figure 12).

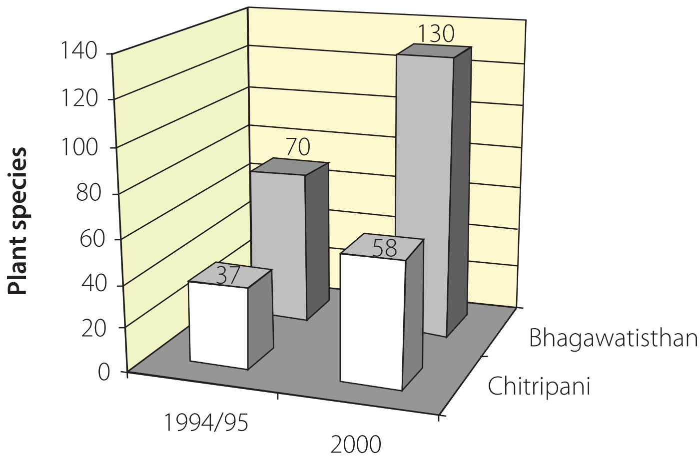

Figure 12. Changes in plant biodiversity in two Leasehold Forest sites between 1994 and 2000 (Ohler 2000)

No detailed studies on the mitigation benefits of LF have been carried out. One review by FAO states that the LF programme is in total a sink and leads to carbon sequestration. The activities such as agroforestry in the LF areas can account for 3 442 904 $tCO_{2\text{-e}}$. Another benefit is the land-use change from degraded land to annual and perennial croplands. However, livestock production is a source of GHG emission, with a total of 773 270 $tCO_{2\text{-e}}$, which is moderate. The overall results of reversing land degradation can translate into benefits of 96 tons of $CO_{2\text{-e}}$ per hectare or 85 tons of $CO_{2\text{-e}}$ per farmer.

Conclusions

This transfer of degraded forests lands on a 40-year lease to some of the poorest people in rural areas of Nepal achieved multiple objectives. It is one of the best forestry models that while focusing on poverty alleviation and food security, also improved the environment and forest recovery. The examples of the impacts include: a) significant increase in income for the user groups from sale of goats, milk and animal feed; b) enhanced food security and improved diets for children; c) diversification of income beyond that of casual labour; d) reduction in women's time for forage and firewood collection that can be transferred to other vital uses; and e) an improvement of the environment and expansion of forest cover in the hilly areas, which also can contribute to climate change mitigation. Considering the participants were mainly from marginalized groups, this change in their quality of life would mean a big difference to their status in society. The LF of Nepal holds another important lesson in the annals of development work – the LF programme required little investment other than the transfer of some degraded lands to the people. Most of the development took place through empowerment of the people.

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Case 7
Vertical farming: An innovative agriculture system for producing food in urban areas[1]

Introduction

The world's population is expected to reach 9 billion by the year 2050. With the impact of climate change, producing enough food for the growing population would be a challenge. With this concern for maintaining food security, FAO has introduced the concept of CSA aiming to foster climate change adaptation while achieving sustainable production of adequate food supplies. The CSA has three objectives: i) sustainably increase agricultural productivity and incomes; ii) adapt and build resilience to climate change; and iii) reduce and/or remove GHG emissions where possible. The concept of CSA is rather a location specific; therefore, the adoption of the practice can vary across the region.

The population projections show that today 54 percent of the world's population lives in urban areas, and by 2050 the ratio is expected to reach 66 percent (United Nations 2014). And much of urbanization growth is likely to take place in Asia and Africa (ibid 2014). These projections provide valuable guidance for the governments and policymakers to develop long term urban development plans and strategies including sustainable urban agriculture. There is growing interest worldwide in urban farming, which can provide food locally, as fresh as possible, with reduced "food miles" from long-distance transport. There are other benefits such as making the city greener and reconnecting people to the Earth. Urban farming comes in various types, and includes small land plots, rooftop gardens and other more technology-based approaches referred to as vertical farms.

In this context, the developments with urban farming taking place in Singapore may provide a beacon for other similar urban setups. Singapore with 716 km^2 and a population of over 5.4 million is one of the most densely populated cities in the world. Most of its land is allocated for urban development, leaving only about 101 ha of farmland for agriculture development. As a result, Singapore could only produce 7 percent of the green leafy vegetables locally and it has to rely on imports to feed its growing population. This has its drawbacks which includes food security, exposure to price volatility, higher costs, and much more GHG emissions as a result of transport.

To reduce their dependence on food imports somewhat, the Government of Singapore has set a target to produce at least 10 percent of local production of leafy vegetables. The country is embarking on innovative work on urban farming which is simultaneously resilient to climate change. While hobbyists and volunteers are starting minor initiatives such as rooftop gardens and small land lots for agriculture, the major advancement is with vertical farming. Some entrepreneurs have come up the concept of a green vertical farming system which can provide high agricultural yields, good quality food with high adaptability to the growing media and environment while minimizing the use of natural resources. The Government of Singapore is a strong promoter of such enterprises, and has established a public-private partnership (PPP) between the Agri-Food and Veterinary Authority of Singapore (AVA) and a local firm called Sky Greens to launch the green vertical farm in 2010. This case study of vertical farming concept is based on the Sky Greens enterprise in Singapore. The study aims to identify the role that vertical farming plays in increasing agricultural productivity while minimizing area of land use, reducing water and energy consumption as well as lowering GHG emissions.

Vertical farming technology: the Sky Greens

Vertical farming refers to the practice of cultivating plant life within a skyscraper greenhouse or on vertically inclined surfaces (Hix, 1974). The vertical farming implemented in Singapore was invented by Mr Jack Ng, the founder/CEO of the Sky Greens. The Sky Greens started building its first prototype in 2009. In April 2010, a Memorandum of Understanding (MoU) on collaborative research agreement was signed between Sky Greens and AVA. The joint-venture is considered as the world's first low-carbon, water-driven, rotating, vertical farm for growing tropical vegetables in an urban environment.

[1] Prepared by Ms Wirya Khim (FAO), with advice from Mr Simmathiri Appanah (FAO); this work received considerable support from the Officers of AVA.

Following its success, the Sky Greens' Vertical Farm won the Minister for National Development's Research & Development (R&D) Award 2011 (Merit Award) for providing an innovative and green solution for the national urban food sustainability challenges. The technique is called "A-Go-Gro" technology (Figure 1). The system gives a much higher yield, uses much less water, energy and natural resources, and aims to achieve a sustainable agriculture practice which is in line with the CSA practice promoted by FAO. The technology is available for about S$10 000 to 15 000 for each tower based on the dimensions required. Although the initial set up cost is high, the vertical farming system could boost productivity, use less inputs and raw materials, with very low maintenance costs.

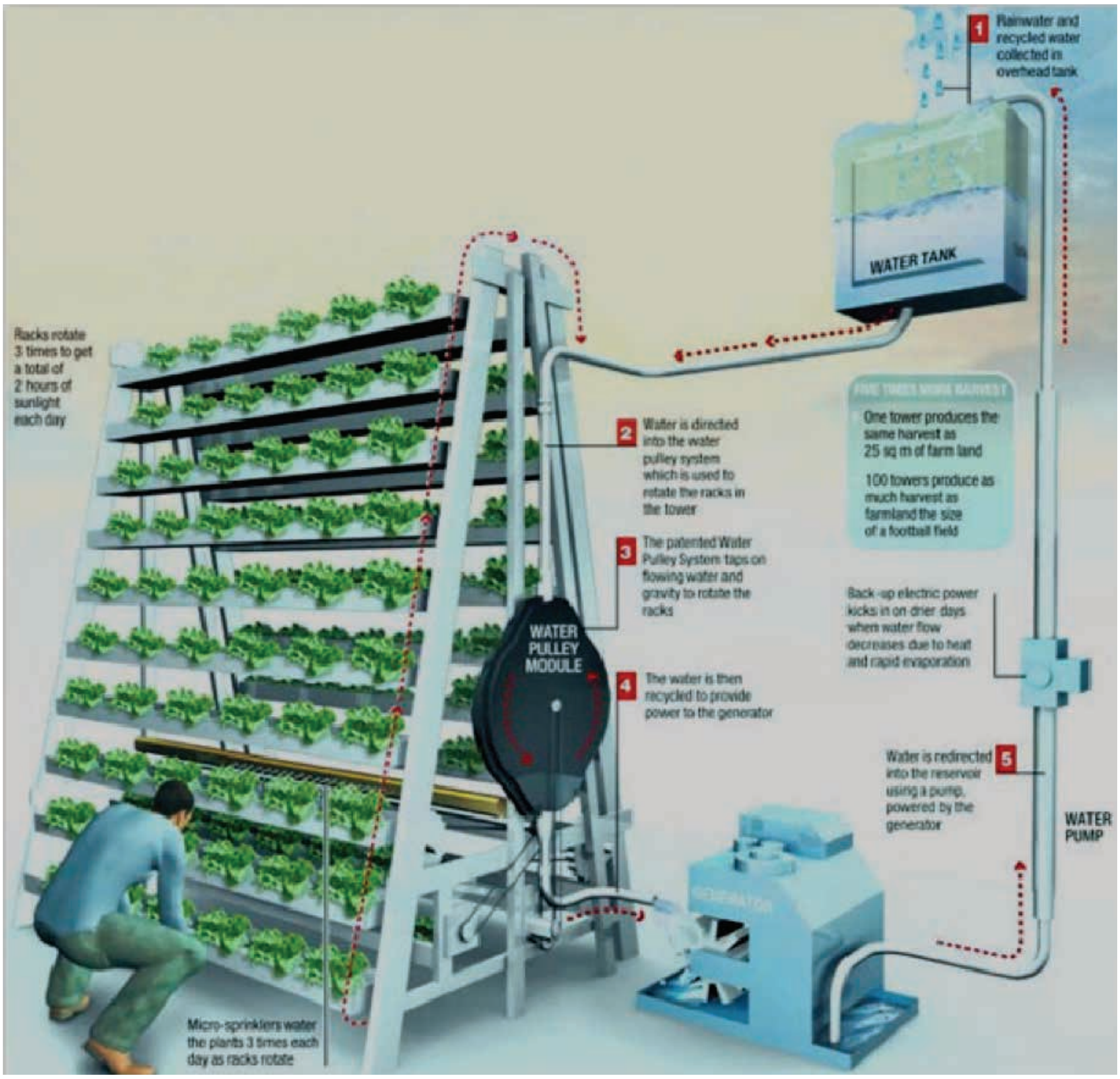

Figure 1. The A-Go-Gro vertical farming technology of Sky Greens (2012)

In this system, the vegetables are grown in A-shaped towers, each of which is 9 metres tall. These modular A-frames are quick to install and easy to maintain. It can also be installed on the rooftop if there is a concrete base, as the system is specifically designed for urban areas. Each tower consists of 38 tiers of growing troughs, which are rotated around the aluminum tower frame at a rate of 1 mm per second to ensure uniform distribution of sunlight, irrigation, nutrients and good air flow for all plants. Each tower is powered by a gravity water wheel (Figure 2). According to Mr Ng, "by using the water wheel to rotate the tower, the plants don't get overstressed under the sun and at the same time they can get nutrients from the water equally."

Figure 2. A-frame shaped tower and water wheel, Sky Greens (2012)

The vertical farming system is installed in a protected environment of polyvinyl chloride (PVC) roofing and netted walls to enable cultivation of vegetables under natural sunlight all year round. All these efficiencies ensure that production costs are kept low. Operational costs include items such as soil, seed and electricity for pumping water. This green technology is designed with the five principles called MAGIC (Figure 3).

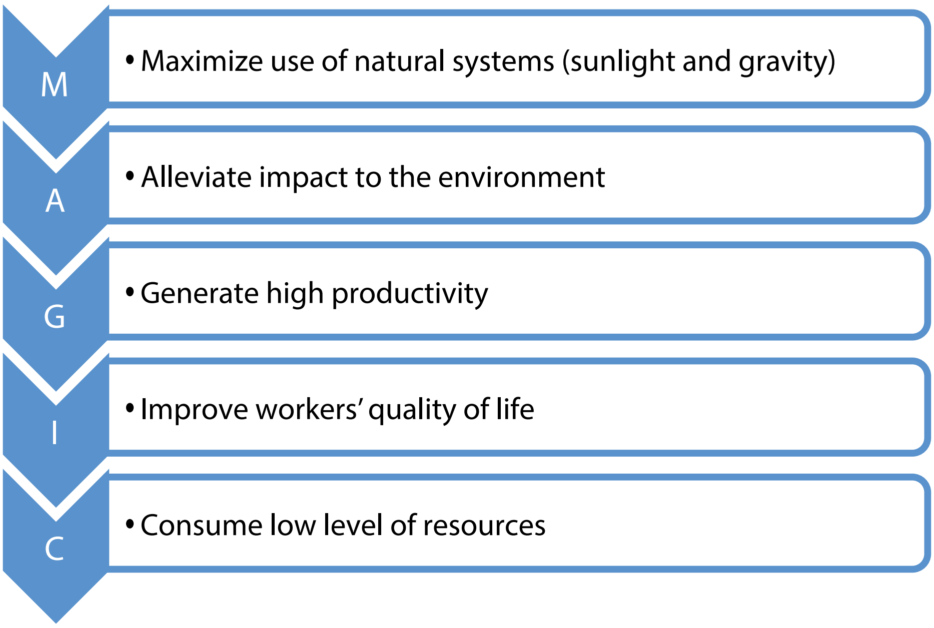

Figure 3. MAGIC principles of Sky Greens

Conditions in the greenhouse are carefully monitored to ensure that weather related events will not impact the production. The temperature in the greenhouses is normally 2ºC lower than the outside temperature (year-round temperature in Singapore is around 30ºC).

Results

The vertical farm covers an area of 3.65 ha (greenhouses space occupies 2.5 ha) located in Lim Chu Kang, Kranji, about 23 km from the city centre. Currently, the farm employs 20 full-time trained workers. Training in-house takes about two to three days, with additional practice in the greenhouses. At the start of operation, the farm had only 120 towers, which could produce up to 500 kg of vegetables per day. However, with 1 800 towers in operation now, the farm produces from 4 to 9 tons of vegetables per day (Figure 4).

Figure 4. Production trays with leafy vegetables

The process of growing leafy vegetables takes a five-week cycle (i.e. 28–30 days after transplanting) in total (Figure 5). This has allowed 11 harvests across a year. This includes four weeks for growing, and one week for harvesting and processing (Figure 6), and transplanting (Figure 7) (i.e., two days for harvesting, one day for soil cleaning and processing, two days break, and two days for transplanting). During the full four weeks of growing period, pest management control is required twice a week inside the greenhouses. Although the soil could be used up to five times for five cycles of production, the yield starts to decrease slightly after three cycles of harvests. After being used for five full cycles, the soil will then be re-processed and appropriate organic matter and nutrients will be added.

Figure 5. Five-week cycle of vegetable production

Figure 6. Workers harvesting and packing the Chinese cabbage

Figure 7. Transplanting activity

Economic analysis of the production

Detailed economic analysis of production per unit (per tower) per month is provided in Table 1 below. According to Sky Greens, the estimated sales per tower are about S$700.00 while the production cost is around S$130.

Table 1. Economic analysis of the production per unit (per tower) (AVA Singapore, pers. comm.)

Production output per tower			**150kg**
Estimated sales per tower			**$700**
	Production cost per tower		
Cost components	Requirement per tower	Cost/Unit	Cost (S$)
Manpower	9 man-hours	$8/man-hour	$72
Media	900 L	$0.015/L	$13.50
Seeds	100 g	$2.50/100 g	$2.50
Fertilisers	3.2 kg	$3/kg	$9.60
Pesticide		$2.60	$2.60
Power / Energy	60 watt daily / tower	$3/month	$3
Packing materials	150 g/bag	$0.03/plastic bag	$20
Maintenance cost		$10	$10
Production cost per tower			**$130.60**
Total estimated profit per tower			**$569.40**

Vertical farming versus traditional farming

A comparison between vertical and traditional farming practices is summarized in Table 2.

Table 2. Comparison between vertical farming and traditional farming

Inputs required	Vertical farming	Traditional farming
Land area and space	Uses only **6 m²** to produce **150 kg** of vegetable per month, which is 10 times higher output compared to average traditional farming	Requires at least **72 m²** to produce **150 kg** per month with intensive care and inputs
	Crop rotation is not required	Requires crop rotation
	Multi-layer system to maximize the use of airspace	Monolayer farming
Water	Uses recycled water (**12 l** to produce **1 kg** of vegetables)	Uses **300–400 l** to produce **1 kg** of vegetables
Energy	Sunlight, and each tower consumes only **60 watt of power daily** to rotate the trough	Sunlight and requires more energy to run the water pump for irrigation
Labour	Uses less than half the labour compared to traditional farming (requires only 9 hours for 5-week cycle) for each tower	Requires higher manpower cost for the whole farming process (at least 12–15 days for a 5-week cycle)
Soil, seed, and nutrients	Consumes **75% less** raw material than traditional farming (nutrients are input into the water with no wastage from water run-off)	Requires more seeds and a large amount of soil and nutrients

When compared with traditional monolayer farms, the vertical farming system could intensify land use and produce higher yields (1 320 tons per ha per year), which is more than ten times that of traditional farming as practiced in Singapore (90 tons per ha per year). According to Mr Ng, this vertical farm practice uses at least ten times less land space than traditional farming (Figure 9). Actually it does not need arable land, each 9-metre tower occupies up to 6 m^2 of space, and can accommodate 2 500 plants (545 plants per square metre) and produce 150 kg of vegetables within a five-week cycle. In comparison, one would need 72 m^2 of land to produce the same amount of vegetables in traditional farming. This is a multiple of 12 times in favour of vertical farms.

The vertical farming system produces high quality vegetables. The structures are installed in a controlled environment which enables a strict control of input materials. It allows high flexibility as the modular structures are made of aluminum and steel which are highly customizable and scalable. The system uses very little water. While traditional farming uses 300 to 400 litres of water to produce 1 kg of vegetable, this system only consumes 12 litres of water to produce the same amount. Each tower uses only 0.5 litres of recycled water to rotate the 1.7 ton vertical structure.

The operational system of the vertical farm requires very low energy use. Sky Greens' vertical farm technology is different from others because the greenhouses are designed in a way that they could receive abundant natural heating and light. Therefore, artificial lighting is not required, which is a major constraint of vertical farms in other regions. In addition, the trough rotation system does not require an electrical generator. The rack is rotated three times a day to ensure that all plants receive adequate sunlight (approximately two hours per day). It is powered by a unique gravity aided water-pulley system. Each tower consumes 60 watt of power daily (equivalent to the same amount of energy consumed by a single light bulb) which is about S$3 per month, with a breakdown cost of S$0.05 for 1 kg of vegetables.

The vertical farming system is installed in a protected environment which ensures that the system can be relatively maintenance-free and has high manpower efficiency. Specifically, for a full five-week cycle of growing, each tower requires only nine hours of manpower. This vertical farming uses less than half the labour compared to traditional farming to produce the same amount of output. The system is therefore considered as low cost and wastage because it uses less energy and water (reduces utilities bills), and organic matter is composted on-site at the farm. Mr Ng also added that his farming practice consumes at least 75 percent less raw material than traditional farming.

The benefits of the vertical farming system are presented in Figure 8.

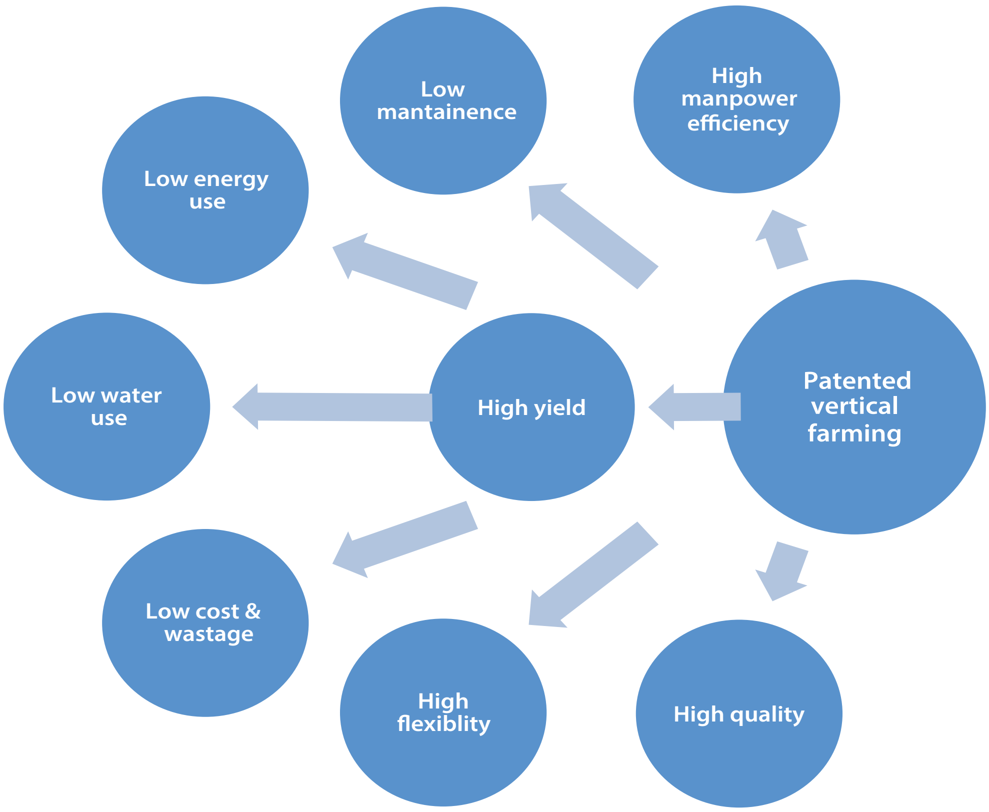

Figure 8. Economic and environmental benefits of the vertical farming system

Currently, the vertical farm produces four types of vegetables: *Bok Choy*, *Nai Bai* (Milk cabbage), *Xiao Bai Cai* (Chinese cabbage), and *Cai Xin* (Choy Sum). All of Sky Greens' produce are exclusively sold to National Trades Union Congress (NTUC) FairPrice Finest supermarkets. Despite costing 20 to 30 percent more than vegetables from other sources, Sky Greens' produce has received a positive response from customers and the demand keeps increasing. There are two main reasons why customers choose to purchase Sky Greens' produce. Firstly, they know clearly where the vegetables are grown. Consumers in Singapore, with Government's campaign, are becoming more conscious about their carbon footprint, and this too has been a positive point for the vertical farm's vegetables.

However, the innovative vertical farm in Singapore is facing pest problems. Mr Ng suggested that, "there is a need to understand the full cycle of pests in order to successfully manage them. This obviously takes time for us to learn. When we face pest problems, sometimes it even requires a short shut down of the system of the infected tower and immediate soil treatment is required". Mr Ng added that the soil condition will remain fertile even if the system is shut for a few days.

"Our vegetables are harvested every day and delivered almost immediately to retail outlets. Although it costs about 20 to 30 percent more than the imported vegetables, they are in great demand by customers because our produce is safe, fresh and coming from a reliable farm that they trust. And most importantly our produce is delicious."

– Mr. Jack Ng.

Figure 9. Mr Jack Ng, CEO of Sky Greens

Implications for food security

Urban farming such as a vertical farm could contribute significantly to national economic development and food and energy security. The system is designed in an enclosed and protected environment that is not subject to the impact of changing weather and could provide outputs all year-round. This has made vertical farming become much more efficient than traditional farming. For example, the A-Go-Gro technology has already begun to make a small step towards reducing Singapore's dependence on food imports. At present, the vertical farm produces 4 percent of locally grown vegetables in the country. It has worked to reduce manpower cost by undertaking the harvesting and packing at the same time. Compared to traditional farming practice which uses fossil fuel inputs to plant, harvest, pack and transport their produce, the savings from the vertical farm is quite high (Table 1). Despite the high initial set up cost, the vertical farm's annual output per hectare is 1 320 tons, and at a cost of only a quarter of that to run a conventional farm in Singapore. The vertical farming system could provide livelihoods not only for urban farmers, but also retirees and housewives as the system requires only a few hours up on the roof to operate and attend. This technology-based system can even attract the younger generation who are currently shifting away to non-agricultural employment sectors.

Implications for ecosystem enhancement

The patented vertical farming system in operation in Singapore can be considered a "climate-smart" solution for sustainable food production. It adopts green technologies to achieve the 3Rs (reduce, reuse and recycle). The system only requires a small amount of energy, and therefore, boasts a very low carbon footprint. The water powering the tower is recycled and filtered before returning to the plants. This study confirmed that the system could save up to 95 percent of water (12 l/kg of vegetables) compared to traditional farming (300–400 l/kg of vegetables). This is an important factor with droughts becoming more frequent and demand for water for farming is increasing. The vertical farms have reduced the use of industrial fertilizers and chemical pesticides as well. The organic waste in the farm is composted and reused.

In addition, the shorter farm to market distribution makes it much more environmentally friendly compared to imported produce. For example, it takes only six hours from the farm to the supermarket. If the vegetables are imported from Malaysia, it may take up to 16 to 18 hours, or even days from elsewhere. The local produce is, therefore, contributing significantly to reduce food miles, transportation costs, GHG emissions and risk of spoilage. Most importantly, what is unique about the vertical farming is that it offers a win-win option to maximize the land use in urban areas – even land unsuited for agriculture can house a vertical farm.

Conclusions

This case study clearly reinforces the view that vertical farming system can effectively raise food production and can be an effective contributor for addressing food security issues, particularly in urban areas with high population density and associated land pressures. The vertical farm, exemplified by Singapore, not only demonstrates its viability for enhancing food production, but this practice helps in adding the "what works" to the paradigm of

CSA. The green technology-based vertical farming system boosts productivity, while requiring much less of the natural resource inputs (water, land, energy) and labour, and GHG emission reduction is achieved through reducing food miles and the use of industrial fertilizers and chemical pesticides. The data have not been clearly accessed, but the vertical farm, as operated in Singapore, is a major step forward in terms of reducing GHG emissions, and thereby reducing a nation's carbon footprint. It is in step with many of the principles advocated through the CSA approach. This case study shows that there is clear efficiency, resiliency and environmental benefits of vertical farming over traditional "land-based" farming in land scare urban areas.

Besides climate change, agriculture also has to contend with declining arable land and water resources, and this is not an issue only in urban centres. In fact, the time has come to investigate how vertical farming can also provide additional solutions for the continued decline in our natural resource base that is particularly affecting the agriculture sector. In this context vertical farming and related approaches can even be considered as alternatives to conventional farming where natural resources for supporting agriculture are on the decline.

Recognizing the benefits of vertical farming, the Government of Singapore is committed to boosting food security and food safety in the country by using this CSA practice in their urban environment. The vertical farming system could be adopted and replicated in urban areas of other countries in the region to ensure responsible and sustainable food production. However, it requires a high initial capital input, obviously a deterrent for poor urban communities.

The future capacity and ability to deliver agricultural outputs is strongly dependent on healthy ecosystems. Therefore, there is a need for policy support from governments in the region to foster this environmentally responsible food production system that could meet the growing population in urban areas. Further experiments are needed to see if vertical farms can also grow other vegetables, such as tomatoes, beans, carrots and cucumbers. Additional research is also needed for a more effective pest control and management technique.

With the growing challenge from climate change, every option possible for achieving resiliency in agriculture and food security is a major step forward. Vertical farming, while still in its infancy, holds a great potential for achieving food security without high GHG emissions. While we may debate that vertical farming, particularly the intensive and high-technology based systems may not be affordable for many countries in the region, with economy of scale, further improvements to the technology, and adoption of cheaper components, this may change, and variations of the vertical farming systems may dot the landscape where traditional farming once stood. What may have started as a solution to agriculture in land-scarce urban areas, may even eventually be a part of our solution for feeding the world without the deleterious impacts on climate and depletion of natural resources.

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Annex 11

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Regional Asia-Pacific Workshop on Climate-Smart Agriculture: A call for action

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