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Measuring the contribution of small-scale aquaculture

An assessment




Cover photographs:
Left top to bottom: Feeding grass carp pond (Viet Nam); small-scale seaweed culture (Philippines).
Right top to bottom: Tilapia seed nursery (Malawi); small-scale oyster culture (Philippines).
All photos courtesy of Dr Melba B. Reantaso (FAO).

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An assessment

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Preparation of this document

The Aquaculture Management and Conservation Service (FIMA), Fisheries and Aquaculture Management Division (FIM) of the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO), is implementing a project entitled "Methods and indicators for the appraisal and evaluation of the contribution small-scale aquaculture to sustainable rural development". The project, which commenced in 2008, is being carried out through a combination of commissioned thematic papers, two expert workshops and the implementation of pilot case studies.

As part of the project implementation, the "FAO Expert Workshop on Methods and Indicators for Evaluating the Contribution of Small-scale Aquaculture to Sustainable Rural Development" was held in Nha Trang, Viet Nam, from 24 to 28 November 2008.

The commissioned review papers and expert workshop were technically supervised by Dr Melba B. Reantaso, Fishery Resources Officer (Aquaculture) of FIMA.

The study and expert workshop were made possible with financial support through the FAO Multi-Partnership Programme (FMPP) under B.1 Objective administered through the FishCode Programme of the FAO Fisheries and Aquaculture Department.

Abstract

The contribution of small-scale aquaculture (SSA) to sustainable rural development (SRD) include, for example, securing food, efficient use of water, farm materials and other resources, creating wealth, diversifying livelihoods, generating rural employment and income, utilizing family labour, fostering social harmony and empowering women. While recognized as such, there has not been a systematic assessment which clearly measures its contribution.

An "FAO Expert Workshop on Methods and Indicators for Evaluating the Contribution of Small-Scale Aquaculture to Sustainable Rural Development", held in Nha Trang, Viet Nam from 24 to 28 November 2008, attempted to develop an indicator system which can measure the contribution of SSA to SRD. Indicators are measures, used for different purposes, to help understand issues or conditions, to know how well a system is working and to determine what direction or solutions may be taken to address an issue or a problem before it gets too bad. While indicators are as varied as the systems they try to monitor, there are certain characteristics that effective indicators have in common, e.g. relevance, ease of understanding, reliability and data accessibility.

The expert workshop used a number of processes and series of steps in the development of the indicator system. These included the following: (i) understanding the subject of measurement, (ii) identifying an analytical framework and setting criteria, (iii) developing a list of SSA contributions, (iv) categorizing the contributions based on analytical framework and agreed criteria, (v) devising and organizing the indicators of contribution, and (vi) measuring the indicators. The major outcome was the development, through an iterative process, of an indicator system which was thought to provide a good measure of the contribution of SSA using an analytical framework (i.e. the Sustainable Livelihood Approach or SLA) and agreed criteria (accuracy, measurability and efficiency or AME). Using the SLA and AME criteria, the experts narrowed down to some 20 (from a freelisting of some 50), indicators which were deemed appropriate to assess the contribution of SSA to SRD. The SLA was selected as an appropriate analytical framework as it reflects the primary objective of an SSA system which is to balance the use and/or build up of the five livelihood capitals or assets (natural, physical, human, financial and social).

The experts agreed by consensus that the 20 potential indicators include: (1) flows/enterprises, (2) off-farm nutrient use/farm products (input/output ratio), (3) enterprises' contribution to cash income, (4) productive use of pond water, (5) return to land capital and labour; trends in physical asset used for SSA, (6) income from SSA and derived from SSA, (7) SSA contribution to Gross Domestic Product (GDP), (8) farmers who are members of active farmer associations or community organizations, (9) household consumption of fish, (10) seasonal distribution of fish consumption, (11) women access to resources and benefits of SSA, (12) women engaged willingly and as active decision-makers in SSA (including post-harvesting), (13) batch testing for banned chemicals or poor quality aquatic products aquatic, (14) farmers adopting Better Management Practices (BMPs), (15) farmers involved in traceability system, (16) export earnings, (17) employment generation, (18) disease, (19) vulnerability, and (20) resource use conflicts.

This publication contains two parts: Part 1 contains the report of the above expert workshop; Part 2 contains 10 technical papers presented during the expert workshop and an additional paper which provides a detailed account of the processes undertaken in the development of an indicator system to measure the contribution of SSA to SRD.

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Acronyms and abbreviations

ADB	Asian Development Bank
AESA	Agro-ecosystem analysis
ACF	Aquaculture carbon footprint
AFP	Aquaculture footprint
AHP	Analytical Hierarchy Process
AIT	Asian Institute of Technology
AME	accurate, measurable, efficient
ASEAN	Association of Southeast Asian Nations
BRFDs	Bioresource flow diagrams
BOD_5	Biological oxygen demand
CAARP	Community Agriculture and Aquaculture Resource Persons
CARE	Cooperative for Assistance and Relief Everywhere
CBA	Cost-Benefit Analysis
CBOs	Community-based Organizations
CO_2	Carbon dioxide
COLA	Cost of living allowance
CSD	The UN Commission on Sustainable Development
CV	Coefficient of variation
DFID	Department for International Development of the United Kingdom
DO	Dissolved oxygen
EAA	Ecosystem Approach to Aquaculture
eFCR	Economic Feed Conversion Ratio
FAO	Food and Agriculture Organization of the United Nations
FFA	Farmer field school
FFER	Fish Feed Equivalence Ratio
FIMA	Aquaculture Management and Conservation Service
FMA	Farm management analysis
GDP	Gross domestic product
GIS	Geographic information system
GMO	Genetically modified organism
GNAEP	Greater Noakhali Aquaculture Extension Project
HDI	UN Human Development Index
IAA	Integrated agriculture-aquaculture
IAASP	Integrated Aquaculture-Agriculture Systems Program
ICLARM	International Center for Living Aquatic Resources Management
IIRR	International Institute of Rural Reconstruction
IoE	Intensity of explotation
IRR	Internal rates of return
ISEAL	International Social and Environmental Accreditation and Labeling
JPOI	Johannesburg Plan of Implementation
KAP	Knowledge Attitude Practice
MA	Millenium Assesment
MBN	Minimum Basic Need
MCDM	Multi-Criteria Decision-making

MDGs	Millennium Development Goals
MDGIs	Millennium Development Goal Indicators
MEA	Millenium Ecosystem Assesment
MFA	Material Flow Accounts
NACA	Network of Aquaculture Centres in Asia and the Pacific
NAMEA	National Accounting Matrix including Environmental Accounts
NEDA	National Economic Development Authority
NPVs	net present values
NRTs	natural resource types
NTU	Nha Trang University
ODA	Official Development Assistance
OXFAM	Oxfam International
PAD	Pangasius Aquaculture Dialogue
PI	Profitability index
PIPs	Processes, institutions and policies
PME	Participatory monitoring and evaluation
POPDEV	Population and Development Indicators
PRA	Participatory rural appraisal
PSR	Pressure state response
RESTORE	Research Tool for Natural Resource Management, Monitoring and Evaluation
RFLDC	Regional Fisheries and Livestock Development Project, Noakhali Component
RRA	Rapid rural appraisal
SAPA	Sustainable Aquaculture for Poverty Alleviation
SD	Sustainable development
SDI	Sustainable development indicator
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SES	Special Evaluation Study
SESAM-UPLB	School of Environmental Science and Management University of the Philippines Los Baños
SIEEA	System of Integrated Environmental and Economic Accounting
SL	Sustainable livelihoods
SSA	Small-scale aquaculture
SLA	Sustainable livelihoods approach
SMART	specific, measurable, accurate, repeatable, timely
SRL	Sustainable rural livelihoods
TMR	Total materials requirements
TN	Total nitrogen
TP	Total phosphorus
TWG	Technical Working Groups
UK	United Kingdom
UNDP	United Nations Development Programme
UPLB	University of the Philippines at Los Baños
VAC	Vuon, ao, chuong (in Vietnamese which means garden/pond/livestock pen)
WCED	World Commission on Environment and Development
WFC	WorldFish Center
WWF	World Wide Fund for Nature/ World Wildlife Fund
ZOMAP	Lake zone map

PART 1

Report of the FAO Expert Workshop on Methods and Indicators for Evaluating the Contribution of Small–scale Aquaculture to Sustainable Rural Development

24–28 November 2008

Nha Trang, Viet Nam

Report of the FAO expert workshop on methods and indicators for evaluating the contribution of small–scale aquaculture to sustainable rural development

24-28 November 2008, Nha Trang, Viet Nam

BACKGROUND

The contribution of small-scale aquaculture (SSA) to global aquaculture production as well as rural livelihood development is generally recognized.[1] These include providing livelihoods and income generating opportunities for rural communities, enhancing food security, improving social equity and enhancing the quality of life of rural poor communities.

In the past, a number of projects/studies[2] attempted to assess and review the current status of small-scale (or rural) aquaculture at the country level as well as the various issues (potential, limitations, constraints) affecting the sector. In addition, some methods/frameworks (e.g. rapid rural appraisal, participatory rural appraisal, impact assessment, etc.)[3] for assessing the impact of small-scale rural aquaculture projects on poverty alleviation and food security, useful tools for sectoral planning and development, have been presented.

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[1] FAO. 2002. "The role of aquaculture in rural development". Working Paper No. COFI:AQ/1/2002/3 prepared for the First Session of the Sub-Committee on Aquaculture, Beijing, China, 18-22 April 2002; IBRD/WB. 2007. Changing the face of the waters: The promise and challenge of sustainable aquaculture. The World Bank Agriculture and Rural Development Conference Edition. Washington, D.C. 163 pp.

[2] Edwards, P. and Demaine, H. 1997. Rural aquaculture: overview and framework for country reviews. RAP Publications 1999/36. Regional Office for Asia and the Pacific. FAO, Bangkok, Thailand. 61 pp.; Edwards, P., Little, D.C. and Demaine, H. (eds.). 2002. Rural aquaculture. UK: CABI Publishing. 358 p.; Halwart, M., Kuman, D. and Bondad-Reantaso M.G. (comps). 2005. Papers presented at the FAO/NACA Consultation on Aquaculture for Sustainable Rural Development, Chiang Rai, Thailand. 29-31 March 1999. FAO Fisheries Report No. 611. Rome. FAO. 282 p.; Arthur, J.R., Phillips, M.J., Subasinghe, R.P., Bondad-Reantaso M.G. and MacRae, I.H. (eds.). Primary aquatic animal health care in rural, small-scale aquaculture development. Technical proceedings of the Asia Regional Socping Workshop. Dhaka, Bangladesh, 27-30 September 1999. FAO Fisheries Technical Paper No. 406. Rome, FAO. 2002. 382 p.; IBRD/WB. 2007. Changing the face of the waters: The promise and challenge of sustainable aquaculture. The World Bank Agriculture and Rural Development Conference Edition. Washington, D.C. 163p.; Bondad-Reantaso M.G. (ed.). 2007. Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Paper No. 501. Rome, FAO. 628 p.

[3] Townsley, P. 1996. Rapid rural appraisal, participatory rural appraisal and aquaculture. FAO Fisheries Technical Paper. No. 358. Rome, FAO. 109 pp.; Gupta, M.V. and Dey, M.M. 1999. A framework for assessing the impact of small-scale rural aquaculture projects on poverty alleviation and food security. FAO Aquaculture Newsletter (23): 22-25.

However, there has not been a systematic assessment of how much and how small-scale aquaculture is contributing to aquaculture and rural livelihood development. Assessment indicators will help measure the sector performance and will assist local, regional and national policy-makers to account for the level of performance of the sector (good or poor), understand the risks and the threats and thereby assist in determining appropriate interventions (e.g. highlighting the positive aspects, preventing or mitigating the negative aspects), and aid in setting priorities and allocating resources.

This project on Methods and Indicators for the Appraisal and Evaluation of the Contribution of Small-scale Aquaculture to Sustainable Rural Development is being carried out by the Aquaculture Management and Conservation Service (FIMA) of the Department of Fisheries and Aquaculture of the Food and Agriculture Organization of the United Nations (FAO) through a combination of commissioned thematic review papers, expert workshops and implementation of case studies.

The FAO Expert Workshop on Method and Indicators for Assessing the Contribution of Small-scale Aquaculture to Sustainable Rural Development was held from 24 to 28 November 2008 and hosted by the Nha Trang University. The outcomes of the expert workshop are highlighted in this report.

OPENING OF THE WORKSHOP

The workshop, moderated by Dr Huu Dung Nguyen of Nha Trang University (NTU), was officially opened by Prof. Mr Hoang Hoa Hong, Vice-Rector of the university. He appreciated FAO for the opportunity that it offered to the university to collaborate in the organization of the workshop. He said that the recent progress in Viet Nam aquaculture development, including the measures that it had taken to address the sustainability problems associated with its rather rapid growth, might be able to provide the expert meeting some instructive examples for its deliberations and recommendations.

Dr Melba G. Bondad-Reantaso, Fishery Resources Officer (Aquaculture), FIMA, welcomed the participants on behalf of FAO. She conveyed the appreciation of FAO's Department of Fisheries and Aquaculture to the Government of Viet Nam and the Nha Trang University for hosting the workshop and to the participants for their time and contributions. She briefly described the background and explained the purpose of the workshop.

The participating experts provided a short self-introduction of their current affiliations, responsibilities and interest in the subject of the workshop.

PURPOSE OF THE WORKSHOP

The aim of the expert workshop was three-fold: (i) to better understand small-scale aquaculture (SSA) and their contribution to rural development; (ii) develop a list of indicators and a procedure to measure the contributions; and (iii) develop the steps that will test the validity and the suitability of indicators through case study concepts.

The expert workshop agenda is attached as Appendix 1.

WORKSHOP PARTICIPATION

The workshop was provided technical guidance by a Project Team consisting of three FAO professional staff members. A total of twenty experts whose fields of expertise or disciplinary specializations include aquaculture, aquatic animal health, ecology, sociology, human geography, law, economics and information participated in the expert workshop. The list of participants and expert profile are presented as Appendixes 2 and 3, respectively.

WORKSHOP PROCESS

The workshop was divided into three sessions, namely: Session 1 – Setting the scene; Session 2 – Preparation of an indicator system for measuring the contribution of SSAs; and Session 3 – Preparation of case study concepts. Each session, with an elected Chaiperson and Rapporteur, had a specific objective and expected outcomes. Each session was followed by working group break-out sessions (with same or multiple tasks) and a presentation. A plenary concluding session presented the achievements and conclusions of the workshop and the way forward.

WORKSHOP HIGHLIGHTS

Technical sessions

Session 1

Eleven papers (commissioned and contributed papers) were presented in plenary to achieve the objective of Session 1 of setting the scene in order to have a broader understanding of the general concepts and principles of sustainability, indicators and sustainable development indicators (SDI), SSA and sustainable livelihoods (SL) and broad considerations concerning the application of sustainability indicators to SSA (general principles, context, terminologies, and scale of operation).

Dr Victoria Espaldon, in her presentation on "Key concepts and principles in developing indicators for sustainable rural development" (i) reviewed the following concepts: sustainable development and how they have developed; sustainable development indicators (SDI), system and trends, how they are approached in theory and practice; (ii) reflected on the various SDI systems; and (iii) offered a set of options for developing an SDI system for sustainable rural development (SRD). She concluded her presentation with an emphasis on the definition of sustainable development according to the Brundt Report which sought to address the twin concerns of development and environment. SDI is part and parcel of ensuring the right path of sustainability which is anchored on three pillars of sustainable development, i.e. economic, social and environmental – three pillars which cannot be separated and must be taken as a whole.

Dr Harvey Demaine, in his presentation on "Rural aquaculture: reflections ten years on" reviewed the experience which led to views expressed in a previous FAO monograph on rural aquaculture ten years on. The presentation revisited the definition of rural aquaculture and classifications of SSA set against those outlined in the monograph. Experiences from two projects, the Aqua Outreach Programmme of the Asian Institute of Technology in mainland Southeast Asia and the Greater Noakhali Aquaculture Extension Project and its successor, the Regional Fisheries and Livestock Development Project in Bangladesh – illustrated the nature of the farming systems approach advocated in the FAO monograph at two levels: the farm system and the wider regional support system. The presentation was concluded with a brief discussion of the implications for methods and indicators for assessing the contribution of rural aquaculture in SRD, stressing the importance of measuring human and institutional capacity.

Dr Premachandra Wattage, in his presentation on "MDGs and aquaculture: indicators to evaluate the conservation of resource base for poverty reduction" emphasized the role of environmental sustainability as the foundation on which strategies for achieving all Millenium Development Goals (MDGs). Environmental degradation is causally linked to problems of poverty, hunger, gender inequality and health. Therefore, protecting and managing the natural resource base that supports aquaculture is essential for economic and social development in rural Asia. As well, integrating the principles and practices of environmental sustainability into country policies and planning programmes are key to successful poverty reduction strategies. The presentation provided some suggestions on methods and approaches (e.g. benefit assessment methods) to identify and quantify the environmental and socio-economic values of aquaculture measurements which could be used to develop indices for evaluating performance.

Dr Curtis Jolly, in his presentation on "Small-scale aquaculture: a fantasy or economic opportunity", presented doubts and questions concerning the contribution of SSA to economic development despite its obvious contribution to local protein consumption in developing countries. He reported that attempts to measure societal and economic values of SSA have mixed results. Uncertainties have been raised concerning the actual contribution and the measures used. He emphasized the need for the use of more holistic approach using participatory methods and that measures of economic, social and environmental evaluation, while considered useful, are not universal. He used a specific example (smoked catfish in the United States of America) to demonstrate that measures are appropriate when examined in a dynamic setting.

Drs Susana Siar and Percy Sajise in their presentation on "Access rights for sustainable small-scale aquaculture and rural development" examined the resources under different property regimes (communal, private, state-property, open access) that SSA use. Close scrunity of access rights to resources and assets will help analyse what is needed to support their sustainability. The Sustainable Livelihoods (SL) framework is a useful tool which provides an understanding as to why and how small-scale aquaculturists do what they do to generate income, create livelihoods for food security and improve their well-being. The presentation was concluded with a statement that following the SL and rural sustainability frameworks, access to the resource base is a necessary condition to enhance sustainability; however, it is not a sufficient condition by itself.

Dr Le Xuan Sinh, in his presentation on "Social impacts of coastal aquaculture in the Mekong Delta" presented the important positive impacts of coastal aquaculture in terms of improving household income which lead to better opportunities for education, health care and entertainment to communities, improvement in the status of women and children and decrease in conflicts at both family and community levels. However, the sector also faces a number of risks due to many factors such as low profits and other social impacts. The presentation provided perspective on how improving and strengthening linkages among relevant stakeholders through appropriate planning and organization at village and district levels in association with availability and suitability of investment and support from both public and private sectors can be used for long-term development of coastal aquaculture in the Mekong Delta.

Dr Mark Prein, in his presentation on "Assessment of aquaculture adoption by smallholder farms using sustainability indicators", presented the rationale for, and the mechanics within, an approach to introducing integrated agriculture-aquaculture (IAA) for smallholder farm development and for measuring the impact on whole farms using a standardized tool package that was first developed at ICLARM (now the WorldFish Center) since the early 1990s termed RESTORE. A systems approach is used, going far beyond the simple unidirectional link, e.g. from livestock manure to a fish pond. It is a participatory process involving the entire smallholder farming system with its natural resources, probing farmers about opportunities for diversification of enterprises and subsequently about possible integration linkages involving recycling flows suitable to their context, both on-farm and between-farms. It is hypothesized that integrated smallholder farming systems which have an aquaculture component and reuse unused waste materials are more sustainable than less-integrated or monoculture-dominated ones. With the research tool, the farm household is accompanied over several years and whole-farm data is collected and analysed, producing economic and biological performance metrics and a set of sustainability indicators, for interannual and between-farm comparisons. The impact assessment tool has been applied in numerous countries in Asia, Africa and Latin America, and over a range of farming systems and farmer livelihoods contexts, from which experiences were presented.

Mr Alvin Morales, in his presentation on "Special evaluation study of small-scale freshwater aquaculture development for poverty reduction", reported on the outcomes and recommendations of a special evaluation study (SES) conducted by the Asian Develpment Bank (ADB) based on case studies in Bangladesh, the Philippines and Thailand as well as lessons and experiences drawn from evaluation of ADB-financed operations in freshwater aquaculture development. The SES recognized the importance of access to capital assets in five dimensions (human, social, natural, physical and financial capitals), and key transforming processes, including (i) markets; (ii) public and private institutions; (iii) facilities, infrastructure and services; (iv) legal framework and development policies; (v) aquatic resources management and the environment; and (vi) various safeguards, including biosafety and aquatic health. The SES also recognized seasonality, shocks and trends that influence outcomes.

Dr Nathanael Hishamunda, in his presentation on "Summary of the FAO Expert Consultation on Socio-economic Impacts of Aquaculture: Identification and Assessment Methods" highlighted the major outcomes of this expert consultation held from 4 to 8 February 2008 in Ankara, Turkey. The positive and negative impacts of aquaculture include those on land and land-based habitats, water and wild species, the downstream and upstream industries of aquaculture, infrastructure, incomes, employment, food supply, food quality and safety, food access, food stability, human health, education and training, population and demography, and community and social order. The consultation emphasized that these impacts have profound interdependence and socio-economic implications which make the task of assessing them challenging. The consultation identified a number of potentially useful measurement techniques such as Multi-Criteria Decision-making (MCDM), Analytical Hierarchy Process (AHP), Cost-Benefit Analysis (CBA).

Dr Victoria Espaldon, in her presentation on ''Theory and practice of sustainable livelihood development" provided a historical account of the origins of the concept of SL from community development theories to ecosystem approach. The livelihood approach framework was fully elaborated in terms of principles, features and characteristics. A very important consideration of the SL approach is the vulnerability context, e.g. shocks, trends and seasonality which are beyond the control of households, and which are influenced by the transforming structures and processes. The presentation provided examples of application to recent approaches to SRD especially in the agriculture and forestry sectors as well as recent endeavours of converging these concepts with natural resources management. Examples from national and local programmes for rural development were provided.

Although not included in the original agenda, Dr Flavio Corsin made a brief presentation on "Indicators and standards for responsible aquaculture production", which described the processes involved in roundtable discussions called Aquaculture Dialogues, used by the World Wide Fund for Nature as a way of involving the various aquaculture stakeholders such as farmers, retailers, non-governmental organizations, scientists and others in developing indicators and standards for responsible aquaculture.

Following the above technical presentations, the experts were divided into two working groups which tackled terminologies and general principles concerning sustainability, indicators and SSA. The outcomes of Session 1 are described in detail in the following sections.

Session 2

Mr Pedro Bueno, in his presentation on "Indicators of sustainable small-scale aquaculture development" proposed and described indicators of a sustainable SSA farm system under the three broad goals of economic viability, social responsibility and environmental sustainability and linked with the fundamental goals of a farmer, which are higher yields, lower cost, better economic returns and less risk. The sustainable livelihoods approach (SLA) framework was used as the basis for developing the sustainability indicators for small farms. A list of possible measurement and data sources for each proposed indicator was provided. The presentation emphasized that sustainability indicators provide a holistic view and understanding of the sustainability of an entity such as a farm, a farming community or a commodity industry sector and therefore can guide an integrated approach to problem solving and aid a holistic policy and development planning approach focused on SSA.

The above commissioned paper, complemented by other background papers and, informed by the wide range of disciplinary specializations of experts, became the basis for deliberation during Session 2 whose objective was to draw a list of indicators to assess the contribution of SSA to SRD. As in Session 1 experts were divided into two working groups to develop the indicator system that will measure the contribution of SSA to SRD. The outcomes of Session 2 deliberations are presented in the section below.

Working group sessions

Session 1

Session 1 whose objective was to set the scene of the workshop, used 11 presentations which prepared the participants for sessions 2 and 3. Session 1 reviewed key concepts, principles and definitions pertaining to sustainability, indicators, sustainable development indicators, sustainable livelihoods, poverty and resilience.

A major outcome was characterization of the various features (through examples of positive contribution and negative impacts) of SSA and an agreed working definition based on scope, scale (typology), objectives and characteristics, as follows:

Small-scale aquaculture (SSA) is a continuum of:

1) *systems involving limited investment in assets, some small investment in operational costs, including largely family labour and in which aquaculture is just one of several enterprises (known in earlier classifications as Type 1 or rural aquaculture); and*
2) *systems in which aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labour, infrastructure and capital (this was labeled as Type II SSA system).*

Session 1 also deliberated on a number of terminologies and some considerations in their definitions and developed some guiding principles for sustainable aquaculture development as relevant to SSA in terms of goals, context, sustainability and measure of success.

Session 2

The main outcome of Session 2 was the development of an indicator system that will measure the contribution of SSA to SRD. The process and the series of steps used in the development of the indicator system was an important achievement of the workshop. These steps include: (1) understanding the subject of measurement; (2) identifying an analytical framework; (3) developing a list of contributions of SSAs; (4) categorizing the contrubutions; (5) devising the indicators of contribution; and (6) measuring the indicators.

The sustainable livelihood approach (SLA) was selected as the apppropiate analytical framework that can guide the development of the indicator system. The SLA reflects the primary objective of an SSA system which is to balance the use and/or build up of the five livelihood assets (natural, physical, human, financial and social) so that the system continues to enjoy the flow of services and benefits from these assets. Only if it is sustainable itself can SSA contribute to sustainable aquaculture and rural development.

The SLA model enables a clear classification of the elements of a farming system that should be measured. It also shows the linkages and interactions of these elements and how these interactions could make or break the sustainability of the system. This holistic perspective that it gives is useful to development planning; it enables systematic rather than piecemeal problem diagnosis and therefore also a systematic devleopment of a solution.

Using the SLA framework and the modified SMART (specific, measurable, attainable, relevant and timely) criteria using only accurate, measurable and efficient (AME), the experts narrowed down to some 20, from a freelisting of some 50, indicators which were deemed appropriate to assess the contribution of SSA to sustainable rural development.

The experts agreed by consensus that the 20 potential indicators include: (1) flows/enterprises; (2) off-farm nutrient use/farm products (input/output ratio); (3) enterprises' contribution to cash income; (4) productive use of pond water; (5) return to land capital and labour; trends in physical asset used for SSA; (6) income from SSA and derived from SSA; (7) SSA contribution to GDP; (8) farmers who are members of active farmer associations or community organizations, (9) household consumption of fish; (10) seasonal distribution of fish consumption; (11) women access to resources and benefits of SSA; (12) women engaged willingly and as active decision-makers in SSA (including post-harvesting); (13) batch testing for banned chemicals or poor quality aquatic products aquatic; (14) farmers adopting Better Management Practices (BMPs); (15) farmers involved in traceability system; (16) export earnings; (17) employment generation; (18) disease; (19) vulnerability; and (20) resource use conflicts.

The experts recommended that the indicator list be further developed after the workshop and elaborated to include a detailed description as well as information on its importance and relation to sustainability, what it measures and how it can be measured based on workshop discussions (see Bondad-Reantaso *et al*., 2009, this volume).

Session 3

The outputs from Session 3 include: (i) development of generic survey design table of contents to include background, objectives, methodology, results, analysis, conclusions, recommendations on the adoption of indicators and future work; and (ii) approaches and criteria to identify and select the SSA systems and the possible sites for the pilot tests.

Through intensive working group discussions, the workshop came up with a short list of potential SSAs which may be considered for pilot testing of the indicators. These include the following:

Philippines
- tilapia cage culture
- seaweed culture

Thailand
- *Clarias* sp. pond culture
- Mixed finfish species culture in trench (orchards and gardens)

Indonesia
- shrimp culture in ponds

Bangladesh
- rice-freshwater prawn-carps, vegetables
- rice-fish rotational systems in seasonally flooded rice fields

Viet Nam
- lobster cage culture
- marine finfish and penaeid shrimp integrated farming
- pond/orchard ditch; rice-fish/shrimp
- small scale pond (shrimp and others)
- mud-flat culture of mollusc
- *Pangasius* sp. culture

WORKSHOP OUTCOMES

The detailed outcomes of the workshop will be presented in the FAO Fisheries and Aquaculture Technical Paper No. 534, which will contain the following: (i) Workshop report (this document); (ii) 10 technical papers (commissioned and contributed papers presented during the workshop) and an additional paper which provides a detailed account of the processes undertaken in the development of an indicator system to measure the contribution of SSA to SRD.

CONCLUSION AND THE WAY FORWARD

The final plenary session summarized the achievements (Table 1) of the workshop and recommended measures (Table 2) to carry forward the initiative, as follows:

TABLE 1
Summary of outputs

Session	Objectives	Outcomes
1	Setting the scene	• Considerations of terminologies • Definition of small scale aquaculture (SSA) • General principles for developing small-scale aquaculture in the context of sustainable rural development (SRD)
2	Indicator system to measure contribution of SSA to sustainable rural development	• Framework for measuring the contribution of SSA to sustainable rural development with the sustainable livelihood approach (asset pentagon) as the analytical framework and the 3 pillars of sustainable development, namely, economic, social and environmental, as the overarching objectives. • An initial free listing of over 50 indicators • Criteria for evaluating good indicators with the revised SMART criteria (AME - Accuracy, Measurability, Efficiency) • Shortlisting of indicators to 20; with 15 receiving consensus and 5 under consideration.
3	Country case study concepts	• Broad outline and a generic guideline for the pilot study (Session 3 Group 1) • Detailed information for a pilot study in Viet Nam (Session 3 Group 2)

TABLE 2

Recommended measures to follow up the expert consultation with provisional schedule and designated focal points of responsibility for specific actions

Activity	Target time-frame	Responsibility
General Survey Questionnaires (general guiding questions pertaining to the indicators to be tested; specific example of more detailed questions based on Thailand case study)	Third week of January 2009 (for circulation)	FAO with inputs from participants
Finalize survey questionnaires and methods for selected countries agreed by commissioned authors through e-mail correspondence	Mid-February 2009	FAO and commissioned authors
Workshop Report	End of 2009	FIMA
Fisheries and Aquaculture Technical Paper 11 papers	End of 2009	Secretariat, contributors Espaldon, Bueno, Siar, Demaine, Sinh, Corsin, Curtis, Siar, Prein, Wattage
Pilot testing of case studies	First half of 2009 Selected countries	Contracts for the studies
Follow-up Workshop: • presentation of outcomes of pilot test • validation and cross country analysis • refining • replication of case studies to selected regions (Asia, Latin America, Africa??)	Third to fourth quarters of 2009	FAO/experts
Submission of outcomes for information and/or consideration during COFI/SCAV/Millenium+10 global conference	2009–2010	FAO
Additional information for an improved aquaculture data collection	To be presented to CWP	FAO

CLOSING OF THE WORKSHOP

The closing activity was held on the morning of Friday 28 November. The planned field trip to aquaculture projects and farms was cancelled because of a very adverse weather system that made it hazardous to undertake the visits.

A vote of thanks by FAO and the participants was given to NTU, especially to Dr Huu Dung Nguyen and the secretariat staff for the efficient organization of the consultation and the warm hospitality accorded to the participants. FAO thanked the participants for their valuable contributions to the consultation. FAO assured that in view of the high priority that the governments have given to the sustainable development of SSAs, it shall endeavour to find the resources to carry out the pilot projects. Many of the experts appreciated the stimulating discussions from the multidisciplinary group that was assembled for the workshop.

Appendixes

APPENDIX 1
EXPERT WORKSHOP AGENDA

Date and time	Activities
23 November, Sunday: Arrival of participants	
24 November, Monday	
09.00–09.30	Registration
09.30–10.00	Welcome address from Vice-Rector of Nha Trang University (Prof Mr Hoang Hoa Hong) Opening remarks from FAO (Dr Melba G. Bondad-Reantaso) Self-introduction of participants (Moderator: Dr Huu Dung Nguyen)
10.00–10.20	Coffee break
10.20–10.45	Workshop objectives (Dr Melba G. Bondad-Reantaso, FAO) Election of session Chairs (3) and Rapporteurs (3)
	Introduction to Session 1 Objectives of the session – To set the scene of the workshop Expected outcomes of the session – Broader understanding of the general concepts and principles of sustainability, indicators and sustainability indicators, small-scale aquaculture and sustainable livelihoods – Broad considerations concerning the application of sustainability indicators to small-scale aquaculture (general principles, context, terminologies, scale of application, others)
10:45–11:30	Presentation 1: Key concepts and principles in developing indicators (SDI) for sustainable rural development (Dr Victoria Espaldon)
11.30–12.00	Presentation 2: Rural aquaculture: Reflections 10 years on (Dr Harvey Demaine)
12.00–12.20	Presentation 3: Millennium Development Goals and aquaculture (Dr Premachandra Wattage)
12.20–12.40	Presentation 4: Small-scale aquaculture: a fantasy or economic opportunity (Dr Curtis Jolly)
12.40–13.00	Presentation 5: Access rights for sustainable small-scale aquaculture and rural development: Is it a sufficient requirement? (Dr Susana V. Siar)
13.00–14.30	Lunch break

14.30–14.50	Presentation 6: Social impacts of coastal aquaculture in the Mekong Delta – Viet Nam (Dr Le Xuan Sinh)
14.50–15.10	Presentation 7: Assessment of aquaculture adoption by smallholder farms using sustainability indicators (Dr Mark Prein)
15.10–15.30	Presentation 8: An evaluation of small-scale freshwater rural aquaculture development for poverty reduction: an ADB special evaluation study (Mr Alvin Morales)
15:30–15.50	Presentation 9: Summary of the FAO Expert Consultation on Socioeconomic Impacts of Aquaculture: Identification and Assessment Methods (Dr Nathanael Hishamunda)
15.50–15.35	Presentation 10: Theory and practice of sustainable livelihoods development (Dr Victoria Espaldon)
15.35–16.00	Coffee Break
16:00–16.45	Discussion
16.45–17.00	Session 1 Working Group guidelines
25 November, Tuesday	
08.30–10.00	Session 1: Working Group discussion
10.00–10.30	Coffee Break
10.30–11.30	Session 1: Working Group discussion
11.30–12.00	Session 1: Working Group presentation
12.00–12.30	Conclusions and recommendations of Session 1
12.30–14.00	Lunch break
14.00–14.15	Introduction to Session 2
	Objectives of the session: – To review the working document on sustainability indicators for small-scale aquaculture Expected outcome of the session: – A list of sustainable development to assess the contribution of small-scale aquaculture to sustainable aquaculture and to rural livelihood development
14.15–15.00	Presentation 11: Indicators of sustainable small-scale aquaculture development (Mr Pedro Bueno)
15.00–15.30	Discussion
15.30–15.45	Session 2: Working Group Guidelines
15.45–16.15	Coffee break
16.15–17.45	Session 2: Working Group Discussions
19.00	Dinner
26 November, Wednesday	
08:30–10.00	Session 2: Working Group Discussions (continued)
10.00–10.30	Coffee break
10.30–11.30	Session 2: Working Group Progress Presentation and Discussion
11.30–13.00	Session 2: Working Group Discussions (continued)
13.00–14.30	Lunch break
14.30-15.30	Session 2: Working Group Discussions (continued)
15.30–16.00	Coffee break
16.00–17.30	Working Group final presentations and discussion

27 November, Thursday	
08.30–08.45	Conclusions and recommendations of Session 2
08.45–09.00	Introduction to Session 3
	Objectives of the session: – To prepare case study concepts considering the agreed scales of small-scale aquaculture Expected output of the session: – 3-4 case study concepts
09.00–12.00	Working Group discussions (Case study concepts)
12.00-13.30	Lunch break
13.30-18.00	Field trip
28 November, Friday	
08.30–10.00	Working Group discussions (Case study concepts) and preparation of presentations
10.00–10.30	Coffee break
10.30–11.30	Presentation of case study concepts
11.30–12.30	Discussion Conclusions and recommendations of Session 3
12.30–16.00	Lunch break/Free time
16.00–17.00	Presentation of the outcomes of the workshop/core messages Presentation of follow-up actions
17.00–17.30	Closing ceremonies

APPENDIX 2
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APPENDIX 3
EXPERT PROFILE

BOSMA, Roel (Mr). Project Manager INREF-POND (Livestock Research for Development), Aquaculture and Fisheries Group, AFI, Department of Animal Sciences, Wagenigen University. Graduated MSc in Tropical Animal Husbandry (1979) and PhD in Animal Sciences (2007) both at Wageningen University (WU). From 1980 to 1999, he was active in livestock research system research, university education, farmer's training and rural development in Burkina Faso, Ivory Coast and Mali. From 2000 to 2005, he assisted in the development of new courses at WU, assessed the benefits of new forage technologies in Indonesia, Philippiness and Viet Nam, and evaluated EU-funded livestock research programme in six West African countries. Since 2003, he is research/project-manager at the Aquaculture and Fisheries group of WU and is involved in coastal zone management, sustainable aquaculture, environmental impact analysis and institutional capacity development, for which he travels frequently to Benin, Indonesia, Philippines, Thailand and Viet Nam. He acquired experience in participatory research and development programmes and project management. His main research interest is in integrated production systems and in motives of farmers and fishermen to comply with the certification criteria for social, economic and ecological sustainability.

BRIONES, Roehlano (Mr). Senior Research Fellow, Philippine Institute for Development Studies (PIDS). Economist, experienced in research and consultancy. Track record in international peer-reviewed publications. Expertise in rural development, impact assessment, economics of agriculture and natural resources. Specializes in policy evaluation, modeling, econometrics. BSc, MSc and PhD degrees in economics from the University of the Philippines.

BUENO, Pedro (Mr). Retired NACA Director-General. Former director general of NACA (2001–2006), former information specialist of the UNDP/FAO NACA Project and Regional Seafarming Development Project (1987–1991) and the NACA Organization (1992–2000). Was assistant scientist working in farming systems socio-economics research and training at the International Rice Research Institute (1984–1987), communications specialist or manager of SEARCA, SEAFDEC Aquaculture Development, technical services manager and researcher of the Forest Research Institute, Philippines (now ERDB), programme specialist (for Socio-economics) and Information Specialist under the Technical Services Division of the Philippine Council for Agricultural Research and Resources Development, faculty member of the University of the Philippines at Los Baños and visiting lecturer in communications at the Institute of Mass Communications University of the Philippines and the UP Visayas (1966–1987). Had been consultant in information, rural development, aquaculture development and management, aquaculture network development, and training in rural development for ADB, FAO, NACA, UNDP/UNOPS, UNESCO and the World Bank. Now a free lance worker in aquaculture and rural development, based on Bangkok. Had worked in Uzbekistan, Eritrea, Aceh in Indonesia, Malaysia and Myanmar.

CORSIN, Flavio (Mr). Senior Aquaculture Advisor, WWF. Sustainable aquaculture and aquatic animal health specialist, coordinating aquaculture activities for WWF in Viet Nam and supporting sustainable aquaculture initiatives for a wide range of international organizations. Graduated with a M.Sc. in Aquaculture from the University of Stirling, he initiated a Ph.D. in aquatic epidemiology with the University of Liverpool with research in rural areas in Viet Nam and India. He conducted post-doctoral research in

North Carolina State University, United States of America, before deciding to move to a more applied and development-oriented position. Worked for NACA for 3 years, during which he coordinated several projects aimed at developing, disseminating and implementing strategies for sustainable aquaculture development in Viet Nam, Iran, Indonesia and other Asia-Pacific countries. He is currently playing an active role in reviewing aquaculture certification schemes and in developing standards for sustainable aquaculture. Member of the OIE ad hoc group on aquatic surveillance he also supports several FAO activities aimed at controlling aquatic animal epidemics and at improving the sustainability of the aquaculture sector in Asian and African countries. He is also involved in supporting the development of sustainability strategies for several governments and in reviewing fish welfare issues for the European Food Safety Authority.

DEMAINE, Harvey (Mr). Senior Advisor, Regional Fisheries and Livestock Development Project, Noakhali Component, Agricultural Sector Programme Support, Danida, Bangladesh. Harvey Demaine holds a Ph.D. degree in Agricultural Geography from the School of Oriental and African Studies, University of London. He has worked in agricultural, rural and regional development planning and management in Southeast and South Asia since 1971. He has been involved in small-scale aquaculture development since 1988, initially as socio-economist, then as coordinator of Asian Institute of Technology's Aqua Outreach programme in mainland Southeast Asia. He is the co-author and co-editor of a FAO monograph and collection of papers on "Rural Aquaculture". For the last five years he has been involved in DANIDA's Agricultural Sector Programme Support in Noakhali, Bangladesh, searching for a sustainable model for aquaculture and animal husbandry development for the rural poor. This has involved a major thrust in small-scale freshwater prawn culture.

GRIFFITHS, Don (Mr). Senior Aquaculture Adviser (Danida), Ministry of Agriculture and Rural Development (MARD). Has over 25 years experience in fresh, brackish and marine aquaculture development and extension primarily in Asia (Bangladesh, Cambodia, India, Lao PDR, Malaysia, Thailand, Viet Nam), but also Fiji, Lesotho and Mozambique, working for a variety of donor agencies including Overseas Development Agency (ODA), United Kingdom Department for International Development (DFID), Danida, United States Agency for International Development (USAID), the European Union (EU) and Mekong River Commission. Currently working as the Senior Advisor for the Government of Viet Nam-DANIDA funded Sustainable Development of Aquaculture (SUDA) component under the Fisheries Sector Programme Support Phase II (FSPS II). FSPS II runs to end of 2010.

HANH, Chau Thi Tuyet (Mr). Government officer, Aquaculture Department – Viet Nam's Ministry of Agriculture and Rural Development. Focal point for sustainable development of aquaculture. With Master in Aquaculture degree from Wageningen University (1999–2001). Lecturer and researcher of aquaculture faculty (Hue University of Agriculture and Forestry, 1994–2006) and consultant for Center for Rural Development in central Viet Nam. Participated in many development projects funded by IDRC-Canada, IMOLA, WB, DANIDA. Interest and expertise on community-based coastal management, livelihood analysis, and participatory researches.

JOLLY, Curtis (Mr). Professor and Chair, Agricultural Economics of the Department of Agricultural Economics and Rural Sociology, Auburn University. Before assuming the position of chair of his department he was assistant, associate and full professor in the department where he conducted research and taught in the areas of Economics of Aquaculture, International Trade and Development. He has published a number of scientific journal articles on aquaculture and trade and he is the co-author of the book on the Economics of Aquaculture. Dr. Jolly has worked in over 15 African and Caribbean countries on various projects. Dr. Jolly served as advisor of the director of the Institut sénégalais de rescherche agricole from 1982 to 1985 and as Farming Systems Economist at the Institut de l'economie rurale in Mali from 1985 to 1986. He works in the areas of Economics of Aquaculture, Agricultural Marketing, Agricultural Trade, and Project Planning and Sector Analysis. Recently he has concentrated his efforts on studying the effects of aflatoxin on the marketing of peanuts in Ghana and Benin. He is the member of the Board of Directors of the Auburn University Credit Union, and he has received a number of awards for his work on research and teaching.

MORALES, Alvin. Evaluation Officer, Operations Evaluation Department of the Asian Development Bank (ADB). He obtained his BS and MS degrees in Agricultural Economics from the University of the Philippines. He also earned a post-graduate degree (Master in Development Planning) from the University of Queensland, Australia. Prior to joining ADB, Mr Morales was engaged in research and consulting work for projects funded by various bilateral and multilateral donor agencies. The projects were mostly related to natural resources and fisheries economics. His current involvement includes the conduct of evaluations of ADB projects on agriculture, natural resources, and water supply and sanitation.

NGUYEN, Lam Anh (Mr). Lecturer, Faculty of Aquaculture, Nha Trang University. MSc in Aquaculture and Aquatic Resource Management from Asian Institute of Technology (AIT), Thailand. Eighteen years experience as a researcher and lecturer of Nha Trang Institute of Oceanography, Research Institute of Marine Fisheries (Hai Phong) and Nha Trang University. Has been involved in a number of projects pertaining to aquatic resources management and aquaculture, including projects at international level such as DANIDA, SEAFDEC, NACA/FAO, UNU-FTP, and national, ministry and provincial levels. Two years (2000–2001) participation in the Working Group on Fisheries Policy in SEAFDEC Secretariat (Bangkok, Thailand) as a representative of Ministry of Fisheries of Viet Nam. Joined project of College of Agriculture and Forestry – Hue University/IDRC on environmental management of shrimp culture area based on local community at Ninh Thuan Province (2004-2005). Has gained significant knowledge and experiences with regard to seed supply network of freshwater fish species through a collaborative project with NACA/FAO on market chain of not-so-high value species in 2007.

NGUYEN, Thi Kim Anh (Mrs). Dean, Faculty of Fisheries Economics, Nha Trang University. Lecturer and researcher (1985–2003), senior lecturer from 2004, Vice Dean of the Faculty of Fisheries Economics (2003). Masters degree in Economics (Thesis: " The assessment of efficiency and economic performance of the small and medium scale enterprises: A case study in seafood processing industry, Nha Trang City, Khanh Hoa province, Viet Nam", National University of Economics, Hanoi, 1995-1997). PhD degree in Economics (Thesis: "The economic strategies for seafood export industry of Khanh Hoa Province, Viet Nam", National University of Economics, Hanoi, 2003). In addition, with relevant experience in in rural development and community-based management for DANIDA, PACCOM. Worked on a number of development projects on fisheries and aquaculture management, marketing of agricultural and aquatic products.

NGUYEN, Thi Bich Thuy (Ms). In-charge of Information and International Cooperation, Research Institute for Aquaculture No. 3. Has 24 years experience in artificial rearing of crustacean seed and aquaculture research. Lead investigator of 16 larviculture, aquaculture and resource management projects, including 6 international projects with IFS, IDRC, DANIDA and ACIAR funding. Completed PhD and MSc theses on spiny lobsters in Viet Nam.

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ORTEGA-ESPALDON, Victoria (Ms). Professor and Dean, School of Environmental Science and Management, University of the Philippines at Los Banos. With post graduate degree in Geography (PhD Geography (Rural Resource Assessment and Environmental Analysis) from the University of Guelph, Ontario, Canada through a fellowship grant of the Canadian International Development Agency (CIDA) and UPLB; a fellow of the Beahrs Environmental Leadership Program of the University of California Berkeley where a broad range of community and environment development theories and issues were staples of the training curriculum, including sustainable development indicators. Background degrees are MS Forestry (Social Forestry) and BS Biology (Program in Ecology) taken at the University of the Philippines Los Baños (UPLB). Natural interest in human-environment interactions and the promotion of human well-being through a framework of community participation and empowerment has taken her to various rural communities in Asia-Philippines, Viet Nam, Indonesia, Myanmar, Bhutan. Sustainable agriculture in the uplands became one of her professional engagements, working with international research institutions like IRRI and SEARCA; and directly with local communities upon request as part of the university's mandate to extend extension services. She is one of the pioneers in the literature of community based natural resources management in the early 1990s in the Philippines when this model was not that popular in the country. This commitment to engage communities in the determination of their own development path has led to her involvement in the study of sustainability of community based natural resource management approaches and related rural development programmes in the Philippines, Viet Nam, Myanmar, Bhutan and Indonesia. At present, she is a professor at and Dean of the School of Environmental Science and Management– UPLB. On top of her R&D activities, and administrative responsibilities, she continues to teach both graduate and undergraduate students in environmental science; and agricultural systems and extension.

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SAJISE, Percy (Mr). Percy E. Sajise served as Regional Director for Asia, the Pacific and Oceania Office of Bioversity International from January 2000 to March 2008. Prior to this he served in the following capacities: Director of the Southeast Asia Ministers of Education Organization (SEAMEO) Regional Center for Graduate Study and Research in Agriculture (SEARCA) from 1994–1999; Dean of the University of the Philippines at Los Banos (UPLB) College of Human Ecology, Dean of the College of Arts and Sciences, Director of the University-wide Program on Environmental Science and Management and Department Chairman of Agricultural Botany between 1976-1991; and Research Fellow at the Environment and Policy Institute, East-West Center, Hawaii from 1992–1994. He is a plant ecologist by training and has a PhD in Plant Ecology from Cornell University. His research involvement is in grassland ecology, plant succession and in interdisciplinary and human ecological approach to upland development in general. He has directed and managed large interdisciplinary teams working on upland hydroecology, community-based forest management and in setting up an environmental program and academic curriculum for MSc and PhD programs at the University of the Philippines at Los Baños. He was also one of the original initiators of a regional network of academic institutions in Southeast Asia involved in collaborative and interdisciplinary methodology development for human ecology studies – the Southeast Asian Universities Agroecosystem Network (SUAN). He became a member of the prestigious World Academy of Science and Arts in 2001. He has written and co-edited eight books and published more than 150 papers and articles.

SEN, Sevaly (Ms). Director, Fisheries Economics, Research and Management (Australia)**.** MSc in Marine Economics, Policy and Planning from London School of Economics, LLB(Hons) from University of London. Twenty-five years experience as an economist/socio-economist in aquaculture and fisheries development in Africa and Asia, predominantly as a consultant for international agencies including FAO, IFC, DFID, DANIDA and the EU. Socio-economist for the FAO Aquaculture for Local Community Development Programme in southern Africa 1992–1994. Since 1999 based in Australia as a consultant on fisheries and aquaculture industries in Australia. Professional focus has been on resource allocation issues, cross-border management issues across steep socio-economic gradients, economics of marine protected areas, co-management and evaluation of aquaculture research.

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Bank, Asian Development Bank, and the UNDP. He has enhanced his postgraduate education with more than ten years of teaching and research experience in the area of Agricultural Development Economics including fisheries in developing countries. Over the last twenty years, he has gained experience and knowledge in the areas on fisheries and aquaculture, environment valuation, environment cost-benefit analysis, modelling, environment and social impact assessment and sustainability in the United Kingdom, United States of America and the European Union.

PART 2

Contributed papers on measuring the contribution of small-scale aquaculture

Key concepts and principles in developing indicators for sustainable rural development

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ABSTRACT

This paper presents the concept that underlies sustainable development indicators (SDI) – dating back to the articulation of sustainable development paradigm embodied in the World Commission on Environment and Development Report, popularly known as the Brundtland Report. To date, many countries from both developed and developing countries, albeit individually, have instituted SDI system to tract sustainability of each development pathways. In the selection of SDIs, the paper presents a process that was adopted by the United Nations Council of Sustainable Development. Basically, it consists of four phases. Phase 1 is the development of initial set of SDIs. SDIs are grouped into the three pillars of sustainable development – social and institutional, economic and environmental. Agreeing on the framework to use is basic at this stage. Phase 2 is pilot testing of selected SDIs. Phase 3 is evaluating the test results and review of the SDI set and finally revision of the framework and the SDIs. The last phase is the adoption and wider use of indicators, followed by evaluation, learning and adaptation with regards to overall approach, framework, indicator set, methodology sheets and indicator use.

INTRODUCTION

At the forefront of sustainable development is the concept of ensuring human well-being of the present and future generations. The Millennium Ecosystem Assessment of the United Nations (UN) has forwarded an overall view that human well-being can only be possible if we can ensure the ability of ecosystems to provide ecosystem services such as: provisioning (food, fiber, water), regulating (climate, diseases), cultural (recreational, tradition and culture) and supporting (primary productivity, soil generation) (MEA, 2003). This emerging discourse has reinforced the understanding of the concept of sustainable development first articulated in the UN commissioned study now popularly known as the Brundtland Report. Sustainable development is defined as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. This is a kind of development that ensures a quality of life for the present and future generations via working within the limits of the carrying capacity of the earth's system.

Since then, governments and communities around the world, led and encouraged by the UN, endeavored to develop sustainable development indicators SDI as a means of tracking the long-term sustainability of the world's socioeconomic system. SDI development was provided for in Chapter 40 of Agenda 21 of the 1992 Earth Summit, held in Rio de Janeiro and confirmed by many countries during the summit. In 1995, the UN Commission on Sustainable Development (CSD) approved a programme of work on SDI. This was reinforced by the Johannesburg Plan of Implementation (JPOI) in 2002. It called for *"further work on indicators of sustainable development by countries at the national level, including integration of gender aspects, on a voluntary basis, in line with national conditions and priorities"*. Further to this, the UN CSD pointed to the need to continue work on SDI at the national level, and invited the international community to support the efforts of the developing countries.

To date, many governments and institutions from both developed and developing countries, albeit individually, have instituted SDI systems to track sustainability of each ones' development pathways. While this is welcome progress towards sustainability, much effort are still needed in the sub-sectors of national economies in terms of ensuring their sustainability, especially in the area of sustainable rural development. This paper intends to focus on sustainable development indicator SDI systems that are relevant to development endeavors in the rural sector of which agriculture and fisheries are the backbone. Key objectives of this paper include the following:

- review of concepts of sustainable development and how they have developed;
- review of SDI systems and trends, how they approached the issue in theory and practice;
- reflections on various SDI systems; and
- recommendations on options for developing an SDI system for sustainable rural development.

Sustainable development

The definition of sustainable development by the Brundtland Report in 1987 has undergone many re-interpretations. This is primarily due to its "creative ambiguity". This astounding feature allows inclusion of programmes on environment and development at various scales (local to global) as well as the participation of different stakeholders from government institutions, civil society, business and industry, in the realm of sustainable development (Kates, Parris and Leiserowitz, 2005).

While the Brundtland definition is simple and brief, the articulations on environment and development that followed in the report are clear, although less quoted (Kates, Parris and Leiserowitz, 2005):

> *The environment does not exist as a sphere separate from human actions, ambitions and needs, and attempts to defend it in isolation from human concerns have given the word "environment" a connotation of naivety in some political circles. The word "development" has also been narrowed by some into a very limited focus, along the lines of "what poor nations should do to become richer", and thus again is automatically dismissed by any in the international arena as being a concern of specialists, of those involved in questions of "development assistance". But the "environment" is where we live; and" development" is what we all do in attempting to improve our lot within that abode. The two are inseparable.*

Based on this section, the focus on development is very clear–human needs are basic and that equity of benefits from development must transcend both the present generation (*"intragenerational equity"*) and the future (*"intergenerational equity"*). Further, the Brundtland Report is clear on its concern for the environment.

> *The concept of sustainable development does imply limits–not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and the ability of the biosphere to absorb the effects of human activities.*

Through the years, a veritable school has emerged to understand and operationalize the elusive subject of sustainable development. Books and literature are littered with various definitions and systems of operationalization. One of the many studies that looked into the blossoming of interpretations and meanings of SD is the study of the US National Academy of Sciences and its findings are embodied in a report – *Our Common Journey: A Transition Towards Sustainability*. It came up with what is considered a broad definition of SD as illustrated in Figure 1. This study identified that the literature so far focused on two concerns: what is to be sustained and what is to be developed. What is to be sustained includes nature, life support and community. For nature, it is the intrinsic value of the earth where we all live, its biodiversity and ecosystems. According to this study, numerous published studies focused on the life support function as a source of ecosystem services for use by humankind. Studies on ecosystem services, of which the Millennium Ecosystem Assessment has played a significant role, has strengthened this definition so far. Recognition of the value of sustaining communities to include cultures, groups and places is also highlighted. On the other hand, what is to be developed includes people, economy and society. Kates, Parris and Leiserowitz (2005) noted that while the earlier efforts at SD focused on economic development with productive sectors, there was a shift in its focus to include human development - such as increased life expectancy, education, equity and opportunity, and later even gender issues. These foci are now part of the UN Human Development Index (HDI) and the Millennium Development Goals (MDGs) which will be mentioned in the next section of this paper. The study also identified the call to develop society that emphasized the values of security and well-being of countries and regions and their social capital. The study also noted that published studies on SD varied on the time horizons of meeting the goals. For example, some studies have definite time duration as 25 years while some are in the realm of now and in the future or even forever. The concept of MDG is considered the most recent development in terms of setting the sustainable development pathways of most countries; it sets a definite time frame to 2015. The level of sustainability, however, also varied from "sustain only" to varied forms of "and" and "or".

FIGURE 1
Definitions of Sustainable Development

WHAT IS TO BE SUSTAINED:	**FOR HOW LONG?**	**WHAT IS TO BE DEVELOPED:**
NATURE **- Earth** **- Biodiversity** **- Ecosystem** **LIFE SUPPORT** **- Ecosystem services** **- Resources** **- Environment** **COMMUNITY** **- Culture** **- Groups** **- Places**	**25 years** **"Now and in the future Forever"** **LINKED BY** **Only** **Mostly** **But** **And** **Or**	**PEOPLE** **- Child survival** **- Life expectancy** **- Education** **- Equity** **- Equal opportunity** **ECONOMY** **- Wealth** **- Productive sectors** **- Comsumption** **SOCIETY** **- Institutions** **- Social capital** **-States, regions**

Source: US National Research Council, Policy Division, Board of Sustainable Development, Our Common Journey: A transition Towards Sustainability, Washington DC: National Academy Press, 1999.

The standard definition of SD was further expanded by the 2002 World Summit on Sustainable Development to include three major pillars: economic, social and environmental. The review of three pillars of SD (Kates, Parris and Leiserowitz, 2005) noted that while the three pillars are acceptable to most nations, no agreement was made on details. The major variants are in terms of the social pillar. These variants include social development or social progress (a generic one); human development, human well being or people; and lastly, one that focuses on issues of justice and equity, i.e., "social justice", "equity" and "poverty alleviation".

Indeed, the transition to sustainability has become a great task to those who are at the forefront of governance of communities, countries and the world. Albeit defining sustainability has become an elusive task, the most concrete endeavor comes in the form of developing indicators of sustainable development. This is perceived to be one way of putting SD concepts into action and setting up an SDI system that enables relevant stakeholders to determine the sustainability of a country's development path.

Sustainability

Sustainability usually refers to a description of whether a certain program, initiative or activity is able to continue through time, beyond a short-term period, without a continuous dependence on inputs from the outside. In discussing sustainability, the following are key concepts that need to be defined first to enable better discussion:

- sustainability capital
- strong vs. weak sustainability
- sustainable livelihoods
- environmental sustainability
- systems
- scale
- indicators

Sustainable Development Indicators

Indicators have been traditionally used to determine the extent to which the activity has reached the target. Usual characteristics of a good indicator are its being measurable and achievable within the capacity of the monitoring institution. Indicators have been developed for many purposes - be it in the government, private or public institutions. Sustainable development indicators serve various functions. They can enable the tracking of the condition and of change in the economy, social setting and environmental integrity. SDI can also be relevant to diagnose causes and effects of issues in order to develop responses and actions at a regional level as well as to predict future trends and impacts to determine future strategies and policies for development.

In developing indicators for sustainable development, efforts are not wanting in number. Parris and Kates (2003) noted that of the 12 SDI studied, 50 percent were global in coverage (UN Commission on Sustainable Development, Consultative Group on SDI, Well-being Index, Environmental Sustainability Index, Global Scenario Group and the Ecological Footprint). Others are at country and city levels. A brief overview of the results of the study is given in Table 1. Countries in Asia, e.g. Indonesia, Malaysia, the Philippines, Thailand and Viet Nam, have followed suit and developed their own national SDIs.

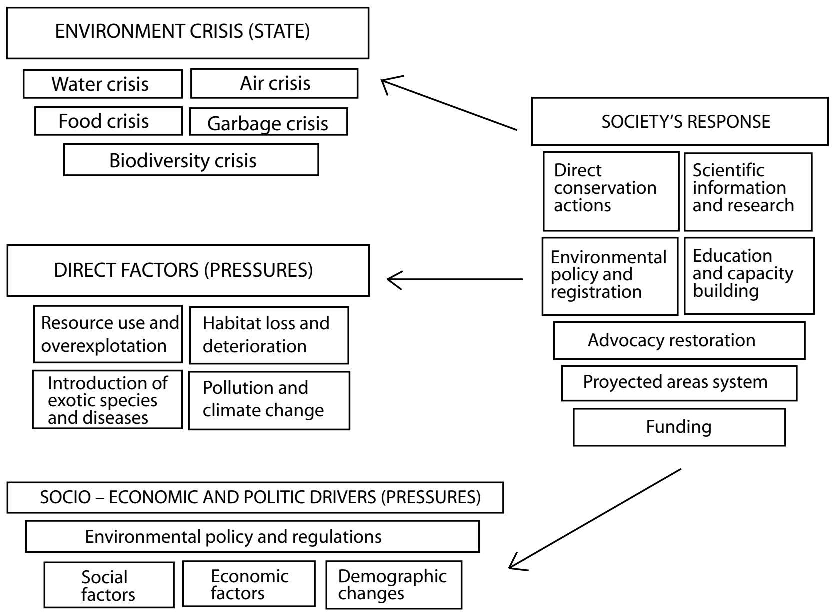
Use of conceptual frameworks

The most recent review conducted for the UN CSD in 2005 showed a total of 669 SDI entries (Pinter, Hardi, and Bartelmus, 2005). The process of developing the SDI varied from country to country, from local to global. The commonality rested on the dynamic and iterative processes that most have undergone to come up with these indicators and these basically arose from the adoption or development of a specific conceptual model or framework. The most common frameworks that have been used were the following (Pinter, Hardi and Bartelmus, 2005):

- pressure-state-response (PSR) model and its variations;
- human well-being and/or ecosystem well-being;
- issue- or theme-based frameworks; and
- capital accounting-based framework, centered on economic and environmental pillars of SD.

The PSR framework has three basic interacting components: the pressure, state and responses. As an example, Figure 2 presents an analysis of the environment using the PSR framework, where direct and indirect pressures are influencing the quality of the environment i.e. the state (Ong, 2005). The responses are the institutional actions addressing both the pressures and the state of affairs of the system under study.

FIGURE 2
Pressure-state – response framework (Ong, 2005)



The human well-being or the ecosystem well-being framework has been the basis for the Millennium Ecosystem Assessment (MEA). The conceptual framework for the millennium assessment (MA) is of the view that people are integral parts of ecosystems and that a dynamic interaction exists between them and other parts of ecosystems. The changing human condition triggers changes, both directly and indirectly, in ecosystems and thereby cause changes in human well-being. At the same time, social, economic and cultural factors unrelated to ecosystems alter the human condition and many natural forces influence ecosystems. Although the MA emphasizes the linkages between ecosystems and human well-being, it recognizes that the actions people take which influence ecosystems result not

FIGURE 3
The MA framework (MA, 2000)

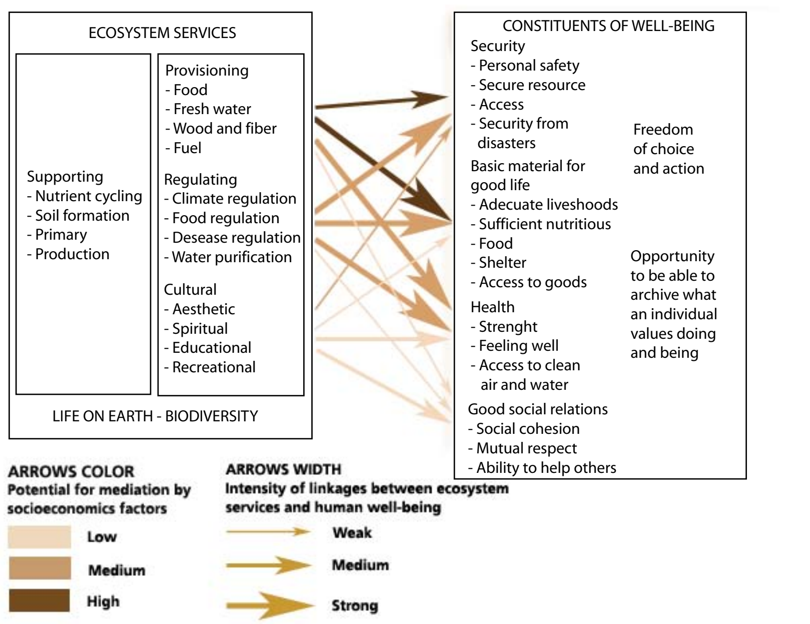
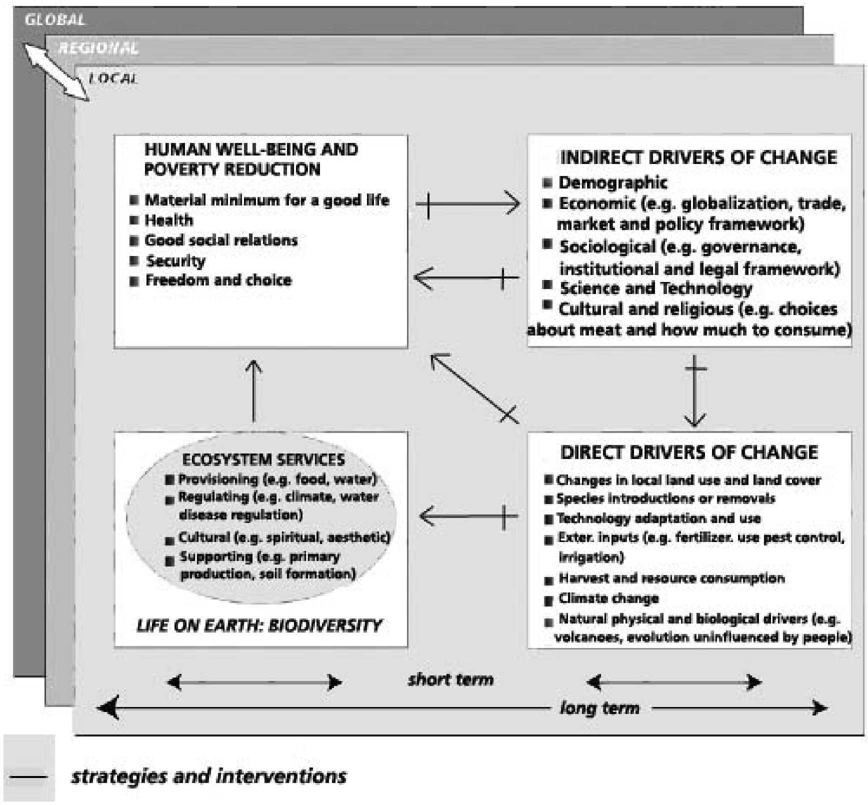


TABLE 1
Definitions of sustainable development implicitly or explicitly adopted by selected indicator initiatives

Indicator initiative	Number of indicators	Implicit or explicit definition?	What is to be sustained?	What is to be developed?	For how long?
Commission on Sustainable Development	58	Implicit, but informed by Agenda 21	Climate, clean air, land productivity, ocean productivity, fresh water, and biodiversity.	Equity, health, education, housing, security, stabilized population	Sporadic references to 2015
Consultative Group on Sustainable Development Indicators	46	Same as above	Same as above	Same as above	Not stated; uses data for 1990 and 2000
Well-being Index	88	Explicit	"A condition in which the ecosystem maintains its diversity and quality—and thus its capacity to support people and the rest of life - and its potential to adapt to change and provide a wide change of choices and opportunities for the future".	"A condition in which all members of society are able to determine and meet their needs and have a large range of choices to meet their potential"	Not stated; uses most recent data as of 2001 and includes some indicators of recent change (such as inflation and deforestation)
Environmental Sustainability Index	68	Explicit	"Vital environmental systems are maintained at healthy levels, and to the extent to which levels are improving rather than deteriorating" [and] "levels of anthropogenic stress are low enough to engender no demonstrable harm to its environmental systems."	Resilience to environmental disturbances ("People and social systems are not vulnerable (in the way of basic needs such as health and nutrition) to environmental disturbances; becoming less vulnerable is a sign that a society is on a track to greater sustainability"); "institutions and underlying social patterns of skills, attitudes, and networks that foster effective responses to environmental challenges"; and cooperation among countries "to manage common environmental problems".	Not stated; uses most recent data as of 2002 and includes some indicators of recent change (such as deforestation) or predicted change (such as population in 2025)
Genuine Progress Indicator	26	Explicit	Clean air, land, and water	Economic performance, families, and security	Not stated; computed annually from 1950–2000
Global Scenario Group	65	Explicit	"Preserving the essential health, services, and beauties of the earth requires stabilizing the climate at safe levels, sustaining energy, materials, and water resources, reducing toxic emissions, and maintaining the world's ecosystems and habitats."	Institutions to "meet human needs for food, water, and health, and provide opportunities for education, employment and participation"	Through 2050
Ecological Footprint	6	Explicit	"The area of biologically productive land and water required to produce the resources consumed and to assimilate the wastes produced by humanity".		Not explicitly stated; computed annually from 1961–1999
U.S. Interagency Working Group on Sustainable Development Indicators	40	Explicit	Environment, natural resources, and ecosystem services	Dignity, peace, equity, economy, employment, safety, health, and quality of life	Current and future generations
Costa Rica	255	Implicit	Ecosystem services, natural resources, and biodiversity	Economic and social development	Not stated; includes some time series dating back to 1950
Boston Indicator Project	159	Implicit	Open/green space, clean air, clean water, clean land, valued ecosystems, biodiversity, and aesthetics.	Civil society, culture, economy, education, housing, health, safety, technology, and transportation	Not stated; uses most recent data as of 2000 and some indicators of recent change (such as change in poverty rates).
State Failure Task Forcek	75	Explicit	Intrastate peace/security.	Two years	
Global Reporting Initiativel	97	Implicit	Reduced consumption of raw materials and reduced emissions of environmental contaminants from production or product use.	Profitability, employment, diversity of workforce, dignity of workforce, health/safety of workforce, and health/safety/ privacy of customers	Current reporting year

Source: Adapted from Parris and Kates (2003) and United Nations Division of Sustainable Development (2001).

FIGURE 4
Conceptual Framework, MEA 2003



just from concern about human well-being but also from considerations of the intrinsic value of species and ecosystems. Intrinsic value is the value of something in and for itself, irrespective of its utility for someone else (MA, 2005).

Human well-being and poverty reduction are at the heart of the framework - with indirect and direct drivers of change. The indirect drivers of change are demographic pressure, economic trends, sociopolitical governance, science and technology and cultural and religious concerns. The direct drivers of change include changes in local land use and land cover, species introductions and removal, technology adaptation and use, external inputs, harvest and resource consumption, climate change and natural biophysical processes. These drivers are affecting ecosystem services through provisioning, regulation, cultural and supporting and at various scales (Figure 4).

The issue- or theme-based frameworks focus on various specific concerns such as energy, food and water security, agriculture, health and environment and are used by different actors and stakeholders.

The capital accounting-based framework centers on environmental and economic pillars of SD. The System of Integrated Environmental and Economic Accounting (SEEA) is an example having resulted from the collaboration of the statistical services of international organizations and selected countries (Pinter, Hardi and Bartelmus, 2005). The "hybrid" accounting framework, which included both physical and monetary indicators, is enhanced with environmental indicators. Land uses and material flows are considered to be pressures on environmental carrying capacity.

While the MDGs did not develop out of a specific conceptual framework, these are founded on Agenda 21 and embodied in the UN Millennium Declaration. All indicators are aimed to measure the progress towards agreed upon targets by 2015. Inspite of being brief in the environmental indicators (MDG7), the MDGs remain to have powerful influence on designing SDI at the national and sub-national levels.

The process of selecting SDIs

How do we select SDIs? We can understand the process from the experience of the UNCSD. The CSD started with a total of 134 indicators, gleaned from various sources. After an evaluation, the CSD shortlisted 58 indicators. (Pinter, Hardi and Bartelmus, 2005) reported that even the short listed 58 SDIs cannot be applied to all countries. Some indicators are irrelevant to some countries with unique ecosystems and hence each may come up with a unique set of SDIs.

Figure 5 describes the process of developing the SDI. Basically, it consists of four phases. Phase 1 is the development of an initial set of SDIs. SDIs are grouped into the three pillars of SD – social/institutional, economic and environmental. Phase 2 is the pilot testing of selected SDIs. Phase 3 is evaluating the test results and review of the SDI set and finally revision of the framework and the SDIs. The last phase is the adoption and wider use of indicators, followed by evaluation, learning and adaptation with regards to the overall approach, framework, indicator set, methodology sheets and indicator use.

The uniform methodology sheet provides a description of each indicator in the form of an indicator definition (name, brief description, unit of measurement); place in the framework, significance and relevance (purpose), methodological description and underlying definitions, assessment of the availability of data and sources; agencies involved in the development of the indicator and other information such as bibliographic sources.

Some existing SDIs at national levels

Generally, at the macro or country level, a fundamental indicator of a country's wellbeing is the value of its wealth over time as in the case of the Philippines (NEDA, 2008). It is generally considered that while non-declining national wealth does not guarantee sustainable development, declining national wealth is a cause for concern. Normally, the framework being used is the modified capital-based accounting framework, where physical indicators of macro level performance are used instead of monetary indicators. The use of physical indicators reflects a strong sustainability approach. The two major sources of physical macroeconomic indicators are the National Accounting Matrix including Environmental Accounts (NAMEA) and the Material Flow Accounts (MFA), which are closely related to environmental accounts.

The NAMEA provides indicators for major environmental policy themes: climate change, acidification of the atmosphere, eutrophication of water bodies and solid wastes. These indicators are then compared to a national standard (e.g. target level of greenhouse gas emission based on National Communications) to assess sustainability. The MFA, on the other hand, provides several macroindicators, the most popularly known is total materials requirements (TMR). The TMR adds up all the materials used in the economy by weight, including "hidden flows" or materials excavated and disturbed along with the desired material. These are considered, as mentioned above, pressures on environmental carrying capacity.

Another feature of the green accounting approach to SDI is the use of monetary environmental indicators. The purpose of this set of indicators is to more accurately measure sustainable income. The National Germanic Development Authority NEDA (2008) notes that the first system revised conventional macroeconomic indicators by adding and subtracting the relevant environmental components of the System of Integrated Environmental and Economic Accounting (SEEA) – the depletion of natural capital and environmental degradation. The main difficulty in setting up this SDI system, encountered by the developing countries including the Philippines, is the need for data to measure these indicators. Imperative to the implementation of an SDI system like this is to begin to gather the needed data so that they can use these indicators.

Whilst the green accounting approach looks at the twin concerns of environment and development, human well-being must also be paramount in developing indicators. The United Nations Development Programme (UNDP) uses the Human Development Index to monitor various countries' achievement of the goals of eradicating poverty, promoting human dignity and equality and achieving peace, democracy and environmental sustainability (i.e. the various means of achieving better life or well-being), using three composite indicators, namely: life expectancy, educational attainment and adjusted real income.

The Population and Development Indicators (POPDEV) has a total of 539 population-denominated indicators of development which are grouped into: population processes, population outcomes, development processes and development outcomes based on the framework for integrating population and development in planning (Herrin, 1990). This list of POPDEV indicators was developed under the POPDEV Planning at the Local Level Project of the Commission on Population of the Philippines in 1999. The indicators, expressed as number, percentage, ratio, rate, average, mean or median, measure various ways and levels of well-being.

The Minimum Basic Need (MBN) Indicators and Poverty Indicators on the other hand have 33 indicators established through the Integrated Approach to Local Development Management. These MBN indicators were intended to regularly monitor, at the barangay[1] level, the situation of families in terms of the attainment of their minimum basic needs of food and nutrition, health, water and sanitation, clothing, shelter, peace and order/public safety, income and employment, basic education and literacy, people's participation and family care/psychological needs, as well as to identify families that need poverty reduction interventions. These indicators can also show how many families are moving in or out of poverty.

The Presidential Commission to Fight Poverty adopted 19 of these MBN indicators for its use in identifying the poor. However, these indicators were trimmed down to 16 indicators because of the difficulty of obtaining information on the other indicators from the community-based monitoring systems. Balisacan's (2007) study on correlates of poverty in the Philippines provides such indicators such as location, dwelling, family characteristics and ownership of durable goods to predict household welfare levels.

In the United Kingdom, the SDI system consists of 68 national sustainable development indicators that fall into one or more of four priority areas:

- sustainable consumption and production
- climate change and energy
- natural resource protection and enhancing the environment
- creating sustainable communities and a fairer world

The SDI system of Viet Nam, on the other hand, covers the so-called three pillars of SD, the **economic, social and biophysical environment.** Indicator fields are broadly selected to measure sustainable development performance in each component (Tran, 2002).

- **Economic development: sustainable development indicators include:**
  - o *Increase in gross domestic product (GDP) per capita.* This is a key measure of the economic aspects of sustainable development.
  - o *Economic policies and instruments becomes a principle force in implementing sustainable development and environmental protection objectives.* It consists of two indicators. One relates to building environmental factors into all economic policy, the other to using various economic incentive mechanisms to achieve environmental protection and objectives.

[1] Smallest administrative division in the Philippines and the native Filipino term for a village, district or ward.

- o *Expenditure on environmental protection increases as percentage of GDP.* This indicator reflects the efforts undertaken by Viet Nam to protect and restore the environment.
- o *Disbursement of Official Development Assistance (ODA) to sustainable development.*

- **Social development: sustainable development indicator**
  - o *Population growth rate.* This indicator measures how fast the size of the population is changing.
  - o *The proportion of the population with a standard of living below the poverty line.*
  - o *Adult literacy rate.* A response indicator, which could be used is GDP spent on education.
  - o *Life expectancy at birth.*
  - o *Human and economic loss due to natural disasters.*
  - o **Governance and institutions: sustainable development indicators include:**
    - *Increasing authority and democratic working of the National Assembly.*
    - *Active involvement and commitment to intentional environment agreements and forums.*
    - *An increasingly open, honest and competent administrative system.*
    - *Environmental protection institutions are established, operating effectively and well resourced at all levels of government and within all sectors.*
  - o ***Sustainable development mechanisms:*** This measure would need to be advised that show the level of performance in applying SD mechanisms to all decision making.
  - o ***Human settlements:*** This establishes an overview on the sustainability of urban centers. Sustainable development indicator is waste recycling and reuse.
- **Biophysical environmental development:** Five indicator fields have been selected as representative of sustainable development performance relating to the biophysical environment in Viet Nam: forests, water resources, energy, fisheries and biodiversity resources.
  - o ***Forests indicator:*** Increase in total coverage, density and quality of forest. A number of measures are required for this indicator.
  - o ***Water:*** three indicators are selected to reflect the status, accessibility and use or misuse of water resources. Sustainable development indicators include:
    - *Annual withdrawal of ground and surface water.* This provides a measure of total water extracted for various uses as percentage of the total average available volume of fresh water.
    - *Access to safe drinking water.* This reflects the quality of water resources.
    - *Waste water treatment.* This indicator provides a sense of progress in integrated water resources management.
  - o ***Energy:*** The long-term sustainable development goal of Viet Nam's energy policies is for development and prosperity to continue through gains in energy efficiency rather than increased production. The three indicators suggested here relate to energy conservation, use of renewable resources and total consumption over time. Sustainable indicators include:
    - *Annual energy consumption per capita.*
    - *Expenditure on energy conservation as proportion of GDP.*
    - *Energy consumption from renewable sources as a percentage of total energy consumption.*
  - o ***Biodiversity:*** There are three levels of biodiversity: species, ecosystem, genes. Sustainable indicators include:
    - *o Threatened species as a percentage of total native species.*
    - *o Protected areas as a percentage of total land and sea area.*

o *Number of protected area management plans, staff and size of budget.*

- ***Fisheries:*** Sustainable indicator is maximum sustained yield.

In general, a number of systems for SDIs already are in place in most countries. Whilst there is no common framework used nor common set of SDIs, some areas remain inadequately covered (Pinter, Hardi and Bartelmus, 2005). These include, among others, institutional indicators such as conflict and refugees, governance; and environmental, e.g. risk of soil degradation, vulnerability to climate change and biodiversity weighted land use change.

SDI initiatives at the sub-national and local levels

The establishment of SDIs for use at the sub-national and local levels that are particularly focused on SRD brings us to the discussion of agriculture and the fishery sector, the backbones of rural economy. While the SDIs at the national level have been flourishing, a more localized set of SDIs becomes imperative if we commit to tracking the sustainability of rural economies where the majority of the poor and vulnerable groups are found. Unlike the national SDIs, efforts to develop SDIs for smaller scales such as for the agriculture and fisheries sectors have been but few. The most classic of which is the 1995 SEARCA work on Sustainable Agriculture Indicators.

The work on the development of SDIs for sustainable agriculture is anchored on the principle that sustainable agriculture is a system of food production that incorporates the following characteristics: a) long-term maintenance of natural resources and agricultural productivity; b) minimal adverse environmental impacts, c) adequate returns to farmers, d) optimal crop production with minimized chemical inputs, e) satisfaction of the human needs for food and income and f) provision for the social needs of the farming families and communities. This system is an alternative to the modern agricultural practices that have led to increases in agricultural production but have exacted a high toll on the environmental resources.

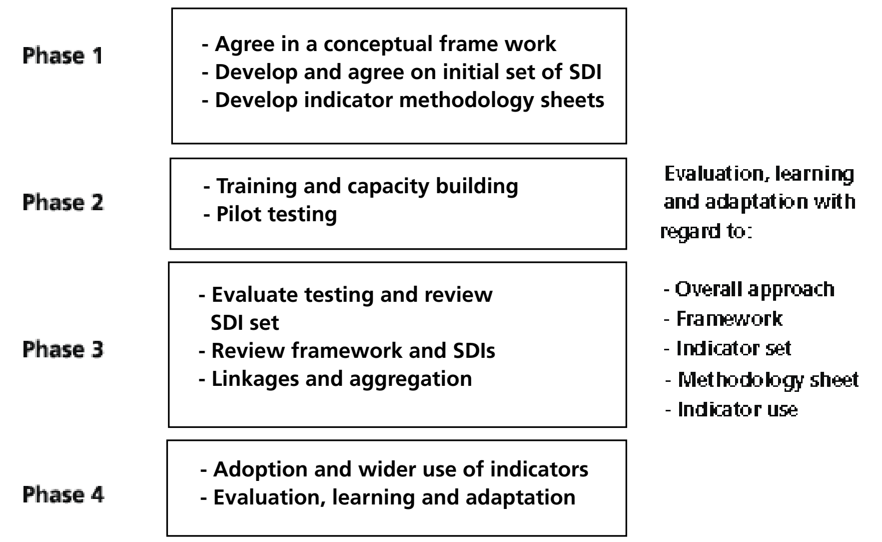
Zamora (1995) outlined the criteria for sustainable development which served as the conceptual framework for developing the SDIs:

- **Economic viability**. This means a reasonable return to investment of labor and cost involved; and ensures a decent livelihood for the farming family
- **Ecologically sound and friendly**. This means a system are well-integrated into the wider ecological system; a focus on maintenance of the natural resources; biodiversity oriented, and avoidance of environmentally damaging practices.
- **Socially just**. This means that the system respects the rights of individuals and groups; and treats them fairly; allows access to information, market and farm related resources including land.
- **Culturally appropriate**. It gives due consideration to cultural values, including beliefs and religion in the development of agricultural systems, plans and programs.
- **Systems and holistic approach**. This means viewing agriculture in terms of farming systems and systems approach; and their relationships - including biophysical, social, economic, cultural and political factors.

Further, the goal of sustainable agriculture is to improve the human well-being through economic development, prioritizing food security, placing high value on human resources and fulfillment, emphasis on self reliance, farmer empowerment and liberation, ensuring a stable environment (safe, clean, balanced and renewable) and focusing on long-term productivity goals (Figure 5).

Using this framework, SEARCA has come up with various indicators for different agricultural systems: lowland, upland and coastal. Per ecosystem, the indicators are identified at three levels: farm/household level, community and national. The SDI

FIGURE 5
Schematic view of the SDI Process of UNCSD (Pinter, Hardi and Bartelmus, 2005)



was, however, limited to two categories: biophysical and socioeconomic indicators. Examples of biophysical indicators at the farm/household level of lowland ecosystem are soil quality, biodiversity and use of external/internal inputs. Socioeconomic indicators include diversified sources of income, system yield, management practices, food security, social indicators, membership in organizations, support services. In these, it is observed that the socioeconomic indicators are also indicators of social development.

For upland ecosystems, at the farm/household level, three biophysical indicators of sustainable agriculture were selected: soil fertility (which is also parallel to soil quality, an indicator in the lowland ecosystem); soil loss; and biodiversity. According to the

TABLE 2
Other major fisheries issues and potential indicators

Criteria	Indicators
Crude foods and feeds	Contaminants in shellfish Fish catch Marine species catches
Harvesting of biota	Deforestation rate Fish catch to growth ratio Lumber harvest rate Roundwood Timber harvest to growth ratio Wood product removal
Productive capacity	Coastal water fish kills Fish stock use Forest land for timber Renewable resources Shellfish quality Total growing stock
Biota population	Algal bloom Contamination in biota Dead forest water bodies Forest species population Livestock in dryland Marine maximum sustained yield Maximum sustained yield ratio Sea mammal population change

schema established by SEARCA, appropriate SDIs will be selected for the agriculture and fisheries sectors.

Another equally significant piece of work on SDI for the fisheries sector includes a focus on the changes in the stocks and productive capacity of estuarine and marine fisheries or what we consider as declining fisheries. Six candidate SDIs are: fish catch, fish catch to growth ratio, fish stock use, marine maximum sustained yield, marine species catches and maximum sustained yield ratio. Other issues are: crude foods and feeds, harvesting of biota, productive capacity, and biota population. Each of these has its own set of candidate SDIs (www.hq.nasa.gov/iwgsdi/ISS_SDI) (see Table 2).

CONCLUSION

When the Brundtland Report defined sustainable development, it sought to address the twin concerns of development and environment. It has been a landmark effort and created acceptance of the need to pursue the path of sustainability. Sustainable development indicators became part and parcel of ensuring that we are on the right path. From global to local, the efforts are varied, and mostly profound. The development of SDI is generally anchored on the three pillars of sustainable development: economic, social and environmental. These three pillars cannot be separated and must be taken as a whole. Progress toward institutionalizing SDIs at the national levels is encouraging, even at the regional level as in the case of the ASEAN region. The Human Development Index, Millennium Development Goals Indicators and Environmental Sustainability Index have permeated, albeit gradually, economic development planning endeavors of nations. While some countries are more successful in this effort, there remains still a lot of work in some sectors, particularly the sector that focus on critical and vulnerable regions and sectors of the national economies, especially economies in transition. Some difficulties are in the availability of databases to use the SDI set selected or in some of the insufficient coverage of more locale specific concerns of institutional (groups and places, indigenous people), environmental (vulnerability to climate changes) and social (equity) indicators.

An array of SDIs is already available in the literature. This can provide options for sectors to select and test appropriate SDIs that are practical, observable, cost effective and measurable, either qualitatively or quantitatively. Selection of SDIs can opt to go through a participatory process, as noted in this paper, and can go through an iteration to ensure its adaptability to local conditions.

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Rural aquaculture: reflections ten years on

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ABSTRACT

The Food and Agriculture Organization of the United Nations commissioned a monograph on rural aquaculture in the late 1990s with a view to developing a framework for aquaculture development oriented towards poverty alleviation. In this paper, one of the authors of that monograph reviews the experience which led to the views expressed in the monograph ten years on. Definitions of rural aquaculture are revisited, stressing the poverty dimension and new classifications of small-scale aquaculture are set against those outlined in the monograph. Two experiences are re-examined: the Aqua Outreach Programme of the Asian Institute of Technology (AIT) in mainland Southeast Asia and the Greater Noakhali Aquaculture Extension Project and its successor, the Regional Fisheries and Livestock Development Project, in Bangladesh. Both illustrate the nature of the farming systems approach advocated in the monograph at two levels: the farm system and the wider regional support system. The AIT Aqua Outreach approach was, however, limited by its origins as an applied research project and remained a technology or supply-driven project. In contrast, the two Bangladesh extension and development projects have taken the farming systems approach in a more participatory direction by adopting the Farmer Field School methodology for farmer training and have widened the range of stakeholders in the regional system in an attempt to ensure sustainability at the end of the project period. The paper concludes with a brief discussion of the implications for methods and indicators for assessing the contribution of rural aquaculture in sustainable rural development, stressing the importance of measuring human and institutional capacity.

INTRODUCTION: RURAL AQUACULTURE

Some ten years ago, at the request of the Food and Agriculture Organization of the United Nations (FAO), Professor Peter Edwards and I put together a monograph entitled, "Rural aquaculture: Overview and framework for country reviews" (Edwards and Demaine, 1997). As the title suggests, this was meant to be a starting point for a number of country studies for FAO on this theme. The authors of that monograph could not claim any originality in the use of the term "rural aquaculture". This had been coined several years earlier by FAO and specifically by Manuel Martinez-Espinosa (1992). However, what we sought to do was to clarify what might be meant by "rural aquaculture", linking this to the wider term "rural development", which had emerged in the 1970s to bring about a development focus with a specific objective towards the alleviation of rural poverty. The term "rural aquaculture" thus referred to the promotion of aquaculture systems appropriate to the resource base of small-scale households (these days more commonly referred to as "resource-poor households"). Thus we defined "rural aquaculture" as

> "the farming of aquatic organisms by small-scale farming households or communities, usually by extensive or semi-intensive, low-cost production technology appropriate to their resource base."

Although this definition does not specifically stress the poverty alleviation dimension, this is implied in the preamble and Edwards (1999) makes it more explicit in stating that

> "rural aquaculture contributes to the alleviation of poverty directly through the small-scale household farming of aquatic organisms for domestic consumption and/or income; or indirectly through employment of the poor as service providers to aquaculture or as workers on aquatic farms of wealthier farmers; or indirectly by providing low-cost fish for poor rural and urban consumers".

It is the present author's view that the latter part of this statement goes too far, since the provision of employment and low-cost fish for urban consumers may derive from any aquaculture system. Rather the term "rural aquaculture" should be confined to the low-cost production systems suitable for implementation by the poor. The failure to understand this poverty emphasis of "rural development" as demonstrated by Haylor and Bland (2001) inevitably leads to a very broad definition of rural aquaculture.[1]

It may be noted that we distinguished that "rural aquaculture" was either for household consumption or for sale (contributing either directly or indirectly to improved nutrition and food security) and that, given the resource-poor nature of many farming systems, it could involve some external inputs. Nor, in response to the criticism leveled by Yap (1999a, 1999b), does it necessarily imply low value species as we shall see below, although culture of higher value species will tend to demand higher inputs.

This is implied in our introduction to that monograph, which attempted to set various classifications of aquaculture or more broadly of farming systems in a simple matrix, which may be useful to repeat here since it may throw light on the so-called three scales of small-scale aquaculture production which are referred to in the prospectus for the FAO Workshop in Nha Trang. These scales have been inserted in the original table (Table 1). It will be seen that the classification being used for this Workshop lies somewhere between the other definitions. It differs from Edwards, Pullin and Gartner, (1988) in dividing "industrial monoculture" by scale and therefore corresponding to the specialized part of Lazard's (1991) artisanal agriculture or the Type 2 aquaculture of Martinez-Espinosa (1995). However, it follows Edwards (1999) in the separation of

[1] Rural development is defined by these authors as "the management of human development and the orientation of technological and institutional change in such a manner as to improve inclusion, longevity, knowledge and living standards in rural areas in the context of equity and sustainability". The word "poverty" is not mentioned.

TABLE 1
General correlation between various schema for the classification of farming systems (modified from Edwards and Demaine, 1997)

<table>
<tr><th colspan="5">System</th><th>Authors</th></tr>
<tr><td>Settled Agriculture Phase 1 (crop dominated)</td><td colspan="2">Settled Agriculture Phase 2 (integrated crop/livestock)*</td><td colspan="2">Settled Agriculture Phase 3 (industrial monoculture)*</td><td>Edwards, Pullin and Gartner (1988)</td></tr>
<tr><td>Resource-poor agriculture</td><td colspan="2"></td><td>Green revolution agriculture</td><td>Industrial agriculture</td><td>WCED (1987)</td></tr>
<tr><td colspan="2">Subsistence*</td><td colspan="2">Artisanal*</td><td></td><td rowspan="2">Lazard et al. (1991)</td></tr>
<tr><td></td><td colspan="2"></td><td>Specialized*</td><td>Industrial*</td></tr>
<tr><td colspan="3">Type 1 aquaculture*</td><td colspan="2"></td><td rowspan="2">Martinez-Espinosa (1995)</td></tr>
<tr><td colspan="2"></td><td colspan="2">Type 2 aquaculture*</td><td></td></tr>
<tr><td></td><td colspan="3">Balanced model*</td><td></td><td>Edwards et al. (1996)</td></tr>
<tr><td colspan="3">Rural aquaculture</td><td colspan="2"></td><td>Edwards and Demaine (1997)</td></tr>
<tr><td>Aquaculture as one of several livelihood activities</td><td colspan="2">Aquaculture as part of an integrated farming system</td><td>Aquaculture as the major livelihood system</td><td></td><td>Nha Trang Workshop Prospectus</td></tr>
</table>

* Includes and/or refers specifically to farming systems which include aquaculture, in part or entirely

a specific system of "integrated" aquaculture, which in other classifications straddles the subsistence and the artisanal or Type 1 and Type 2. Finally it will be seen that the systems that we are discussing in this Workshop may be wider than the definition of Rural Aquaculture in the Edwards and Demaine (1997) monograph, extending beyond systems which explicitly address rural poverty. This will have clear implications for the indicators to be considered.

REFLECTIONS FROM EXPERIENCE

Experience of Aqua Outreach Programme of the Asian Institute of Technology (AIT)

a) The Farm System

The discussion of rural aquaculture that Edwards and Demaine (1997) launched was based a good deal from our experience in the AIT Aqua Outreach Programme, which began in Northeast Thailand in 1988 and expanded to three other countries of mainland Southeast Asia, namely the Lao People's Democratic Republic, Cambodia and Viet Nam, in 1993. It also incorporated substantially some of the experiences of the programmes of the Department for International Development (DFID) in Bangladesh and some experiences in other countries of the region, notably India, Indonesia and the Philippines.

The argument in "rural aquaculture" was the need for a "farming systems approach". This was seen to be important at two levels, the farm system and the wider environment, especially the framework for the promotion of rural aquaculture. At the farm level, the farming systems approach implied a careful assessment of the resource base of the farm household would indicate the technology options which were available to it. We summarized this in terms of (a) situational analysis and (b) identification of appropriate technologies.

In the AIT Aqua Outreach Programme, at the farm level, we began with a model in which it was assumed that (a) farmers were increasingly experiencing problems in obtaining an adequate supply of fish for domestic consumption from a degrading wild fishery and that (b) improvements could be made in attempts to culture fish by simple technical recommendations such as stocking of larger fingerlings and from utilizing on-farm resources from the wider agricultural system for pond fertilization and feed. We soon realized, however, the real meaning of resource-poor. Most of the systems in the rain-fed areas of Northeast Thailand lacked the basis for improvement of the pond environment in the sense of fertilizer and feed, hence the emphasis that some inputs had to come from outside the immediate farming system. Much the same was true of the Lao People's Democratic Republic and Cambodia. To create even the minimal level of pond fertility, small amounts of inorganic fertilizer, mainly urea, were needed to create “green water”. The emphasis of stocking thus moved towards filter feeders like tilapia.

As we expanded the programme to Viet Nam, however, the picture changed. Despite the high population densities in the Red River delta and to a lesser extent the Mekong deltas, the local resource base was much richer, with at least two rice crops and other dry season crops in irrigated systems offering the resources, sometimes via livestock systems, to support the integrated aquaculture systems known as VAC.[2] These were also supported by human waste either through two-tank latrines in the north of the country or hanging latrines over ponds in the south. Although many of the aquaculture systems in northern Viet Nam were dominated by a low-input culture based around grass carp, there was considerable scope for intensification.

Our initial concentration is Viet Nam was in the lowlands, but over the course of the association between AIT and the Vietnamese partners in the Research Institute for Aquaculture No.1 and the University of Agriculture and Forestry near Ho Chi Minh City, we were encouraged to move out of the lowlands into the hills of the north and the rolling uplands of the southeast regions in support of the “Sustainable Aquaculture for Poverty Alleviation (SAPA)” project. Once again the picture changed. Although there were less intensive VAC-type systems in the valleys of the north, in areas of poorer resource endowment, the systems – sometimes flow-through ponds – were dominated by grass-carp fed with volunteer grasses, low-productivity systems without recourse to external inputs. Yet another mix of resources was available in the southeast of the country.

The degree to which small-scale aquaculture could contribute to sustainable rural livelihood varied according to this resource-base. In the resource-poor areas of Northeast Thailand, with a typical pond of less than one rai (1 600 m^2), it was difficult for farmers to produce more than 250-300 kg of fish, offering returns of no more than 5-6 percent of the total income of a farm household. On the other hand, in the VAC systems of the deltas of Viet Nam, in the context of relatively small holdings of agricultural land, the VAC system might offer over half of the total household income from agriculture. In Northeast Thailand, if the family wished to take their aquaculture system further, they were obliged to invest higher levels of off-farm input and in the second period of Outreach operations in that region, more intensive fertilization strategies were introduced with sex-reversed tilapia, which had the potential for productivity of 3-4 times the traditional systems and could contribute 15-20 percent of income.

b) The support system

However, there was another dimension to the farming systems approach which was advocated. In systems theory, agriculture development may be seen at a variety of scales. At the micro-scale we are dealing with the physical system of the field, the pond and the individual animal; this is then combined with the farm resource system in which the farmer’s available labor and capital come into play. At a further level, the community comes into play, offering resources in the wider natural environment as well as social capital through its various networks. At a yet higher level, the farmer’s decision-making is influenced by the operation of the regional economic and institutional environment, including the availability of inputs, credit and extension

[2] After ‘vuon, ao, chuong’, the Vietnamese words for garden, pond and pigsty.

services and product markets. Finally there is the global scale, the operation of the international market and associated trade regulations.

It was realized in the Aqua Outreach Programme that these wider dimensions of the system were crucial to a sustainable aquaculture development strategy. A key element in the wider environment was access to quality seed, especially larger size fingerlings to guard against predation. This was not so much an issue in Viet Nam, where traditions of aquaculture had already led to the development of seed trading networks of considerable sophistication. Nor was it a major issue in Thailand, where pond farmers could access netting for nursing in their own ponds at a relatively low cost. However, it became much more crucial in the Lao PDR, where primary sources of seed supplies were a long distance from many farmers; a 'nursing network' thus had to be developed encouraging farmers with better water resources in their ponds to become the suppliers of larger fingerlings to their communities.

However, the thrust of AIT Aqua Outreach Programme does not serve well to demonstrate these wider dimensions of the system. The programme was primarily a farming systems research project and, although we were working with the provincial officers of the various Departments of Fisheries or Fisheries and Livestock in the countries concerned, it is not clear how far they were able to sustain the initiatives which were introduced by the project or to what extent the wider institutional system facilitated their sustainability.

Indeed, looking back at another key publication in Rural Aquaculture, the edited volume which emerged from the Fifth Asian Fisheries Forum International Conference, held in Chiangmai, Thailand in 1998 (Edwards, Little and Demaine, 2002), one gets a strong feeling that many of the papers in that volume describe research initiatives in rural aquaculture without either offering strong evidence that it has had major benefits on poor people or that those various initiatives could be sustained. Many of the papers speak of potentials based upon the research initiatives, rather than hard evidence of how the various interventions could be translated into a broader development programme. Where this was presented in papers for example by Gupta *et al.* (2002) in Bangladesh and by Luu *et al.* (2002), there were some doubts cast about the suitability of the interventions for poorer households and the sustainability of the interventions.

EXPERIENCE OF THE GREATER NOAKHALI AQUACULTURE EXTENSION PROJECT AND BEYOND

In 2003, after fifteen years of working in small-scale aquaculture and ten years of working as Programme Coordinator of the Aqua Outreach Programme, I moved from AIT. There were several reasons for this, but one, probably not too prominent, was the feeling that in the Rural Aquaculture volumes, we were one step removed from testing the ideas of the farming systems approach from the real world of development. I moved then to the Greater Noakhali Aquaculture Extension Project (GNAEP), which was one part of the wider programme of Danida support to aquaculture development in Bangladesh.[3]

a) The farm system

In its initial design, GNAEP was a classical transfer of technology extension project, largely based upon the assumption that the appropriate technologies for improved carp polyculture in ponds had been established in the Mymensingh Aquaculture Extension Project. There was some small variation in that the possibility of introducing giant

3 This had begun in the 1980s with support to what is now the Bangladesh Fisheries Research Institute (BFRI) and was followed from 1989 by the Mymensingh Aquaculture Extension Project (MAEP). This in turn spawned two other projects, the Patuakhali-Barguna Aquaculture Extension Project PBAEP) and GNAEP, which started up in 1997 and 1998, respectively. The MAEP was closed in 2003.

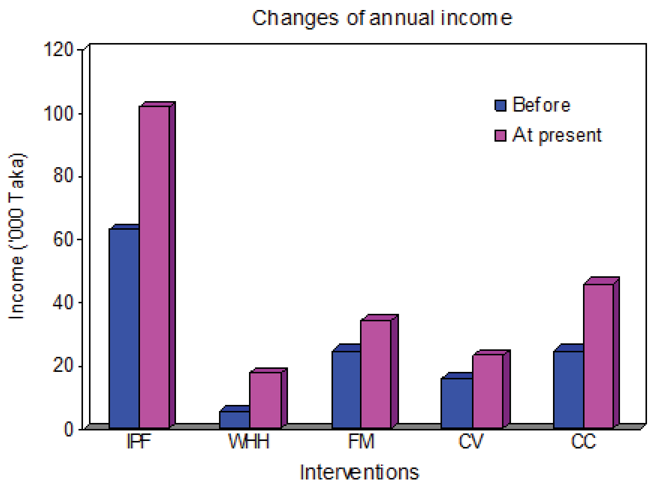
freshwater prawn into the system in the coastal area had been recognized and the first two years of GNAEP did include some modest on-farm research in testing of this possibility, actually with no great success, mainly because of the erratic supplies of post-larvae from outside the region. Apart from this, the project design involved a massive training effort, contracted to a group of local non-governmental organizations (NGOs), who hired a large number of field trainers to conduct a programme of modular training with farmer groups according to the household approach, involving both the men and women of the household. The training programme was supported by a standardized credit programme administered by the same NGOs.

This design enabled GNAEP to reach almost 35 000 households over a period of 4-5 years of intensive extension activity. Results appeared to be generally positive, at least in terms of initial understanding of the technology (measured by Knowledge Tests) and initial adoption. Yields increased around 2.5 times from 1.25 tonnes per hectare to around 3.0 tonnes.

However, there were constraints. It became clear that the package was not suitable in all contexts of Noakhali (there are probably 5 or 6 different ecological systems), especially in the charlands with their limited water holding capacity and in the areas close to the Indian border. Moreover and more seriously, the package did not address the problems of the poorest groups, especially since the concentration of the NGOs upon credit realization meant that they tended to recruit the more creditworthy into the system. Finally, the net returns from the improved pond polyculture offered only a limited improvement to livelihood even for those with better pond resources.

In this context, in 2002-2003, the GNAEP was encouraged to shift its orientation away from a technology-driven approach toward a more explicitly poverty-oriented approach in which the Project tried to identify the main groups of hard-core poor in the region and sought to develop aquaculture interventions which were suited to their resources. Such groups included large numbers of women-headed households in the chars, residents of resettlement villages, landless laborers with no access to ponds of their own and poor fishers in the offshore island of Hatiya.

FIGURE 1
GNAEP: Changes in income levels of poverty groups before and after project intervention



Legend: IPF - Integrated Prawn Farmers; WHH - Women-headed Households; FM –Fishermen; CV - Cluster Village; CC - Cage Culture

In support of this, the GNAEP built upon the experience of the development of freshwater prawn culture pioneered by CARE, especially in the GOLDA project in southwest Bangladesh. The introduction of low-input systems of prawn farming first in paddy fields (*ghers*), then into the pond polyculture systems significantly increased the value of the crop and created opportunities for some of the poorest groups in niche activities such as post-larvae (PL) nursing. Women-headed households adopting PL nursing were able to rear two cycles a year in their small homestead ponds, with a net return of Tk 6-10 000 according to size of the pond.[4] Poor fishers in Hatiya also gained benefit from a regular market for their seasonal catch of a local goby (*chewa*). The GNAEP conducted sample surveys towards

[4] Incidentally survival rates in these micro-ponds managed by poor women reached 70 percent, higher than the assumptions derived from on-station research.

the end of the Project to assess the impact of these pro-poor interventions on livelihood (Akteruzzaman *et al*., 2006a, 2006b). These were highly positive demonstrating that freshwater prawn is a classic case of a high-value product which can be cultured at relatively low levels of input and is thus suitable for the poor (Figure 1).

Perhaps more important than the technical elements of the prawn culture system was the introduction of a more participatory approach to training. GNAEP adopted elements of the Farmer Field School (FFS) approach which had also been pioneered by CARE in their Integrated Pest Management projects, which included a component of rice-fish culture. Young staff members were specifically recruited for their experience in this approach and the approach which began with integrated ricefield culture was extended to the whole training programme over the following three years.

Nevertheless, GNAEP's shift towards an experiential learning approach was diluted and it may be argued that the system was still largely driven by the Project. The promotion of freshwater prawn in the culture systems added a technology, but remained essentially technology or supply driven. Prawn expanded to as many as 8 000 farm households in 2006, but with the end of the Project and a hiatus before the effective start-up of the successor project, these numbers declined sharply in 2007-2008.[5]

In fact it has only been in that successor project, the Regional Fisheries and Livestock Development Project, Noakhali Component (RFLDC) that a fully-fledged FFS approach has been adopted. The RFLDC has a strongly pro-poor orientation with an objective to improve the productivity of and the returns from fisheries and livestock systems of resource-poor households. Its main output is effective support to resource-poor households through decentralized, integrated and demand-driven extension provision. Essentially this means the adoption of FFS approach in which the training content is defined according to the farmers' problems and needs and in which the individual learning sessions (we no longer even use the term "training modules"[6]) involve an analysis of the farm situation, exchange of experiences, guided by a local facilitator and testing of options in designated study plots (ponds/plots/farmyards selected by the group). The farmers then make their own decisions about adoption according to the results obtained. There is no credit line, so that the farmers taking part in the FFS join specifically to learn and are not swayed in their participation by the lure of cheap credit. The RFLDC field schools run over a period of up to 18 months, with fortnightly (but flexible) sessions covering a range of topics including aquaculture (range of options), poultry rearing, small ruminant rearing (goats), cattle fattening, vegetable gardening, nutrition and human rights issues. The FFS are run by young people from the same community trained as Local Facilitators in a practical Season-long Learning approach over a period of four months. The Local Facilitators are trained by Master Trainers, who themselves go through a similar practice-oriented Season-long Learning.

Such an approach extends the Farming Systems approach discussed in "Rural Aquaculture" a step further. The Farming Systems approach is still at its heart. The situational analysis on the farm is traditionally termed agro-ecosystem analysis"(AESA), although it is now more usually termed "farm management analysis" (FMA). The FFS starts by looking at problems and resources and then moves on to system planning (often "space planning", or "what can we do where"). The net result is adoption of

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[5] The reasons for the decline are complex; they included a loss of confidence related to a major flood in the Noakhali region in 2004, early season droughts shortening the growing season, problems of seed quality from brood derived from culture systems and too vigorous promotion, especially by partner NGOs into pond systems of marginal suitability. RFLDC is now trying to consolidate freshwater prawn culture in the more suitable contexts and to ensure supplies of PL from brood of riverine origin.

[6] The rhetoric of development is important. It is important that field staff realize that the FFS is not the same as conventional group training.

enterprises and technology which really fit into the farm household's resource base and with which they are comfortable. Asked why they do not expand a successful enterprise, farmers often reply that they do not have the resources.[7] Farmers coming out of the FFS may have adopted/expanded 5-6 different enterprises all of which are contributing to that improved livelihood. In the Sustainable Rural Livelihoods framework, all of them contribute to strengthening the asset base of the rural household, enabling it to better withstand pressures and shocks. We do not prescribe whether these enterprises are fully integrated or not, since this depends upon the farmer's own resources and priorities.

The Support System

RFLDC sees the FFS approach as the key to ensuring the sustainability of its interventions. By helping the farmers to analyze their situation and develop their learning skills, the Project builds capacity to take informed decisions in a future which is bound to involve dramatic changes in the environment, both physical and socio-economic. We see, for example, the FFS as a vehicle to facilitate adaptation to climate change.

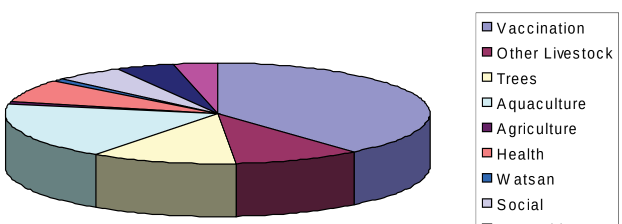
However, RFLDC's adoption of the systems approach does not end with the FFS. In fact the Project is designed to support what we may term "whole system sustainability". The other outputs of the Project are to build capacity in the support or service provision system. RFLDC recognizes that training through the FFS will not be successful unless the farmers have access to the necessary inputs and to a fair market system. It recognizes that the government agricultural extension services just cannot reach the large numbers of poor households, even if they were so inclined. This is particularly the case in the fisheries and livestock sectors. The Bangladesh Department of Fisheries has only three officers at the Upazila level (frequently less) and none at the grass-roots or Union level.

Thus, the Project encourages farmers to form Community-based Organizations (CBOs) as grass-roots service providers. These organizations may come from existing organizations at community level or may emerge from the amalgamation of the field schools themselves. The farmer organizations are properly established, with elected committees and office holders and they offer services for a modest charge which allows them to accumulate capital for their future operations. The Project offers training to key resource persons in the CBOs in planning and project proposal writing, financial management and in technical areas. Thus CBOs have recruited Poultry Workers, Community Livestock Workers and Community Agriculture and Aquaculture Resource Persons (CAARP)[8]; each of these provides particular services (vaccination, health care treatment, operating community nurseries) as well as advice to farmer clients, both within Field Schools and

FIGURE 2

Distribution of Activities Carried Out by CBOs promoted by RFLDC

CBO Activities 2008 (to August)



Legend: Watsan – Water and Sanitation

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[7] Parallel to the situation often encountered in the promotion of standard models of integrated agriculture – aquaculture, where farmers fall back to an equilibrium suitable to their situation, which comprises only parts of the original model.

[8] Originally CARP (Community Aquaculture Resource Persons), but it has been realized that the aquaculture resource person is rarely occupied year-round and needs other activities to achieve a regular income.

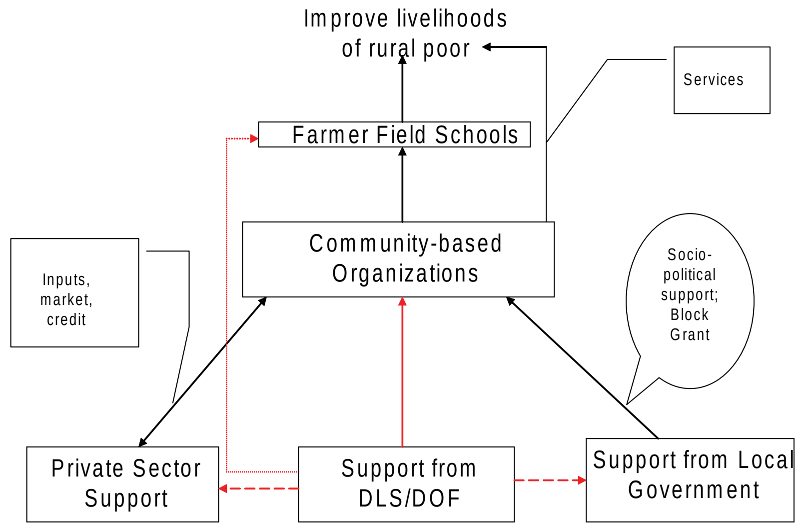
outside. Established CBOs are one channel for organizing the Farmer Field Schools. In this way, the CBOs become a positive element in the Transforming Structures and Processes which are seen as an important dimension in Sustainable Rural Livelihood.

The CBOs were first promoted under GNAEP with a view to supporting the freshwater prawn farming system, to ensure the availability of quality post-larvae and low-cost feed inputs to the farmers. The CBOs were offered commission by private agribusiness (see below) to distribute the inputs to their members and other nearby clients. Very rapidly, however, the CBOs began to offer services in other sectors reflecting the needs of their communities, with vaccination services for livestock and provision of vegetable seeds and fruit tree saplings amongst the early developments. Services now include a range of activities including hosting mobile clinics and pre-school education centers (Figure 2).

The CBOs are in turn supported by three other key stakeholder groups: private agribusinesses, who supply inputs and access to markets, sometimes using the CBOs as their agents; local government institutions, which provide the CBO with socio-political protection, as well as offering financial resources for investment in facilities to expand their activities through a discretionary Block Grant; and the sub-district (Upazila) offices of fisheries and livestock (Figure 3). These stakeholders provide economic, socio-political and technical backstopping, respectively. In the case of the sub-district fisheries and livestock offices, there is recognition of the mutual benefits of this relationship, since the CBOs both get services and provide a convenient outlet for the work of the Upazila officers. There is a regular monthly meeting between the two groups to which other service providers are invited.

In creating this system, RFLDC hopes to ensure that the learning promoted through the FFS will be extended beyond the life of the Project. It is hoped that each of the stakeholders will offer sustainable services: the CBOs and private agribusiness through the profits gained, the Upazila offices through more-responsive demand-driven services, the local government institutions through playing a wider role in local economic development. Building such capacity is not simple and RFLDC technical assistance staff has to work hard with the institutions concerned over an extended period before they are able to play their role in the system. There is a regular monitoring of the progress of capacity building particularly with the CBO

FIGURE 3
Conceptual Framework of RFLDC Extension Model



Legend: DLS — Department of Livestock Services; DOF — Department of Fisheries and local government institutions using indicators adapted from the United Nations Development Programme (UNDP) and the World Bank.[9]

It is rather premature to assess the impact of this intervention upon the livelihood of local farmers. As part of whole process, the monitoring and evaluation of the experience is carried out with the farmers themselves through a Participatory Monitoring and Evaluation approach. This is partly sectoral. The group is asked to assess how far they have changed their practices in relation to various indicators, including a number of technical recommendations, income and sales of produce.

LESSONS LEARNT

In 1997 in the Rural Aquaculture monograph, Peter Edwards and I set out a systems framework for the development of rural aquaculture. From an initial definition and classification, we tried to set out the key factors required for the successful promotion of low-cost aquaculture among small-scale farmers. Our recommendations extended to two levels of the system, the on-farm, emphasizing the identification of appropriate technology to fit the farmers' resource base, and the wider farming system to ensure the functioning of necessary support services for enabling farmers to access the technology. We developed this systems approach based upon the experience of AIT Aqua Outreach Programme and some comparative experiences. A wider range of possibilities for rural aquaculture were presented in Chiangmai a year later. Most of these derived from research projects rather than development or extension projects and there was limited evidence that such an approach could be implemented in such projects.

I like to believe that in the successive projects in Bangladesh we have demonstrated that such an approach can work. However, I also believe that we have taken it a step further, especially at the farm level with the introduction of the FFS approach to farmer training. Although in the later stages of the AIT Aqua Outreach Programme, we began to move away from this, much of the work in the Outreach was prescriptive and supply-driven. We recognized the need for analysis of the farmer's situation, but the technical recommendations came from the Project. There were even some assumptions, such as that expressed in our monograph

> "The major concern in rural aquaculture is how to introduce integrated agriculture-aquaculture successfully into the diverse small-scale farms in the developing world" (page 17)

We were after all involved in an aquaculture research project. Inevitably the prescriptions promoted did not suit the situation of all farmers – even to the extent that aquaculture may not have been a suitable, or at least the best, option. Studies by Pant *et al.* (2004, 2005) on integrated agriculture-aquaculture systems in Northeast Thailand suggest that this is indeed not a panacea, nor a model which works well in many circumstances.

The FFS approach in contrast, does not prescribe, but leaves it to the farmer to select his technical options from those available according to his/her available resource base. It is thus demand-driven and it is thus more likely to be sustained at the end of the development initiative. It is a highly participatory, needs-based approach, taking full account of the capacity of the poor and integrating aquaculture into the wider framework of rural livelihoods as recommended by Tacon (2001).

In relation to the wider support system, Rural Aquaculture recognized its importance, but at the time we were locked into the ideas that such services would come from the conventional service providers, the government extension services and, if they

[9] The World Bank is supporting the Local Governance Support Project, which offers discretionary Block Grants to local governments for rural infrastructure. Its UNDP-supported Learning and Innovation Component takes the scope and scale of this project wider on a pilot basis. Both these projects have developed indicators for local capacity building.

will forgive me for calling them conventional, the NGOs. We recognized the need for reform, in essence the re-education of the government services; indeed that was what a large part of AIT Aqua Outreach Programme was engaged in.[10] However, we neglected the possibilities of other service providers, CBOs as real representatives of the farmers in a demand-driven extension system, the private sector and local government, each of them with real opportunities for bringing about a sustainable system.

IMPLICATIONS FOR EVALUATING THE CONTRIBUTION OF RURAL AQUACULTURE TO SUSTAINABLE RURAL DEVELOPMENT

The above discussion suggests that, in at least one dimension, sustainable rural development is based upon the building of capacity of farm households and rural institutions to continue to implement improved production systems and provide services without the support of external development interventions. Thus the contribution of small-scale aquaculture to sustainable rural development depends upon the degree to which it contributes to capacity building. Conventionally, studies of the contribution (impact) of small-scale aquaculture to rural development have been measured by one-off surveys which attempt to measure change at four levels:

- adoption of improved practices (Knowledge Attitude Practice or KAP surveys)
- productivity
- improved income or levels of fish consumption/nutrition
- improvement in living standards based upon the extra income achieved.

The surveys conducted at the end of the GNAEP had this characteristic. It is, of course, often very difficult to measure improved productivity in small-scale aquaculture and to income/nutrition deriving from it. It is equally difficult to assess the contribution of the aquaculture sector to improved living standards. Very often there is need for recourse to softer measures of productivity improvement and income. Participatory Monitoring and Evaluation (PME) may be used in this respect.[11]

In any event, such surveys are inevitably static and do not indicate how far the changes are sustained and enable farmers to become more self-reliant and more able to withstand the stresses and shocks which regularly impact on their livelihood. The FFS approach is aimed at creating this capacity and it requires measures and indicators which indicate how far the farmers' livelihood is robust and resilient. The Sustainable Rural Livelihoods framework in its asset pentagon indicates the areas which can be measured. The same framework also emphasizes the need for structures and processes in the wider environment which operate positively in the support of the farmer. Evaluation of the operation of these processes will also help to assess the contribution of an aquaculture intervention to sustainable rural development.

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[10] One component of AIT Aqua Outreach was oriented towards reforming the curriculum of universities and agricultural colleges engaged in the training of fisheries graduates and technicians. This reform included the incorporation of systems approaches and socio-economic and environmental issues into the curricula.

[11] Illustrated in a recent paper by Demaine and Sobhan (2009).

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Millenium Development Goals and aquaculture: indicators to evaluate the conservation of the resource base for poverty reduction

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ABSTRACT

Environmental sustainability is the foundation on which strategies for achieving the remaining Millennium Development Goals (MDGs) can be accomplished. Environmental degradation is causally linked to problems of poverty, hunger, gender inequality and health. MDGs are interconnected through the environment. Protecting and managing the natural resource base that supports aquaculture are essential for economic and social development in poor countries. Integrating the principles and practices of environmental sustainability into national policies and planning programmes is therefore a key to successful poverty reduction strategies. This paper provides methods for evaluating proposed changes to the aquaculture sector which can be used as tools themselves or converted into indicators to evaluate the contribution of small-scale aquaculture to poverty reduction through sustainable rural development. The requirement for indices of aquaculture management for poverty reduction and achieving sustainability of natural resources base is highlighted. The simple methodology suggests a number of approaches to identify and quantify the environmental and socio-economic variables related to aquaculture which could be used to develop indices for evaluating performance.

INTRODUCTION

Millenium Development Goals (MGDs) are the specific targets agreed by Member States of the United Nations (UN) for fighting global poverty and promoting improvements in health, education, environment and equality by 2015 (United Nations, 2008). Aquaculture is one of the world's fastest growing food production sectors with great potential for food supply, poverty alleviation and enhanced trade and economic benefits, as targeted by the MDGs (WorldFish Centre, 2007). The success of aquaculture is also closely dependent on aquatic ecosystems and a range of other natural resource inputs, requiring continuous support from the natural resource base. On the other hand aquaculture has a great potential to damage the natural resource base, diminishing environmental quality and societal benefits. The success of aquaculture, therefore, depends upon its ability to produce fish as well as to maintain the sustainability of its resource base. Environmental degradation through aquaculture is causally linked to problems of poverty, hunger, gender inequality and health. The impact of aquaculture can be judged through the production of fish respecting the natural resource base. There is, therefore, an increasing demand for reliable information describing the status, conditions and trends of aquaculture, which is important in determining the success or failures. Indicators and pointers can be developed based on collected data which will describe and forecast and also guide policy and practice to meet economic, social and environmental demands.

MDGs are interconnected through the environment and aim to achieve eight different goals by 2015 (Menoz, 2008). Although all eight goals are interconnected through the environment, two specific objectives are directly related to the theme of this paper. The eradication of extreme poverty and hunger is one of the goals directly related to aquaculture. Fish is one of the major protein sources for poor people, but who may be unable to purchase it due to their level of poverty is an important concern. Aquaculture can be developed in any poverty-driven area if an adequate natural resource base exists and even in a small-scale on a subsistence level. Aquaculture can promote gender equality and empower women through employment in aquaculture-related work (Quisumbing and Meinzen-Dick, 2001). Achieving environmental sustainability through aquaculture is one MDG goal that is difficult to monitor. Aquaculture has been one of the major obstacles for environmental sustainability in many parts of the world. Mangrove destruction and an increase in underground water salinity level due to shrimp aquaculture are two common negative examples of aquaculture undergoing massive spread under poor governance (Wattage, 2002). In an attempt to develop a global partnership for development through aquaculture, many factors need to be considered in the management process.

The concept and definition of sustainable development requires an understanding of issues concerning natural resources, economic output and human/social welfare and the exchanges between them. It also encompasses providing undiminished assets to future generations and maintaining human and ecological equity. The development of indicators to measure this change, providing quantitative values describing characteristics of a specific resource or productive activity, may be an effective means of describing desirable or less desirable paths of development. Management can use these indices to form policy approaches and directions for development. Indicators provide a picture built up “from the ground” using suitably validated systems of information. In practical terms, the use of indicators can contribute to a wide range of benefits including better aquaculture farm management, increased food supply for the poor, poverty eradication, rural development and improved allocation and management of resources. Many governments have recognized the potential benefits of promoting the use of indicators in the assessment and management of the sustainability of the aquaculture sector (Frankic and Hershner, 2006).

The aim of this paper is to provide methods for evaluating proposed changes to the aquaculture sector using indicators. The impact of aquaculture can be identified using quantitative tools that can be used as indicators for evaluating the contribution of small-scale aquaculture to poverty reduction through sustainable rural development. The paper next addresses the issues pertaining to the ecological impacts of aquaculture and looking at the ways to ensure environmental sustainability in aquaculture. The following section of the paper reviews the impact of aquaculture on poverty reduction. Possible indicators to evaluate sustainable aquaculture development and methods are described in the subsequent section. Also reviewed are the tools available to define a suitable methodology to quantify the economic benefits of aquaculture on the environment. The methodology suggests a number of approaches to identify and quantify the environmental and socio-economic variables describing aquaculture systems which could be used to develop indices for evaluating performance. Finally the perspective of conservation for poverty reduction through aquaculture will be presented.

ECOLOGICAL IMPACTS OF AQUACULTURE

Although aquaculture is considered to be the solution to the declining fish stocks in the oceans, its ecological impacts are posing major threats to the sustainability of the environment. These impacts have been mainly associated with high-input high-output intensive system effects which include discharge of suspended solids, nutrient and organic enrichment of recipient waters resulting in the build-up of anoxic sediments, changes in benthic communities and the eutrophication of lakes (FAO, 2009). For example, large-scale shrimp culture has resulted in physical degradation of coastal habitats through conversion of mangrove forests and destruction of wetlands (Wattage, 2002). These farms are not helping to reduce poverty levels of the coastal zones as the income directly goes to elite shrimp farmers. Evidence shows that in many parts of the world, these shrimp farms cause high salinity levels in agricultural and drinking water supplies (Primavera, 1997). Most of the local poor agricultural farmers who have no way to avoid polluted drinking water from ground water sources are further affected (Wattage, 2002). The damage to mangrove plantations in the coastal zones will have a chain effect, not only on available fish, but also damaging the sustainable coastal ecosystem through alteration of seabed fauna and flora communities (Fortes, 1988). Further, misapplication of husbandry and disease management chemicals, collection of seed from the wild and use of fishery resources as feed inputs are also causing concern in the coastal zones (Kongkeo, 2001).

Environmental interactions between aquaculture farms and surrounding areas are a major cause for negative externality associated with aquaculture. For example, salmon farming in Europe can have negative externalities through self-pollution and transmission of diseases which occur in areas where the high density of farms forces use of water contaminated by neighbouring installations (Whitmarsh and Wattage, 2005). The standard method of raising these species is in sea cages under intensive production conditions in which the fish are fed a processed feed causing negative external impacts. Effects can also occur at a distance with interchange of living materials between farms and a consequent spread of disease. In Asia and Africa, the pressure to use resources more efficiently and to increase competitiveness and to respond to market forces has resulted in intensification of aquaculture production in large farms. These operations are mainly for export which employ more sophisticated farm management methods and monoculture of high-value species. The revenue of this production does not help reduce the poverty of the area but rather benefits the non-poor members of society, as it is mainly targeting more affluent consumers. This trend of intensification will increase environmental impacts if there is no way to measure the impact and reverse the trend. In particular, the inefficient use of resources should be controlled and inputs such as equipment and chemicals should be avoided. Aquaculture has often caused the introduction of alien species and diseases and experience has shown that the introduced species of fish, crustaceans, molluscs and plants will eventually enter the natural ecosystem and negatively affect the natural system (Goren and Galil, 2005). The impact of these species needs to be quantified and controlled in order to avoid negative impacts and to protect the natural environment.

Aquaculture, like any other food producing sector, uses natural resources and interacts with the environment. Aquaculture is increasingly confronted with issues of environmental protection, compared to other sectors (McCausland *et al.*, 2006). However, aquaculture is considered to be the only way to satisfy the increasing demand of fish products in a situation where ocean fish stocks are deteriorating at an alarming rate (Garcia and Newton, 1995). The challenge for the next decade is to produce more fish in aquaculture with increasing efficiency in resource use and minimising adverse environmental interactions. This will be the major goal in aquaculture development which will require commitment and willingness to collaborate by all those involved. Much of the current controversy is centred on environmental degradation resulting, in some cases, from inadequate coordination and management of development. Methods or indicators are needed to measure irresponsible aquaculture practices and to avoid negative externalities of aquaculture production which is the key to aquaculture sustainability.

Environment sustainability is the foundation on which strategies for achieving all the other MDGs are based (Menoz, 2008). Environmental degradation is causally linked to problems of poverty, hunger, gender inequality and health. Protecting and managing the natural resource base is essential for economic and social development. Similarly, the changing consumption and production patterns, particularly in wealthy nations, are directly linked to the environment (Lafferty, 1996). Integrating the principles and practices of environmental sustainability into country policies and planning programmes is therefore the key to successful poverty reduction strategies. Indeed, MDGs are interconnected through the environment.

AQUACULTURE AND POVERTY REDUCTION

Aquaculture accounted for 47 percent of the world's human-consumed fish food supply in 2006 and has grown dramatically in the last 50 years. From a level of less than 1 million tonnes in the early 1950s, production in 2006 was reported to have risen to 51.7 million tonnes, with a value of USD78.8 billion (FAO, 2008a). This means that aquaculture continues to grow more rapidly to satisfy growing human demand for fish than other animal food-producing sectors (Subasinghe *et al.,* 2001)**.** The growth of the capture fisheries production stagnated in the mid-1980s, whereas the aquaculture sector has maintained an average annual growth rate of 8.7 percent worldwide (excluding China, 6.5 percent) during last four decades (FAO, 2008a).

Fish production plays an essential role in the livelihoods of millions of people around the world as a means of providing a nutritional food source as well as securing income and/or employment. In terms of providing employment by fishery, 43.5 million people were directly engaged, part-time or full-time, in primary production of fish, either by fishing or in aquaculture in 2006 (FAO, 2008a). The contribution accounted for 3.2 percent of the 1.37 billion people economically active in agriculture worldwide. Eighty-six percent of the fishers and fish farmers worldwide are located in Asia, with China having the majority of about 8.1 million fishers and 4.5 million fish farmers (FAO, 2008). The other countries in Asia with a significant number of fishers and fish farmers are India, Indonesia, the Philippines and Viet Nam. The majority of fishers are poor, small-scale, artisanal persons, operating on coastal and inland fishery resources (FAO, 2008a). In recent decades, major increases in the total number of people engaged in fisheries and aquaculture have come from the development of aquaculture activities (FAO, 2008a). Aquaculture is therefore a significant source in combating poverty in rural areas of many parts of the world. It can provide an important source of livelihood for the rural poor if the objective is to help poor fishers. Aquaculture can generate income through direct sales of aquatic products and also provide opportunities to work in processing industries (FAO, 2003). Aquaculture also provides the only or main source of nutrition through fish to poor people in their livelihood enhancement (FAO, 2003). The estimated number of fish farmers was nearly 9 million people, with 94 percent operating in Asia in 2006 (FAO, 2008a). No official data exists on the estimated numbers of people involved in the other aquaculture-related activities. Some estimation suggests that for each person employed in capture fisheries and aquaculture production, there are approximately four jobs produced in the secondary activities, including post-harvest. Women play an important role both as workers in the fisheries and aquaculture sector and in ensuring household food security. Women participate as entrepreneurs and by providing labour before, during and after the catch in both artisanal and commercial fisheries in the developing world. Women play an important role in aquaculture compared to commercial fishery activities. In many societies, it is easy for women to engage in activities such as feeding and harvest of fish and collection of prawn or shrimp larvae and fish fry and fingerlings from the wild (De Silva, 2002). However, their most important role in both artisanal and industrial fisheries as well as in aquaculture is at the processing and marketing stages. Fish processing is predominantly performed by women either in form of their own cottage-level industries or as wage labourers in the large-scale processing industry (De Silva, 2002).

Fish products provide more than 2.8 billion people with about 20 percent of their annual per capita intake of animal protein out of which 2.6 billion of whom are from developing countries. Thus, small-scale aquaculture and aquatic resource management, particularly in rural Asia, are fundamental to the livelihoods of many of the rural poor. There is growing evidence that in many cases, the poorer the people are, the greater their dependence will be on aquatic resources (FAO, 2008a). Moreover, the demand for low-value fish and non-fish aquatic resources is high. As such, there is a growing emphasis on poverty alleviation in the aquatic resource sector. For this purpose, the objectives of aquaculture development should be adequately addressed for the needs of the poor, instead of merely considering it as a source of foreign exchange earnings for the country. If it is sought after only to satisfy the needs for foreign exchange earnings, then the task will be only to develop large-scale aquaculture farms in which high grade species will be the prime objective. The income or profit thus earned will not trickle down to the poor, simply ignoring the potential that aquaculture holds for poverty alleviation. Often, the aquatic resource sector has only had a partial understanding of poverty alleviation because of the prime motive of foreign exchange. Policy makers of these countries have had a limited understanding of the significance of aquatic resources in rural livelihoods and the potential aquatic resources interventions hold for poverty alleviation.

Aquaculture development in terms of poverty alleviation requires a continuing need for adaptive, small-scale technological development in order to meet the needs of poor people. The main emphasis includes extending these technologies to poor people by creating opportunities to derive livelihood benefits. The emphasis of development programmes in rural areas should use aquaculture for development addressing the alleviation of poverty. This clearly has significant implications for how poverty alleviation interventions are to be conceptualised and how aquaculture should be integrated with other development activities. The quantification of the influence of aquaculture in poverty alleviation as an index is an *a priori* requirement to achieve this goal.

POSSIBLE INDICATORS TO EVALUATE SUSTAINABLE AQUACULTURE DEVELOPMENT AND METHODS

Indicators are simply quantified information which helps to explain how things change spatially or over time. For many years, a limited number of key economic measures have been utilised to judge the performance of the economy. Widely-used indicators are output of production, the level of employment, the rate of inflation, public sector borrowing and the balance of payments. These statistics give an overall aggregated picture but do not necessarily explain why particular trends are occurring and do not necessarily reflect the situation of a particular industry, society stratum or area. However, these widely-used indicators provide policy-makers and the public reasonable measurement of changes in the economy. Policy makers use this indicative information to make economic policy decisions while the general public use it to judge how the economy is performing overall.

There is no such information available to measure the performance of the fishery and aquaculture sectors. The need for indices to understand the general performance of aquaculture and its impact upon poverty and/or environment in a given location is widely evident. The process begins with collection of data that can be used in estimating indices if secondary data is not available. Analysing data derived from a series of observed facts in the form that it can be developed into some meaningful number or ratio is an indicator. The indicators developed into various types of indices can be directly used in policy decisions. In the case of aquaculture, indices can form the link between the society, institutions and the environment. The impact of aquaculture on poverty links the society and the institutions, just as poverty hinges upon the interaction between people and aquaculture through the institution. As such, indices should be developed to measure the impact of aquaculture work interactively among the three tiers of institution, society and the environment. Health and the integrity of interactions between the three tiers provide key signals in relation to poverty reduction and the damage to the environment, as demonstrated by indices in the area of aquaculture.

Indicator I: intensity of exploitation (IoE):

From an economic point of view, the most significant criterion to classify the aquaculture system is "intensity" of operation. The identification of intensity will indicate the impact of aquaculture activities on the natural environment. In intensive systems, fish are reared in silos, tanks, raceways, cages, pens and ponds and the farmer generally controls factors of production such as farm size, stocking levels and the feeding of fish, etc. Indicators could highlight the intensiveness of production, which is a good reflection of how the process is going to impact upon the natural environment. In practice, the distinction between intensive systems is often less than clear. They are, however, generally linked to the level of inputs of feed and/or fertilizer and to the stocking density of the fish that can be supported. Measures of intensity include the stocking density, production of fish in any given area and the cost of input. *Intensive* aquaculture is often considered to be more damaging to the natural environment compared to extensive aquaculture. It is however, better in terms of higher production, at the cost of damaging the natural environment. Examples of intensive aquaculture are salmon farming in Europe and organized shrimp farming in Asia. If the environmental damage is quantified and valued in the management process, the net benefits of intensive production may not prove to be a viable option. Methods are available to quantify un-priced natural resources and to be considered in natural resources management processes (Wattage *et al.,* 2005). Ranching of fish in which a body of sea, lake or a village reservoir is stocked with fish that feed on natural food is considered as an *extensive* system. Cost of production is relatively less in an extensive system and similarly the damage to the natural system is relatively low, albeit for its area-intensity. Subsistence farming of tilapia or carp , or rearing of milkfish and shrimp in unfed tidal trap ponds with low levels of inputs such as occur in Africa and some parts of Asia are examples of extensive aquaculture. *Semi-intensive* systems are diverse and lie in between intensive and extensive systems. Example of semi-extensive aquaculture is integrated agriculture-aquaculture systems, polyculture systems, and coastal aquaculture systems using crop and animal residues as sole inputs.

This index should highlight the effect that small-scale aquaculture activities would have on the natural resource base and its dependence upon the level of intensity. The index looks at how integrated production systems can be made to reduce the negative interactions with aquatic resources. The production system measured in the index looks at physical processes, growth and reproduction and finally the culture environment.

The impact of physical processes used in the aquaculture system depends on the type of structure used in the process. Single cages attached to floaters that are anchored individually have a higher potential to cause damage, mainly due to their mobility. The platform installation is the second type of physical process used in aquaculture which has a capacity to move the whole installation from one location to another. In terms of damage to the natural environment this method causes similar or more damage. The third process uses land-based farms such as rice fields, wetlands, pond settlements. Production is undertaken in tanks and raceways on land with water pumped from the ocean or from freshwater sources. The damage caused by this process is different and this method can even pollute the underground aquifers and soils.

Growth and reproduction is also important in measuring the intensity. The biological system varies by different species used in aquaculture, consequently the intensity would have an influence in the process. Stock inflows depend on recruits, growth and outflows from natural mortality and harvesting which characterise the intensity. Finally the culture environment also influences the intensity, affecting production by the flushing regime, temperature, oxygen level, organic materials used, underwater topography and protection from wind and waves (Environment Canada, 2001). It is difficult to measure all these aspects in one index; however, it is important to consider these as and when the information is available.

Indicator II: Aquaculture footprint (AFP) & Aquaculture carbon footprint (ACF)

A number of studies have assessed the aquaculture foot print (AFP) on mangroves, coastal and oceanic resources, whereby the dependence of the farming systems on the external ecosystems was estimated (Folke, 1988; Larsson, Folke, and Kautsky, 1994; Folke *et al.,* 1998; Kautsky *et al.,* 1997). The common element of these studies is that they have identified ecosystem support areas that need to be quantified and estimated in order to ascertain the level of dependence of aquaculture on the surrounding ecosystems. The type of information generally required includes data on marine and coastal ecosystem productivity and ecosystem waste assimilation capacity. For example, mangrove support area is the area required to produce the necessary amount of detritus to serve as foodstuff for at least 30 percent of the shrimp larvae (Cattermol and Devendra, 2002).

In general the ecosystem support areas required to sustain the aquaculture were calculated as hectares per hectare of aquaculture area and were based on annual production (Larsson, Folke, and Kautsky, 1994). For example, some of the calculated indices are for mangrove support area, lagoon support area and post-larval mangrove nursery. These indicators measured the required ecosystem areas for the production of aquaculture. Mangrove support area is indicated by the mean area required to yield sufficient leaf litter to provide 30 percent of shrimp feed. This rate is estimated on the basis of productivity measured with an average mangrove litter fall of 5 t/ha and a 10 percent trophic efficiency in converting mangrove carbon into detrital organic matter required for shrimp production. The mangrove support area was estimated to be 4.2 hectares for a hectare of prawn farm (Larsson, Folke, and Kautsky, 1994). Similarly, the production of shrimp is also dependent upon the lagoon support area. Lagoon support area is calculated as the area of the pumped yearly volume (10 percent daily, ponds 1.2 m deep, 300 days per year), assuming the source lagoon is on average 5 metres deep. The lagoon support area was estimated to be 7.2ha/ha of prawn farm (Larsson, Folke, and Kautsky, 1994). The required post-larval mangrove nursery area was estimated to be anywhere between 9.6 and 160 ha/ha of prawn farm.

The intensity of the aquaculture activities is an influence in determining the AFP. For example, the need for a sustainable system for an intensive prawn farm is several times that of an average farm (Kautsky *et al.,* 1997). The more intensive the form of farming, the larger the ecosystem area required outside the farm to sustain it. Not only do these ecosystems have to be larger than the farm, but they must also be uncontaminated and intact to ensure a sustained production. It is thought that the dependence on external ecosystems for resource production and waste production decreases from intensive to extensive aquaculture farming systems. Intensive systems use externally sourced goods, but still rely on the local ecosystem to receive and process waste materials from the aquaculture system. Semi-intensive systems are characterised by an increased use of locally sourced resources, with more recycling of organic matter and nutrients within the pond system. This type of culture relies on both naturally occurring and supplementary foodstuffs (Folke *et al.,* 1998). The extensive systems require very small ecosystem support areas, and as a consequence the AFP for both resource production and waste removal is smaller. However, a larger area of holding structure (e.g. pond) is required per produced unit of product. By measuring the AFP of different aquaculture systems it may be possible to tentatively suggest the most appropriate form of farming for a geographical region or country.

In addition to the estimation of AFP, the aquaculture carbon footprint (ACF) is also a very useful measure in terms of ecosystem sustainability. ACF is a measure of the impact human activities have on the environment, in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide (CO_2). To be more effective it would require a footprint analysis throughout the entire supply chain using a full life-cycle analysis (Mungkung, de Haes and Clift, 2006; Mungkung and Gheewala, 2007). Aquaculture has a different CO_2 carbon footprint dependent upon the type of fish under production. For example shrimp, salmon and marine carnivores have high feed energy or system energy demands causing high footprints. Freshwater herbivorous or omnivorous species such as carp require organic or low-energy supplementary feeds, resulting in a low footprint. In addition to the production process, packaging and other supply chain components also contribute for carbon footprint. Post harvest activities (storage and transport) of aquaculture further cause/require CO_2 emissions, further increasing the carbon footprint. Air freight of fish products contributes very high carbon emission compared to sea freight. Transportation by sea freight in containers delivers seventy times the energy efficiency of airfreight and therefore a significantly better carbon footprint (Cattermol and Devendra, 2002).

ACF also includes the carbon dioxide sequestering area. For example, this relates to the area of ecosystem required by the prawn pond to assimilate the carbon dioxide produced by the industrial inputs to prawn farming. The CO_2 sequestering area is calculated as the area required to absorb CO_2 produced in direct energy use. For example, marine up-welling ecosystem producing anchovies for fish meal and fish oil as key ingredients in shrimp feed will require that the mean marine fish (i.e. anchovy) yield is 6.71 tonnes C/km^2 (Larsson, Folke, and Kautsky, 1994). The marine area necessary to supply ingredients to shrimp feed was calculated at 14.5ha/ha of prawn farm. The CO_2 sequestering area is calculated as the area required to absorb CO_2 from direct energy use which is 6085 litres/ha; the total CO_2 released by the study area aquaculture activities was estimated to be between 14.9-45.1 tonnes of CO_2/ha. In order to estimate the surface area needed for carbon sequestration a carbon assimilation capacity of 5 t/ha and 18.3 CO_2/ha was assumed. The CO_2 sequestering area was estimated to be between 0.8 and 2.5 ha/ha of prawn farm (Larsson, Folke, and Kautsky, 1994).

Energy consumption in aquaculture is measured through fuel and raw materials used in the production process which has impacts on climate change issues (Helena *et al.*, 2009). Aquatic production systems such as rice fields, wetlands and pond sediments contribute undefined levels of farmed aquatic organisms however that do not emit methane (FAO, 2008b). Global warming potential of methane is estimated to be 23 times that of CO_2. However, the contribution of methane and other gases in intensive aquaculture systems are very high (FAO, 2008b).

Labelling of fish products with a low carbon foot print is a more practical way of influencing the production process for sustainability (Jaffry *et al.*, 2004). A product´s carbon footprint will become an increasingly used parameter in a product's future marketing strategy. International retailers can use labels on aquaculture products that have a higher value of the index if they have been imported by air. This carbon foot print measurement informs customers about the impact their planned purchase will have on the environment. For example, several major UK retailers have delisted imported North American-Canadian lobster for the 2007 Christmas sales campaign. This decision has been made purely on the basis of the high carbon foot print impact of air freight. Labelling can inform consumers when products have a "low carbon emissions" footprint, thereby informing the consumer of his or her contribution to the environment.

Indicator III: Ratio of aquaculture fish for human consumption

The contribution of aquaculture in global fish production is a key indicator describing the success story of the aquaculture system. If aquaculture is introduced to meet the demand of fish from growing populations, considering the declining trend of the capture fisheries from oceans and inland water sources, it is necessary to measure the contribution of aquaculture for human consumption. Unfortunately, the majority of farmed fish is fed with other fish caught in the oceans. High amounts of fish meal and fish oil are contained in aquaculture feeds. It requires more wild fish biomass to raise some farmed species than is actually produced in their culture. On average, 1.9 kg of wild fish are required for 1 kg of farmed fish, but this ranges from 5.16 kg for marine finfish (halibut, sole, cod) to only 0.75 for carp (fed) (Naylor *et al.*, 2001). The goal of aquaculture is to produce more fish; however, farming carnivorous fish and shrimps that must be fed on wild-caught fish, which come from the ocean food chain, is not sustainable and does not contribute to the poverty reduction MDG (Naylor *et al.,* 2001).

A simple index of the effects of aquaculture on wild fish supply is a good indicator of the contribution of aquaculture to ecosystem sustainability as well as to poverty reduction. This index will demonstrate the disturbing trend of rapid expansion and intensification of high value carnivorous marine species such as shrimp, salmon, cod and tuna farming. The index can measure the use of wild-caught fish for feed processed into fish meal and oil. A high value of the index indicates more use of wild-caught fish in aquaculture production. Some of the wild-caught fish species used in fish feed are cheap and usually demanded by poorer segments of the society. The production of one unit of fish feed requires 2-5 units of wild-caught fish processed into fish feed. Total aquaculture annual production of finfish, crustaceans and molluscs amounts to 29 tonnes and for that production uses fish feed made out of wild-caught fish of 10 Mt. The contribution of aquaculture for human consumption is about 19 tonnes (Naylor *et al*., 2001).

The index will show the advantage of expansion of the non-carnivorous fish in aquaculture. Improved carp and tilapia strains and associated farming technologies should be developed and disseminated among farmers. Producing genetically superior carp and tilapia strains would increase fish production at minimum cost among the poor segments of populations. This addresses the challenge of sustainably and safely increasing aquaculture production for the benefit of poor people. Sustainability will be established through farming species lower on the food web in culture systems that use reduced amounts of fish meal and fish oil in fish feed. Improved livelihoods by equitable and sustainable management of capture fisheries will result in sustainable increases in aquaculture production through improved access to aquaculture fish by the poor.

Indicator IV: Dependency ratio

Aquaculture expansion has the potential to create new jobs and improve food security among poor households in poor regions globally (ARD, 2006). The effects of increased productivity on poverty reduction can be expressed as a dependency ratio. The results will show that there will be positive or negative effects on per capita income for all households. Because of reduction in poverty associated with price reductions and increases in minimum income associated with income expansion, the poverty gap will decrease in all household groups. Because of high sectoral linkages, aquaculture development is a potential candidate for sector-specific policy support to address poverty reduction in poor regions.

Aquaculture contribution to the income and improved nutrition of poor people under small-scale aquaculture is widely appreciated (WorldFish Centre, 2007). Development for increased aquaculture and fisheries production to benefit poor communities indicates their dependency ratio from aquaculture. Increase in fish supply and economic benefits from fish production will increase the dependency ratio. This will be achieved through assessment of the fish and food supply and demand outlook for the poor as an income source as well as nutritional sources provided in their diet. The foregone value of fish due to family consumption should be a part of dependency ratio as same as income from selling fish. This aspect should be included in the impact of various fisheries and aquaculture technologies and policy interventions on the economic well-being of the poor.

The relevance of the use of the dependency on aquaculture in poor countries is more significant in measuring the impacts against the MDG of poverty reduction. Export of aquaculture products is a key foreign exchange earner for poor countries as these earnings enable them to experience economic growth. This is critical to development and also to allow their populations to access the most basic human needs. This is particularly the case with regards to the increase in shrimp aquaculture. The development of shrimp aquaculture in a rising number of poor countries has witnessed the clearance of large tracts of mangroves to make space for large and small-scale shrimp farming (CEA, 1994). The returns in cash revenue from shrimp farms can be large to those who are able to find the initial capital and land area required to start-up in the industry. However, the benefits of clearing the mangroves to allow for shrimp culture has been seen to outweigh the benefits that mangroves are perceived to give to society if one assigns total value for the mangrove (Wattage and Mardle, 2008). The type of land that is required for shrimp farming is inter-tidal wetlands and marshes which is commonly seen as wasteland and generally under no ownership. The common property nature of these important ecosystems means that they have frequently been encroached on by shrimp farmers and because of the wasteland perception, there is often little or no enforcement regarding trespassers. Despite the lack of secure property rights and the frequently illegal occupation of mangrove areas, owners have an incentive to register their shrimp farms and converted land with the Department of Fisheries to become eligible for preferential subsidies in Thailand (Barbier and Sathirathai, 2004). The establishment of community mangrove forests should occur in both the economic and conservation zones in Thailand (Barbier and Cox, 2006) and this could be a partial solution to the problem.

CONCLUSIONS

Aquaculture may benefit the livelihoods of the poor, either through an improved food supply or through employment and increased income. However, no statistical information exists concerning the direct or indirect impacts of aquaculture on poverty. Indicators are essential in this sense to measure the impact of aquaculture on at least two MDGs, i.e. the impact on poverty reduction and on the sustainability of the natural environment. Many current aquaculture practices are not sustainable and are causing a threat to the already exhausted natural resource base. If we want to measure the impact and include it in a decision-making process, the quantification of the impacts as indices could address the problem.

Aquaculture export is a source of foreign exchange earnings for most poor countries. However, the relationship of foreign exchange earned over time and the poverty reduction is unknown. The viability of exports is determined only by comparing the cost and benefits. The actual environmental cost of aquaculture, for example, the damage to the natural resources base and the actual environment benefits, such as the value of protecting mangroves, are difficult to measure or ignore in cost-benefits calculation. As part of "good governance", environmental fiscal reform can directly address environmental problems that threaten the livelihoods and health of the poor. Marine and coastal economic activities depend on the capacity of ecosystems to provide resources for human economic activities which need to be recognized in the management process. In aquaculture, the price of the resources provided by the environment is not accounted for in the market prices of aquaculture products. In fact, in most developing countries, it is commonly not even perceived by those who manage the human activities within these environments. Neither are these factors included in the economic models of fisheries and aquaculture management (Folke *et al.,* 1998).

As a result of global population growth, the demand for natural resources has increased to a level beyond its replenishing capacity. Fisheries, in particular, have come under increasing pressure from global fleets and declining catches are indicative of an over-exploited resource (OECD, 1997). Because of this, aquaculture has often been held up as a replacement for the decline in catch of the capture fisheries (Willmann, 2005). However, aquaculture relies on the immediate ecosystem for clean water, waste assimilation, foodstuff and juvenile stock. In fact, intensive and semi-intensive forms of aquaculture depend heavily on capture fisheries to provide the animal protein and fish oils that are key ingredients in feed pellets for cultured species (Folke and Kautsky, 1992). Environmental impacts of intensive aquaculture also include the deterioration of spawning grounds of commercially important species, whereby the larvae are extracted from the wild and used to stock the aquaculture operations, and are thereby not allowed be recruited into the wild fishery (Folke *et al.,* 1998). There is a direct need to take into account the environmental services provided to aquaculture which are currently not included in valuing aquaculture production (Folke and Kautsky, 1992). Indices of aquaculture could fill this vacuum by providing accurate information. The ecosystems that provide services to aquaculture production are seldom recognized as a necessity for this type of economic activity. The general consensus is that if aquaculture is to be ecologically sustainable, efforts must be directed towards methods that make use of the natural environment without severely or irreversibly degrading it. One way to judge how close aquaculture is to the limits for environmental carrying capacity is to estimate the indicators that describe its activities.

The World Summit on Sustainable Development (WSSD) held in South Africa in 2002 re-affirmed the MDGs and stressed that poverty reduction and improved environmental management go hand in hand (OECD, 2005). The WSSD Plan of action calls upon governments to *"Promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the costs of pollution, with due regard to the public interest and without distorting international trade and investment"*. The Financing for Development Conference, held in 2002 in Monterrey, also emphasised the importance of mobilizing domestic resources for development including through efficient tax systems (Euro Step, 2008). Environmental fiscal reforms and use of indicators are the ways to increase domestic resource mobilisation for poverty reduction and environmental sustainability in poor countries.

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Small-scale aquaculture: a fantasy or economic opportunity

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ABSTRACT

Doubts have pervaded the development drive of small-scale or limited resource aquaculture as an activity for stimulating rural economic growth. The contribution of small-scale aquaculture (SSA) to economic development has been questioned in spite of its contribution to local protein consumption in developing countries. In Asia, about 50 to 80 percent of animal protein originates from SSA, and fisheries and aquaculture have been considered as means of generating revenue to households of rural and coastal peoples. A number of attempts to measure societal and economic value of SSA contribution to rural development have produced mixed results. The measures used are based on classical techniques which examine returns to resources used, benefit/cost ratios, welfare contribution to households and society, improvement to rural livelihoods, value addition, and the effects on environmental sustainability. Researchers, policy makers and donors are still doubtful about the potential of SSA to contribute to sustainable rural livelihoods. In this paper, we develop a conceptual framework to examine the contribution of SSA to sustainable livelihood. We use past estimates of net returns above costs and a cost of living allowance to evaluate the economic and financial sustainability of aquaculture in Bangladesh, China, India, Indonesia, Malaysia, the Philippines, Thailand and Viet Nam. The internalization of a cost of living allowance in the evaluation of sustainable livelihoods shows that only tilapia monoculture in Bangladesh, and small-scale semi-intensive shrimp culture in India and the Philippines maintain sustainable livelihoods to each farm family member based on the average per capita income that prevails in the area, and the considered welfare generated by other farm family households in the area. The major factors influencing the generation of positive net present values (NPVs) are family size and survival rates of the species. The number of individuals dependent on the enterprise for its livelihood negatively influences the NPV. The survival rate positively influences the NPV. The results show that when farm family livelihoods are included in the analysis SSA becomes less attractive as a sustainable venture.

INTRODUCTION

Aquaculture has been the fastest growing enterprise in the agricultural sector (Pedini, 2000). More than 60 percent of aquaculture products come from Asia and about 90 percent are from small-scale aquaculture (SSA) on fish farms of less than 1.0 ha from integrated farming systems (FAO, 2006). SSA involves the production of finfish, molluscs, crustaceans and plants in small ponds using limited non-farm inputs.

Most of the integrated aquaculture can be distinguished within the general definition of integrated farming systems on the basis of diversification of agriculture towards linkages between subsystems (Edwards, Pullin and Gartner, 1988; Edwards, 1998). A more recent definition put forward by Edwards (1998) is based on the sustainable livelihoods perspective with increased linkages between different farms and specialized agro-industries. It is believed that SSA production would enable fish farmers to attain the Millennium Development Goals. After spending major amounts of donor assistance there are doubts as to whether SSA can still live up to its promises.

Though SSA produces the majority of aquaculture harvested globally, one is not sure whether extensive SSA practised by a farm household can provide a sustainable livelihood to the rural poor. As many rural poor enter and exit aquaculture production, it is worthwhile to ask whether small-scale production is sustainable. Most analyses that have been conducted show that SSA provides positive net returns to resources used, yet indicators of long term success are unable to identify many aquaculture farmers over a long time period. In this paper, we examine the nature of evaluation of SSA sustainability.

MEANING OF SUSTAINABILITY

According to Harwood (1990), a sustainable aquaculture system is one that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment that is favorable both to humans and to most other species. Anamarija and Hershner (2003) defined sustainable aquaculture as an on-going system that continues functioning into the indefinite future without being forced into decline through exhaustion or overloading of key resources on which that system depends. Implied in the definition of sustainability is that the farm system is viewed as a whole when making management decisions, even though specific decisions do not appear to have impact outside the area of use or application (Hauptli *et al.*, 1990). Sustainability means the ability of a system to last long enough to regenerate itself after disruptions or shocks. Sustainability involves durability and the provision of sustenance to its participants over a long period of time. Sustainability of SSA also means the production of aquatic products in a given system over a long time period with minimal environmental effects. There are many types of sustainability and indicator measurements of sustainability. The definition used for sustainability involves social, technical, financial, and environmental and ecological aspects.

Environmental and physical sustainability

The measurement indicators of the sustainability of aquaculture employed are numerous. They include the effects of aquaculture on the soil, water, air, fauna, flora and biodiversity. Beardmore, Mair and Lewis (1997) have classified the effects on biodiversity as aesthetic, ethical, economic, evolutionary survival of individual species and maintenance and stability of systems. So far the effects of aquaculture on the physical environment have not been conclusive. However, Beveridge, Philips and Macintosh (1997) believe that the demand for environmental goods and services are positively related to environmental damage. Whereas intensive aquaculture has been considered environmentally and ecologically hazardous (Jolly and Kusumastanto, 2009) SSA, as practised by limited resource farmers in Asia and Africa, with low amounts of non-farm inputs and where agricultural wastes are recycled and used for fish production, is considered environmentally friendly. Low non-farm input aquaculture which is highly integrated and provides sub-linkages to other sub-systems are considered environmentally appropriate (Edwards, Pullin and Gartner, 1988; Edwards, 1998). These low-input SSA systems produce wastes which are inputs for other sub-systems. Examples of these are sub-systems where waste water and bottom pond residues are used for the production of fruits and vegetables. These small-scale systems also receive wastes from other sub-systems which enhance fish productivity. Hence the integration of fish production and chicken or duck production is a case in point where animal wastes are employed to increase pond productivity (Clonts, Jolly and Alsagoff, 1989). One can, therefore, measure the degree of integration as an indicator for environmental and physical sustainability (Lightfoot and Pullin, 1995; Lightfoot *et al*.,1993a, 1993b).

There has been considerable debate about the effects of aquaculture on biodiversity and the environment. Many researchers believe that the sustainability of aquaculture on the physical environment depends on pond construction. According to Beardmore, Mair and Lewis, (1997), aquaculture development has been largely responsible for the loss of the majority of mangrove habitats, with consequent reduction in species, diversity, and genetic variation in wetland ecosystems. One is the way in which the ponds are constructed and another is the disturbance created during pond construction.

Technical sustainability

Technical sustainability of aquaculture is measured in terms of linkages developed and maintained during aquaculture development. Once aquaculture development results in technical change and does not create imbalance in resource use and allocation, technical sustainability in aquaculture will be maintained. Whitmarsh, Cook and Black, (2006) stated that the expansion of aquaculture will require the adoption of technologies that minimizes damage to the environment. The technologies developed and employed in aquaculture must be based on the physical as well as the social environment. This means that technical sustainability will depend on whether the technologies designed are based on the culture and indigenous knowledge in the locale. These technologies must be self-generating and provide backward and forward linkages to local industries (Brummett and Williams, 2000).

Social sustainability

According to FAO (2006), the positive livelihood impacts of aquaculture include provision of rural livelihoods, better income and new or alternative employment, additional income from rice farming systems or subsistence staple cropping systems, food security and better nutrition, and development of rural areas. The negative impacts of aquaculture, on the other hand, arise from production expansion in less than desirable areas, conflicts which can be classified as social in nature and related to the wider environment within which aquaculture operates.

Social sustainability depends on the effects of aquaculture development on the social welfare of the individual and the community. Large-scale intensive aquaculture, as in the case of shrimp farming, has been noted to cause social disruption where resource rights have been altered during the process of aquaculture development (Primavera, 1991). When lands have been moved from individual farm production to large-scale enterprises where the individual farmer ceases to operate as an independent entrepreneur but a worker in an aquaculture factory setting, then aquaculture has been considered as non-sustainable. However, SSA with limited land inputs has been noted to bring communities and individuals together and improve social welfare. SSA, with low levels of inputs has been shown to increase total farm revenue and farm household revenue. Indicators used for the measurement of social and community sustainability are land rights, labour displacement and migration, community togetherness and leadership skill development.

Economic and financial sustainability

Economic and financial sustainability has been measured in a number of studies. The various measures used are the volume and value of fish measured per given quantity of resources. Some easy, practical and short term metrics used are the gross returns, the net returns above all costs, and the net returns generated to limited resources, such as land, labor, and capital. There are those who use the levels of risks associated with the production of various species. These measures are intended to examine the short term profitability and risks associated with SSA. Dey, Sheriff and Bjorndal (2006) examined various production systems and species for a number of Asian countries and found them profitable. Most of these studies did not stress the long-term profitability and in cases where attempts have been made to measure their long-term feasibility, the indicators used as measures of sustainability have generated positive net present values (NPV) and internal rates of returns (IRR) above the required rates of return (RRR). Hence SSA has been deemed financially and economically sustainable. There remains the following questions:

Is SSA sustainable?
If so, why has it not shown more promise (Edwards, 2000; Brumett, Lazard, and Moehl, 2008)?
Why is the isolation of indicators to measure its success and failure so difficult?
Are our tools inadequate or are we isolating and using the wrong indicators?
Is size a factor in measuring aquaculture sustainability, or should we redefine or reclassify SSA?

To answer some of these questions we examine the financial and economic indicators and use examples to theoretically show that the tools for measurement of financial and economic sustainability are adequate, but we have not been thorough in our analyses. We first use a conceptual framework to show some of the factors that are not considered when examining economic sustainability; then we propose a set of factors that should be considered in measuring financial and economic sustainable livelihoods.

CONCEPTUAL FRAMEWORK

Implied in the definition of sustainability is endurance over a long period of time. Also included in the definition is the ability of self-regeneration. The quest for survival of any system or living entity over time is that of being able to compete in a given environment. Hence, for aquaculture to survive and be sustainable it has to compete with other systems to achieve its designated goal. The stated goal for most production systems is the generation of a given level of welfare for its operators over time. This welfare is often measured by the per capita income received by the operators for the use of a given level of resources in a given time period. The measure of per capita income includes all farm contribution and output extraction from the farm accruing to the farm family. In the case of SSA, the operators are the household members who also supply labor, management and capital for investment, and operation of the farm.

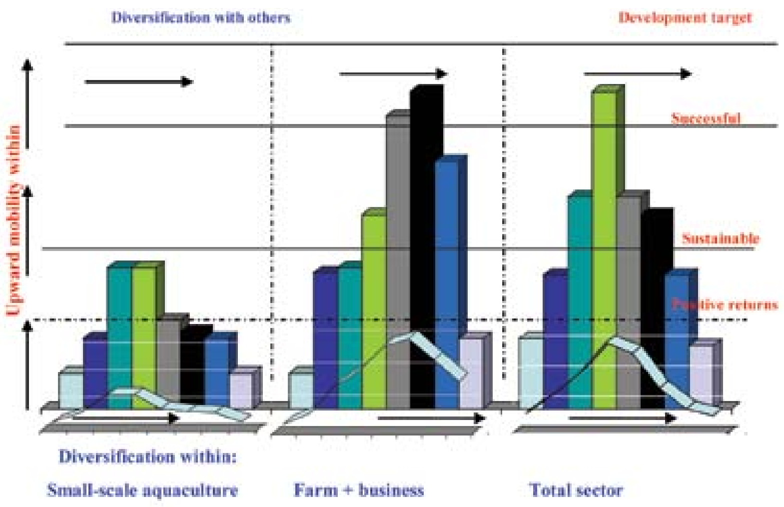
In many developing countries, rural households engage in agriculture or aquaculture on a small piece of land which is supposed to generate all the farm household income. Since we assume that man is a rational being, he will choose the activity or combination of activities that maximizes welfare with a given level of resources within a given time period. The activity need not be agricultural or aquaculture related. Since endurance or durability is inclusive in the definition of sustainability we will, for the purposes of this paper, equate sustainability to the planning horizon of the farm family.

The farm household examines its level of welfare in comparison to that of others engaged in similar activities in the rural area and tries to emulate their performances over the planned period. The level of welfare for our analysis is measured by the per capita income in the area of activity. Let us assume that the existing per capita income generated by SSA is USD500. However, SSA has the potential to generate USD600 over a planned period and this compares favorably with other possible activities in the area; then the farm household opportunity cost at present is USD500 and in the future it is USD600. Assuming that all costs are internalized, the individual is likely to remain engaged in aquaculture. However, if SSA is unable to generate comparable annual per capita income to each member of the farm household, the unsatisfied family member is likely to defect from aquaculture and engage in another activity or combination of activities that will generate comparable per capita income in the area over the long run. The basket of activities chosen will depend on the individual farm household needs and security. If SSA produces less per capita income than another activity but assures the family a given level of animal protein, the farm household may be hesitant to quit this activity. The farm family also considers the risk associated with the other activities. SSA may be less or more risky than a higher income generating activity. Hence the farm household, in deciding to remain in aquaculture, pays a risk premium for remaining in SSA if it is less risky than other comparable activities.

The farm household as a group also has a strategic plan for survival. The strategic plan may include a diversified set of activities for its survival and upward mobility. In the short run, the farm household may consider one activity in its strategic plan or may consider a combination of activities. The household may examine the net farm income of the activity as a short run indicator of success, and though the generated net farm income may be acceptable, the SSA activity may be inadequate to provide a competitive and sustainable per capita income to maintain the livelihood of each household member. Hence, the farm household may diversify and combine fish farming with a non-farm activity that will raise the income to a desired level which is competitive with an average rural and non-rural farm activity.

Figure 1 shows the temporal movement of a small-scale fish farming household attempting to attain its goal. The goal is a sustainable livelihood over time. The process is dynamic. The small-scale rural farm household may use SSA as a rung on the ladder of upward mobility to attain farm and family goals. In Figure 1 the farm household compares its fish enterprise profitability and sustainability with others. The distribution of aquaculture income is also noted. Based on the farm household strategy the activity or set of activities is chosen. To attain its goal it may remain in aquaculture or include non-aquaculture activities in its strategy during its second phase. The distribution of per capita income from the portfolio of activities is also considered. In the following time period the farm household will not only consider aquaculture in its portfolio but also consider a set of activities that will allow the group and each member of the household to attain its objective. The farm household that practices aquaculture to attain a short term livelihood may find it inadequate to meet a desired goal in the long run,

FIGURE 1
Dynamic framework for the evaluation of small-scale aquaculture



and therefore, may choose a different set of activities. Though the farmer may be registered as a fish producer during a baseline survey he may exit aquaculture in future years because it does not satisfy the household's desired livelihood goals. The farmer is not necessarily a quitter or non-adopter but a rational being making logical choices. The household intent is to use aquaculture to temporarily meet its desired objective, and hence aquaculture may be considered profitable in the short run but not sustainable during the planned period.

The farm household's willingness to rely solely on aquaculture or on a combination of aquaculture and non-aquaculture activities depends on aquaculture potential to generate a given level of income for the farm household comparable to the existing per capita income in the area over a period of time. When examining the financial and economic sustainability of a given activity we depend on the financial ratios accepted by bankers, donors, investors and policy-makers. We examine the net returns in the short run, the internal rates of return, profitability index without truly relating those to the farm family goals of maximum or comparable per capita welfare in the short and long run. We state that SSA is profitable in the short run and feasible in the long run hence financial and economic sustainability is implied. SSA may be profitable in the short run and long run but may be inadequate to allow the farm household members to embrace a sustainable livelihood from aquaculture (SLA). Including SLA in the analysis of small scale aquaculture broadens our framework by including a dimension that raises the income of the rural family household member above the poverty line (Adato and Meinzen-Dick, 2002). However, if we only use the narrow approach of net income over production costs as an indicator of sustainability, while all types of capital used for the measurement of sustainable livelihoods are not incorporated, we are likely to find that SSA is sustainable where in fact it may be unable to sustain the livelihoods of the rural farm household.

Another measurable indicator most commonly used to evaluate sustainability is the growth in the number and size of farms. We sometimes forget that farms will expand or contract in terms of size and/or numbers based on whether the activity or combination of activities meets the long and short-term goals of the farm household. If SSA fails to provide the farm family with a sustainable livelihood then the farmer may expand his operation in order to benefit from economies of size or integrate to acquire economies of scope.

If SSA is unable to generate comparable per capita welfare as measured by per capita family income, then the share contribution of aquaculture to the household family budget is likely to decline. There may be a reduction of output per unit of resource or a reduction of inputs in the production of output. As an example, if members of a given household realize that SSA generates less per capita income in the short and long run than selling shirts by the road side then the family member is likely to reallocate some or all of his or her resources towards the selling of shirts. Hence the economic and financial sustainability of SSA depends on measurable financial indicators as well as whether it is able to sustain the livelihood of the members of the farm family. This is based on the goals of the farm household members and is determined through a comparative analysis with other household and is unrelated in most cases to short term profitability or long term financial feasibility. Short-and long-term profitability are necessary, but not sufficient, conditions for long-term livelihood sustainability of an enterprise.

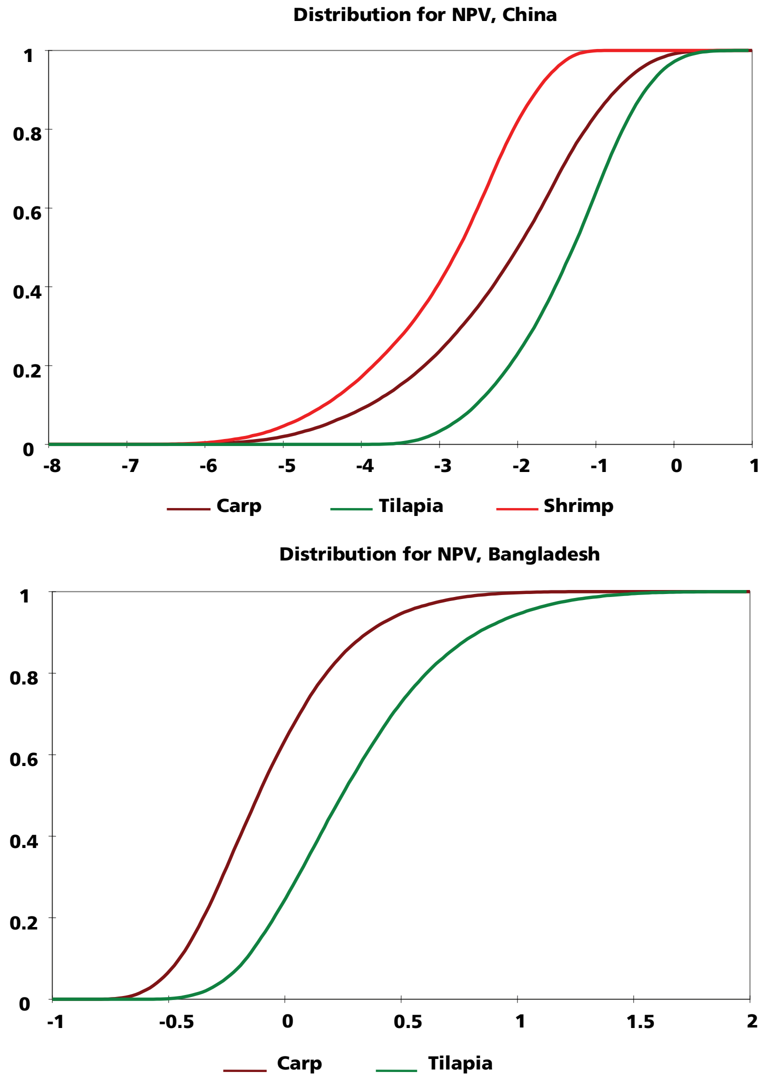
EMPIRICAL APPROACH

We will demonstrate how financial and short term profitability and long term feasibility may not provide useful indicators for the evaluation of SSA. We use the evaluation of indicators by Dey, Sheriff and Bjorndal (2006) on aquaculture development in Asia to show that short term profitability and long term financial feasibility may be insufficient to evaluate the sustainability of a farm household unless all costs of a sustainable livelihood during a given time period are internalized. We will also show that the farm household may examine the stream of income over time to determine the long term sustainability and competitiveness of the flow of income from a given livelihood.

For this exercise we assume that the farm household produces all fish on the average size rural farm. Fish sales generate all the farm income that is distributed equally among the household members. The income received by each member of the farm household is adequate for him/her to maintain a sustainable livelihood. The goal of the farm household is, therefore, to provide a sustainable livelihood to each family member.

We assume that the farm only produces fish on a small-scale and we use the estimates of Dey, Sheriff and Bjorndal (2006) to calculate net present values (NPV), internal rates of return (IRR), and profitability index (PI) for the enterprise. We assume that over the planning period, the farm family will use this enterprise to generate income to place

FIGURE 2
Probability distribution of NPV for China and Bangladesh



its farm family at the same level of welfare with others in the rural area. Failure to do this will result in the household family members to dis-adopt fish farming. Here we add to the investment the cost of living allowance (COLA) that each farm family envisages will allow it to be competitive in maintaining a sustainable livelihood. This COLA takes care of the other forms of capital (human, social and physical) outlined by Adato and Meinzen-Dick (2002). The COLA is the amount that will allow the rural family member to emulate the performance of others involved in an enterprise generating a per capita income over time that is comparable to the average rural per capita income. In this case we consider the various enterprises and countries in Asia considered by Dey, Sheriff and Bjorndal (2006). We also use the average household family size and per capita income collected from the CIA World Fact Book (2008) (Table 1). We assume a planning horizon of 10 years and a discount rate of 7 percent to demonstrate how choices may be made in selecting aquaculture as a sustainable enterprise.

The production risks with COLA added to the investment cost are also simulated using @RISK Analysis and Simulation tools (Palisade, 2009). It means here that the farm household member will consider not only the discounted net farm household income but also the associated risks.

RESULTS

Most enterprises considered by Dey, Sheriff and Bjorndal (2006) generate positive net returns above all costs. These net returns above costs were used to estimate NPVs, IRRs and PIs that were far higher than the discount rate, and all PIs were above 1. The returns above costs are given but since all enterprises in all countries generate positive

TABLE 1
Per capita income and cost of living allowance

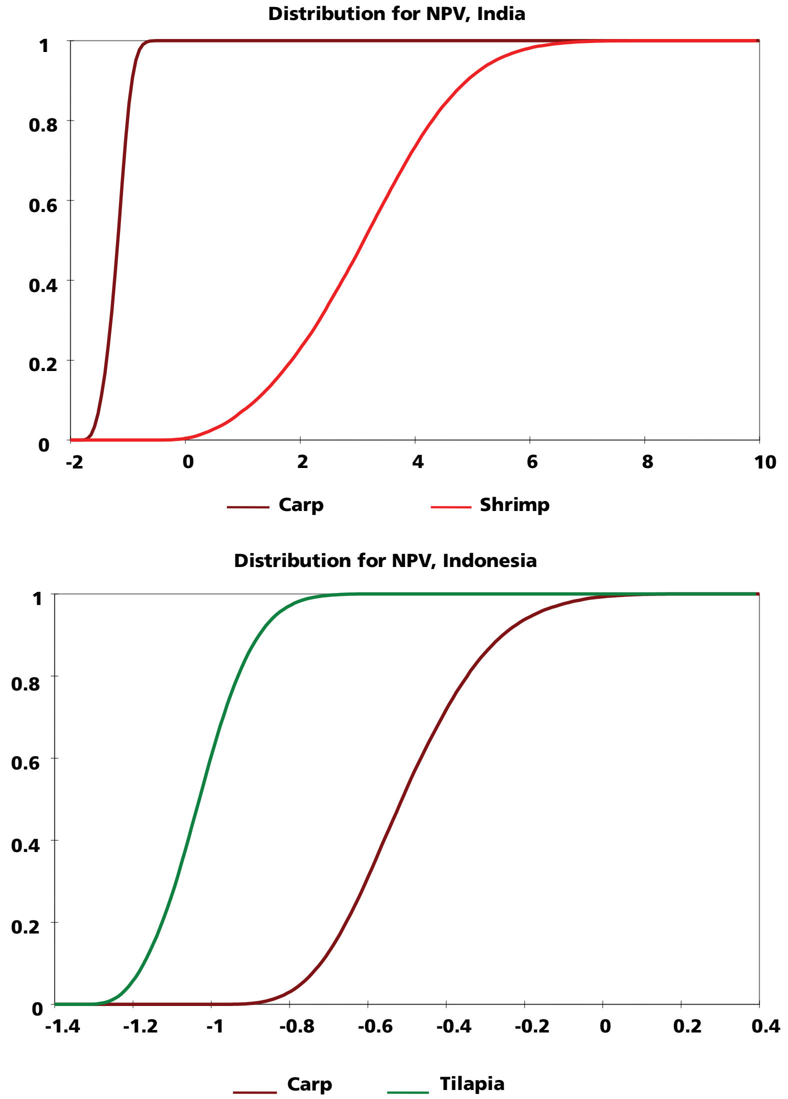
Country	Per capita Income for country at constant dollar (2008)	Per capita Income for rural areas (2007)	Cost of living allowance
Bangladesh	1 500	1 901	1 500
China	6 000	419	2 100
India	2 800	3 331	1 700
Viet Nam	2 800	3 007	1 600
Philippines	3 300	2 996	1 900
Malaysia	15 300	10 757	2 200
Indonesia	3 900	3 753	1 600
Thailand	8 500	8 870	2 000

net returns above all costs (Table 2) and the PIs are above 1, the NPV, IRR, and PI are not included in Table 2. However, when the COLA is added to the investment, SSA enterprises in the rural areas are profitable - tilapia monoculture with a PI of 1.16 and an IRR of 10 percent in Bangladesh, semi-intensive shrimp with a PI of 2.54, 2.72 and 2.54, and an IRR of 31 percent, 31 percent and 27 percent in India, Malaysia and the Philippines respectively – and capable of generating a financially sustainable livelihood for each farm family household independent of other sources of income.

When we simulated the associated risks (Figure 2) we noted that all enterprises in China are at high risk and the probability of generating positive NPV is almost zero. In Bangladesh, carp culture has a probability of at least 40 percent to generate positive NPV, while semi-intensive shrimp culture has at least 20 percent chance of generating a positive NPV. A look at figure 3 shows that in India semi-intensive shrimp culture exhibits stochastic dominance over carp culture throughout the planning horizon. In Indonesia, both carp and tilapia culture are high risk. In the Philippines (Figure 4), semi-intensive shrimp culture is also stochastic dominant over tilapia culture, and tilapia culture is highly risky. In Malaysia, semi-intensive shrimp culture shows low risks as all NPVs are in the positive range for all simulated risk situations. In Thailand, only shrimp culture should be considered based on the levels of risks displayed in Figure 5. Tilapia and carp culture are highly risky based on simulated NPVs and IRRs. In Viet Nam, carp culture is less risky at low levels of income but semi-intensive shrimp culture displays less risks at low levels of income.

The major factors influencing the generation of positive NPVs are family size and survival rates of the species. The number of individuals dependent on the enterprise for its livelihood negatively influences the NPV. The survival rate positively influences the NPV.

FIGURE 3
Probability distribution of NPV for India and Indonesia



DISCUSSION

The fish enterprises considered in the various countries all had positive net returns above all costs and would have been considered acceptable in the short and long run. These enterprises would be included in the farm strategy. However, when the aspect of sustainability was included, that is whether the SSA enterprises provided an income to allow each family member to attain a comparable livelihood based on the living standard in the area, only tilapia monoculture in Bangladesh, and semi-intensive shrimp culture in India and the Philippines are able to provide sustainable livelihoods to each farm family member based on the average per capita income that prevails in the area, and the considered welfare generated by other farm family households in the area. The demonstration effect is always present and family members are likely to emulate the living standards of their counterparts.

The family size negatively impacted the NPV while the survival rate positively influenced the NPV. While the family size can only be controlled internally, service providers in aquaculture can use this method to advise small-scale fish farmers about the choice of enterprise that supports a given family size. For example, we note that mostly small-scale intensive shrimp production can support the average family size, given the average per capita income existing in most of the countries. It must be noted that shrimp is a high priced fish product but its culture under semi-intensive conditions is also associated with some degree of environmental pollution

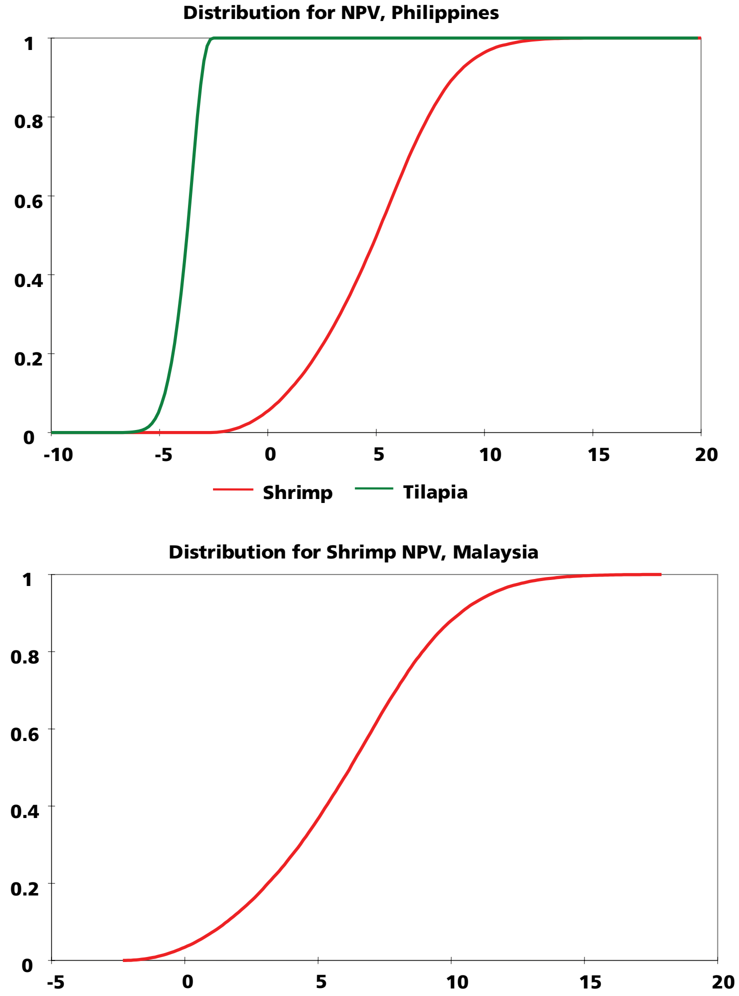
TABLE 2

Per capita profitability measures; NPV and PI computed at 7 percent discount rate. Initial investment for capital budget includes cost of living

				Enterprise budget		Capital budgeting					
						Without COLA			With COLA		
Country	Family Size	Species	Technology/ Intensity	Return on variable cost (in USD)	Return on total cost (in USD)	NPV (in USD)	PI	IRR (percent)	NPV (in US)	PI	IRR (percent)
Bangladesh	5 13	Carp	Polyculture	1 71	1 71	1 277	-[a]	-[a]	-125	0 91	5
		Tilapia	Monoculture	2 94	2 94	1 633	-[a]	-[a]	231	1 16	10
China	4 08	Carp	Polyculture	0 40	0 21	-150	0 91	6	-2 112	0 41	-3
		Tilapia	Monoculture	0 89	0 45	594	1 36	11	-1 369	0 62	1
		Shrimp	Semi-Intensive	0 39	0 14	-885	0 26	-2	-2 848	0 10	-11
India	5 51	Carp	Polyculture	0 33	0 28	398	6 03	56	-1 191	0 29	-12
		Shrimp	Semi-Intensive	0 95	0 85	4 612	13 48	140	3 023	2 54	31
Indonesia	4 25	Carp	Monoculture	3 01	2 89	978	83 56	1107	-517	0 66	-1
		Tilapia	Monoculture	1 59	1 15	460	5 77	56	-1 035	0 35	-10
Malaysia	4 52	Shrimp	Semi-Intensive	0 69	0 57	8 015	6 66	64	5 959	2 72	31
Philippines	4 6	Tilapia	Monoculture	0 80	0 15	1 990	-0 15	-8	-3 766	-0 08	-
		Shrimp	Semi-Intensive	0 69	0 54	6 555	5 33	50	4 780	2 45	27
Thailand	5 01	Carp	Polyculture	0 31	0 27	449	9 38	89	-1 420	0 26	-14
		Tilapia	Monoculture	1 24	1 03	1 264	9 82	98	-605	0 70	0
		Shrimp	Semi-Intensive	6 75	3 95	1 760	9 44	95	-110	0 95	6
Viet Nam	5 36	Carp	Polyculture	1 77	1 23	1 257	5 35	51	-425	0 78	3
		Shrimp	Semi-Intensive	0 46	0 31	1 273	2 22	20	-410	0 85	5

[a] Data for Bangladesh did not include fixed costs for initial investments

FIGURE 4
Probability distribution of NPV for the Philippines and Malaysia



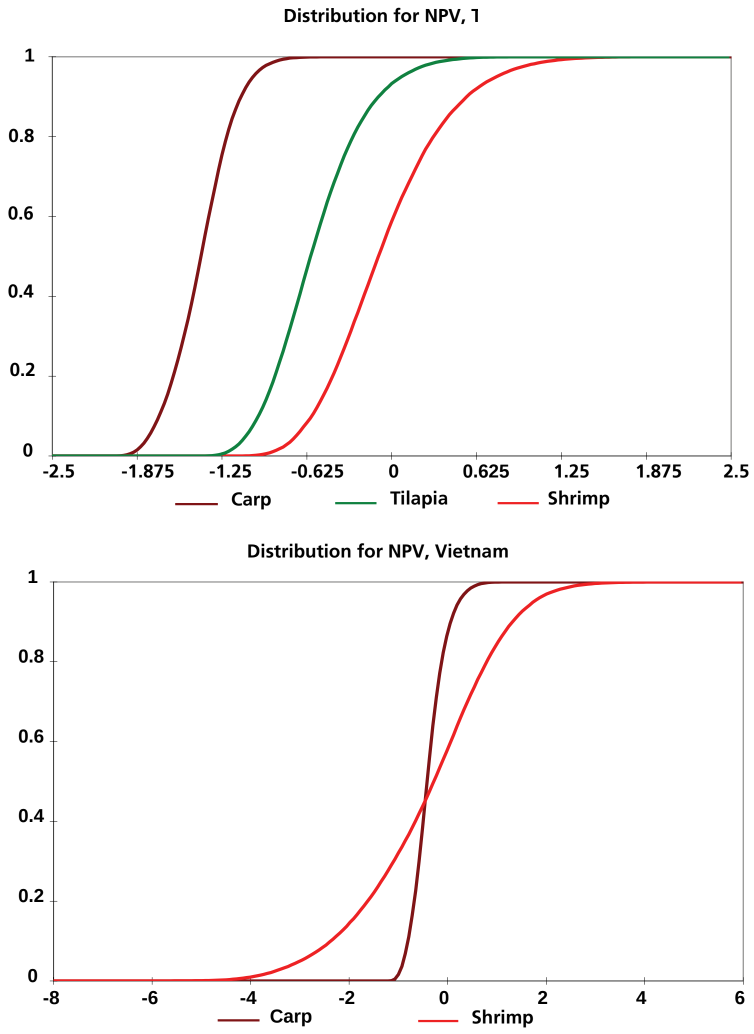
(Jolly and Kusumastanto, 2009). Planners can also use this method to simulate and relate enterprise sizes to family sustainable livelihoods.

The survival rates of the species positively influence sustainable livelihoods. Hence aquaculture extension agents can train fish farmers to adopt technologies that enable them to increase the survival rates. At the same time biologists can increase the research that will help farmers to increase the survival rates of each species. The method can be used to simulate enterprise types and family sizes related to survival rates of the species and sustainable NPVs required for sustainable livelihoods.

The risks associated with the NPVs and IRRs must also be considered in the decision making process. However, those enterprises that adequately sustain livelihoods in those countries are also the least risky.

When we talk about sustainable SSA we anticipate that the enterprise will be able to provide a livelihood for the rural household over the long-run. It is implied that it is capable of self-regeneration with little inputs from the outside, and with minimal negative environmental, social, and economic impacts. While SSA has the potential of meeting these requirements, its size relative to the rural family size, its opportunity cost of survival within the rural community, and its long-term aspirations must be considered in any evaluation of sustainability. Most of the enterprises studied were profitable in the short-run and were financially feasible in the long-run but only the intensive culture of shrimp in India and the Philippines, and the tilapia monoculture

FIGURE 5
Probability distribution of NPV for Thailand and Viet Nam



in Bangladesh showed signs of generating long term benefits to sustain the rural family household when family members' comparable needs were included as part of the opportunity costs. The lesson learned from this study is that production systems must be examined under similar conditions to obtain an improved holistic view of sustainability. SSA can be profitable in the short-run but, unless it can provide for the long term household needs, it might only be a fantasy and not the opportunity we hope it to be. Hence the evaluation of SSA sustainability must internalize all costs, and relate short-and long-run net returns to family size and needs.

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Access rights for sustainable small-scale aquaculture and rural development

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ABSTRACT

Property rights determine who has access to and control over resources as well as the behaviour of resource users by providing incentives or disincentives for short-term gains or long-term sustainability. The resources that small-scale aquaculturists use may fall under different property regimes, such as communal, private, or state property, or under open access where there are no defined property rights. Such resources may be used by many stakeholders who are competing for various uses of the resource and may include land and/or water as the resource base, seed, feed, technology and capital, among others. By looking at the differences in access to the resources and assets used for various types of SSA, we are able to analyse what is needed to support their sustainability. The sustainable livelihoods (SL) framework, on the other hand, helps us understand and analyse why and how small-scale aquaculturists do what they do to generate income, create livelihoods for food security and improve their well being. It is based on the premise that households have five capital assets which they can use for various livelihood options, namely: (1) human, (2) financial, (3) physical, (4) social and (5) natural. The SL framework is a useful tool of analysis in SSA to determine a particular context, identify applicable key interventions and monitor the attainment of the objectives in that particular situation and at that particular level of social and geographical unit. Following the sustainable livelihoods and rural sustainability framework, access to the resource base is a necessary condition to enhance sustainability; however, it is not a sufficient condition by itself.

INTRODUCTION

Small-scale aquaculture (SSA) may be generally defined as low-input farming of aquatic plants and animals, with a large percentage of the labour usually provided by household members. Depending on access to resources and seasonality, SSA may be carried out on a part-time or full-time basis and integrated with other activities such as crop and livestock farming. Merriam-Webster Dictionary Online defines access as the freedom or ability to obtain or make use of something. On the other hand, Wikipedia defines access control as the ability to permit or control the use of something by someone. In this paper, access and control of access refer to livelihood assets in SSA. The hierarchical scale or level of analysis is an important consideration because the sustainability indicators at one level may or may not be carried through to the next level. This is particularly crucial if one looks at multiple uses of the natural resource base for livelihoods as coping mechanisms for small-scale aquaculturists, as well as the necessity for inter-sectoral linkages to promote sustainable rural development. We shall see if access to the aquaculture resource base by small-scale aquaculturists is a sufficient condition for promoting sustainable livelihoods and in contributing to sustainable rural development.

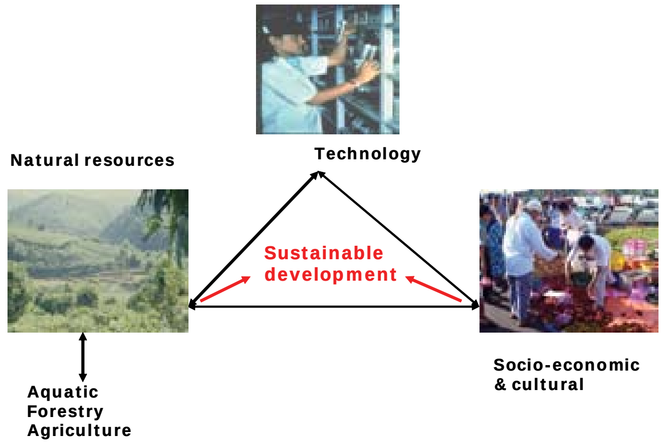
SUSTAINABLE RURAL DEVELOPMENT

Sustainable development, particularly applied to rural development, is the call of the day in the new millennium. It was catapulted into prominence as the guiding principle after the Bruntland Report was published in 1987 and the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. Development in the past widened the gap between the rich and the poor, leading to increased exploitation of the natural resource base and jeopardized long-term achievements of development goals. Sustainable development became the battle cry for an appropriate development process and pathway especially in the context of current issues such as climate change, global trade and most recently the financial crisis. It has become an overpowering concern as nations of the world have committed themselves to the achievement of the Millennium Development Goals (MDGs). In fisheries and aquaculture, the Code of Conduct for Responsible Fisheries "provides a necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment."[1] Article 9 of the Code provides guidance on Aquaculture Development, and Article 9.4.1 and 9.4.2, respectively, state that: States should promote responsible aquaculture practices in support of rural communities, producer organizations and fish farmers; States should promote active participation of fishfarmers and their communities in the development of responsible aquaculture management practices.

Sustainable development is a complex, multi-dimensional and highly contextual state or condition which, in general, adheres to the basic principle of utilizing the natural resource base in a manner that the ability of this natural resource base to provide current and future goods and services useful to human society is not impaired. It is development which is economically viable, environmentally appropriate and socially acceptable. Conceptually, sustainable development can be represented in Figure 1. It is made up of three major and interacting elements: technology, natural resource base and socio-economic factors. These three major elements must work in a synergistic and complementary manner so that goods and services needed by human society are produced on a sustainable basis. For example, in aquaculture, a fish farming technology which does not take into consideration the health of the water body will eventually lead

[1] Preface to the Code of Conduct for Responsible Fisheries (available at www.fao.org/docrep/005/v9878e/v9878e00.htm)

FIGURE 1
Conceptual model of the interaction among natural resources, technology and socio-economic and cultural elements and sustainable development



to self-pollution and bring down productivity. The deterioration of the aquaculture resource base may also come from a land use system which is not compatible where, for example, the land use of the upper watershed is causing discharge of pollutants to the aquatic system used for aquaculture. In such cases, appropriate land use planning can enhance the attainment of sustainable rural development goals. In the same manner, socio-economic factors including policies, governance, institutional processes and arrangements must promote the development of technologies that will optimally utilize the natural resource base while at the same time protecting its regenerative capacity.

An economic incentive which puts marginal and vulnerable groups in a disadvantaged position will increase income gaps between societal groups and create inequity. If one major element will not complement the other, sustainable rural development cannot be attained in a particular context. These contexts will vary given the particular state or condition of any or a combination of these three factors in a particular rural and hierarchical setting (Sajise, 2002).

Sustainable rural development would mean that people have secure access to quality food in the attainment of a healthy and productive life. They must also have the ability and capacity to produce and/or purchase food as needed. It also means that people do not have to rely only on staples such as wheat, rice, potatoes, cassava, fish and fish products but must also be concerned with income, markets and natural resources (Shah and Strong, 1999). This also clearly indicates that food security will emanate from a sustainable resource base consisting of plants, animals and microbial organisms interacting within a given environment and ecosystem.

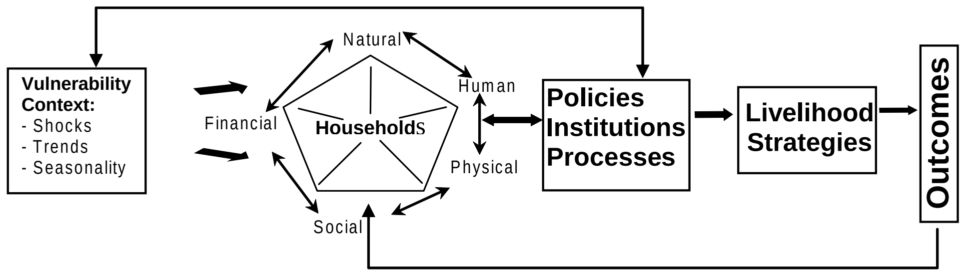
It is necessary that there are sustainability indicators for each of the three elements as well as some overall systems performance. Sustainability indicators for the natural resource base can cover a bigger landscape, a sub-region or a combination of ecosystems, of which the aquatic ecosystem is only a part of several ecosystems interacting in a landscape setting. The social system must have its separate set of indicators which can include governance, policies, economic incentives, equity parameters, and others. The technology part will have to be analyzed in terms of how appropriate the technologies being used are, how they are promoted and developed in terms of impacts on the natural resource base, and how they promote social equity, productivity and other sustainability parameters. Ultimately, the ability of the whole system to adjust and adapt through feedback loops, will determine its sustainability. This system property is often referred to either as "stability" if the perturbation is predictable and regular or "resilience" if it is a due to a major shock.

SUSTAINABLE LIVELIHOODS FRAMEWORK

The Sustainable Livelihoods (SL) framework (Figure 2) will help understand and analyze why and how small-scale aquaculturists do what they do to generate income, create livelihoods for food security and improve their well being.

The SL framework is based on the premise that households have five capital assets which they can use for various livelihood options, namely: (1) human, (2) financial, (3) physical, (4) social and (5) natural. Human capital refers to skills, knowledge and information, ability to work, health and others. Financial capital consists of

FIGURE 2
The sustainable livelihoods framework (from DFID, 2004)



savings, credit, remittances, and pensions among others. Social capital may consist of social networks, groups, trust, access to wider institutions, ability to "demand" and others. Natural capital consists of land, water, livestock, fish stocks, wildlife, biodiversity, environment, air and others. Physical capital may consist of transport, shelter, energy, communications infrastructure, technology and others. These assets which are constantly changing often substitute for and complement one another and determine livelihood options and goals. These assets and their uses are also affected by vulnerability elements and by processes, institutions and policies (PIPs). These vulnerability elements are caused by the environment in which people exist (i.e., population, resources, economics, illness, natural disasters, social conflicts, pests and disease, fluctuation in prices and others). PIPs, on the other hand, may consist of the legal systems and judicial rules, property rights, political system, civil society, trade barriers, cultural norms and values, social relationships, informal networks, formal institutions, policies and others. Processes are the changes brought about in policies, organizations and institutions.

Given the level of the five capital assets that an aqua-farming household has in the context of existing PIPs, a "best" livelihood option is chosen and used to attain certain livelihood outcomes. These outcomes, in turn, affect and feedback into building up the assets and the vulnerability factors of the environment, and thus the cycle is repeated. Livelihoods are considered sustainable when they are: (a) resilient in the face of external shocks and stresses; (b) are not dependent on external support or if they are, the support itself should be economically and institutionally sustainable; (c) maintain the long term productivity of natural resources; and (d) do not undermine or compromise the livelihood options of others. The expected livelihood outcomes are increased income, improved health and well being, reduced vulnerability, improved food security and more sustainable use of the natural resource base.

The SL framework is a useful tool of analysis in SSA to determine a particular context, identify applicable key interventions and monitor the attainment of the objectives in that particular situation and at that particular level of social and geographical unit. The context will vary from place to place as a function of the sociocultural, ecological, institutional, and vulnerability conditions and tools and approaches are needed to provide a baseline assessment. These tools will include participatory rapid appraisal, socio-economic baseline survey, GIS-aided multi-factor analysis and others. These same tools can be used for monitoring the progress and attainment of the goals of sustainability after appropriate interventions are provided and as the conditions also change as a result of the sets of interventions.

ACCESS RIGHTS, SUSTAINABLE LIVELIHOODS AND SMALL-SCALE AQUACULTURE

The resources that SSA utilizes may fall under different property regimes which define who has access and who controls access to the resource, and may be classified as open, common, private or state property.[2] Open access is the absence of defined property rights whereas under common property, a defined group of users control access to the resource. Under private property, a person or a corporation controls access to the resource. Under state property, the government controls access to the resource, although in practice, open access may be operating. Property rights determine the behaviour of resource users by providing incentives or disincentives for short-term gains or long-term sustainability of resources. These resources may include land and/or water as the resource base, seed, feed, technology and capital, among others. Brummett, Lazard and Moehl (2008) have emphasized that, "the absence of any clear position on at least the questions of assured access to land and water resources is surely a constraint to potential fish farmers seeking to protect their investment". Table 1 shows the possible combination of resources and types of access. Among these combinations, securing access to those resources under open and state property is necessary to enhance sustainability. These resources include the water resource base, water resources and seed. For those resources under state property, preferential access rights should be provided to marginalized groups (see Toufique and Gregory, 2008; Beck and Nesmith, 2001).

TABLE 1
Resources and types of access in small-scale aquaculture

Type of access / Resources	Open access	Common property	Private property	State property
Land (base)		x	x	x
Water (base)	x	x		x (lease)
Water (resources)	x	x	x	x
Seed	x	x	x	x
Feed		x	x	
Technology (farming practice, fish health management, fish nutrition)			x	x
Capital		x	x	x

Using this matrix, we can analyse the different types of SSA to determine what is needed to support sustainability (Table 2). The land and water resource base used in SSA is linked to other sectors such as capture fisheries, agriculture, industry, transport, energy, tourism and conservation. These linkages may generate competing and incompatible uses of resources that may negatively impact on the sustainability of SSA. On the other hand, inputs such as seed and feed may affect the sustainability of capture fisheries, in cases where wild seed and low-value fish feed are used for SSA. The multiple use nature of the natural resource base also means that the different stakeholders have different time perspectives. This will affect their decision to go for short-term gains or choose longer-term management and conservation practices.

[2] For a discussion of property rights and property regimes, please see Bromley (1990); Wiebe and Meinzen-Dick (1998).

TABLE 2
Examples of small-scale aquaculture systems and types of access

Types of small-scale aquaculture	Land (base)	Water (base)	Water (resources)	Seed	Feed	Technology	Capital
Shrimp-farming	private state common		private state	open private common	private	private state	private common
Mussel or oyster farming		state common		open		state common	private common
Seaweed farming		state common		private		private common	private common
Pond culture of finfish	private common		private state	private state	private	private state	private common
Cage culture of finfish		state common		private state	private	private state	private common
Pen culture of finfish		state		private state	private	private state	private common

Table 2 indicates that there are differences in access to the resources and assets used for various types of SSA. Conflicts often arise in terms of who has the stronger capacity to "enclose" an aquaculture resource base, be it in the inland freshwater bodies, waterways or near coastal zones (Ridler, 1997; see also Liu, 2007). These create problems because access is often controlled not by the poor but by those with greater access to technologies, capital and social networks. This situation often excludes the poor and marginal groups. Rapid deterioration of the land and water resource base is often a negative consequence of conflicting and incompatible resource uses, hence the need for a holistic view and appropriate land use planning. For example, this holistic perspective gained recognition in SSA where a wetland resource base with multiple functions such as environmental, economic and cultural services and the environmental services is often undervalued or having no market value. Under these circumstances, institutions and property rights regimes associated with resource management decisions become important (Adger and Luttrell, 2000; see also Sida, 2007).

Loss of access to the natural resource base may be due to unsustainable models of resource management and exclusion of use as a result of other competing uses such protected areas, tourism and large-scale aquaculture development. Alternative employment in other sectors can relieve and even promote sustainability of small-scale fisheries and aquaculture, which can include providing greater options for livelihoods including land-based options.

Weak governance at various levels as well as corruption brings in added complications in the sustainability landscape (see Ghezae *et al*., 2009). In this regard, co-management provides a useful platform for determining appropriate access rights, where, to whom and for what goals. The goals could be articulated in terms of reducing poverty, reducing risks and vulnerability, increasing efficiency or a combination depending on a particular context. Pomeroy, Katon and Harkes (2003), in discussing the necessary requirements for a successful co-management, clearly showed that property rights and access to the aquatic resource base is a necessary condition, but there are other equally important conditions required, i.e. incentive system, leadership, empowerment, social preparation and value formation, trust between partners, conflict management, effective enforcement, adequate financial resources and others. This observation on the key elements which can complement secure access to the aquaculture resource base is still along the sustainable livelihoods framework.

IMPLICATIONS FOR SUSTAINABILITY INDICATORS

Access rights to the natural resource base (aquatic and land-based) for aquaculture are necessary but not a sufficient condition for promoting sustainable SSA livelihoods which can contribute to sustainable rural development. To become a sufficient condition for promoting sustainability and depending on the prevailing context, access rights must go hand-in-hand with the buildup of the following livelihoods assets:

- Human capital: Capacity building for improved access and use of better technologies which promote productivity and natural resource regeneration, knowledge and familiarity on the legal aspects of property rights, marketing skills, post-harvest processing and community organizing, transmission and practice of appropriate traditional knowledge.
- Social capital: Equitable mechanisms for providing rights and benefits to women, social networks for absorbing risks and vulnerability, traditional institutions, governance system at various hierarchical levels.
- Natural capital: Regulated harvests of natural capital, traditional knowledge of key indicators for sustainability, stock regulation and carrying capacity, management of pollution, pests and diseases, landscape linkages and interactions.
- Physical capital: Infrastructure support, appropriate physical technology, post-harvest facilities, marketing infrastructure, information technology support for market prices of fishery and aquaculture products, fishing technology information
- Financial capital: Elements for promoting sustainability under this category will include availability of formal credit, social networks for providing financial assistance, link to local and export markets and information access to market.

Since policy and institutions including governance have a strong influence on how these livelihoods assets can be made available, used effectively and synergistically combined to bring about sustainability, these factors have to be included as key indicators. A policy environment which promotes sustainable livelihoods and institutional arrangements supportive of decision-making which enhances transparency, equity and justice regarding the allocation and use of aquaculture resources should be used as positive indicators for sustainability.

The greater challenge for students and practitioners of sustainable aquaculture development will be to look for what was earlier known as emergent properties of agro-ecosystems. These emergent properties are combinations of natural, social and economic properties such as: resilience or the ability of the agro-ecosystem to rebound after a disturbance; the property of productivity; and the sharing of this product or output or equity. These are all measurable but will require a time frame and a strong baseline of data over the same emergent properties. The resilience of an aquaculture system can be used as a sustainability indicator for its level of vulnerability to risks and external stresses.

At the higher hierarchical levels and in order to enhance the contribution of aquaculture livelihoods to sustainable rural development, first and foremost, this livelihood system should be sustainable in itself. The above sustainability indicators can be used to assess the sustainability status of the type of aquaculture involved. Consequently, its sustainability will also be affected and enhanced at the higher hierarchical levels such as in rural-based systems. In this case, the contributions of the other economic sectors in relieving the number of households fully dependent and involved in small-scale fisheries and aquaculture for their livelihood seems to be a key sustainability indicator. This has also been found to be true for other natural resource base such as in forestry where a forest is subjected to the pressure of deforestation due to the lack of livelihood options for forest resource users. The absorption by industry of the labour in this sector has provided the relief needed to rehabilitate the degraded natural resource base and increased the market and non-market values of the ecosystem services provided by the natural resource base.

CONCLUDING REMARKS

Access rights to the resource base for aquaculture need to consider what kind of access is appropriate for which groups and why. This is critical because sustainability is associated with equity, increased income, productivity, food security (quality, quantity and access), and environmental integrity. As Sida (2007) has stressed: "Land, water and other natural resources have many different users and overlapping uses. Distinct tenure arrangements apply to different resources and uses". Access to the resource base is a necessary condition to enhance sustainability. However, it is not a sufficient condition by itself to attain this goal following the sustainable livelihoods and rural sustainability framework. The other livelihoods assets need to be brought in to bring synergy in order to achieve the objective of sustainable aquaculture livelihoods which can significantly contribute in bringing about sustainable rural development.

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Social impacts of coastal aquaculture in the Mekong Delta of Viet Nam

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ABSTRACT

Coastal aquaculture plays a very important role to the Mekong River Delta of Viet Nam due to specific comparative advantages. From 2000, the Government of Viet Nam issued a number of regulations on the restructuring of agricultural economics and rural development with special priority given to aquaculture in the delta. Better investment resulted in an improvement of infrastructure and organisation of both production and living activities, as well as community development along the coasts of the delta. Most of the coastal aquaculture households have improved their income which helped to bring about better opportunities for education, health care and entertainment to the whole community, including women and children. The conflicts at family and community levels have become moderate. Coastal aquaculture practices are associated with high level of risks due to many factors. About 61.5 percent of the total number of aquaculture households do not have enough profit to cover their annual living expenditures, in accordance with other social issues. For long-term development of coastal aquaculture in the delta, improvement in linkages between relevant stakeholders is recommended. A set of solutions must be sychronised based on appropriate planning and better organization at village and district levels. In addition, availability and sustainability of investments and support services from different levels of government and others are also important.

INTRODUCTION

Globally, aquaculture has developed at a fast pace during the past decade with an average growth rate of 7.6 percent in production while the figures of the Mekong River Delta and Viet Nam were 6 percent and 13 percent, respectively. It is projected that by the year 2010, the total aquaculture areas of Viet Nam will be 2 million ha and about 2 million tonnes of farmed aquatic products, of which 1.02 million tonnes will be from coastal aquaculture. The export value of Viet Nam's aquatic products is expected to be about USD 4.5 billion, of which more than 55 percent will be from aquaculture in 2010 (Ministry of Fisheries, 2005). The Mekong Delta of Viet Nam has good potential for development of agriculture, in particular aquaculture. In 2007, the total shrimp (*Penaeus monodon*) cultured area and production in the delta were 560 201 ha and 244 891 tonnes, respectively. This is an increase of 98.2 percent in area and 357.0 percent in production volume compared with that of 2000, covering 89.7 percent of the total cultured area and production of shrimp in Viet Nam, respectively. The Delta also provides about 80 percent of total shrimp production and most of the exported clam production (Ministry of Fisheries, 2002, 2005 and 2007). In 2006, there were about 201 000 households culturing shrimp along the coasts of the delta region, of which 45.4 percent are located in Camau Province, 18.9 percent in Baclieu province, and 11.5 percent in Soctrang Province (Extension Centers of the Provinces, 2006).

Besides the positive impacts that contribute to the development process of the Mekong Delta and Viet Nam, coastal aquaculture also has changed the physical, socio-economic and environmental conditions there. Mangrove ecosystems were destroyed for the establishment of shrimp farming areas (Binh, 1994; Sinh and Binh, 1996). The poverty rate in the coastal provinces was 25.5 percent in 2004 (Cantho University, 2004) while that in the whole delta was only 19.4 percent (World Bank, 2004). There are a number of issues that need to be understood and solved for the sustainable development of the shrimp industry and the fishery sector in the delta.

This paper aims to describe and to analyze the social impacts of coastal aquaculture in order to provide some policy implications and suggestions for a better contribution of coastal aquaculture to the development process of the Mekong River Delta in particular, and Viet Nam in general.

MATERIALS AND METHODS

The secondary data were collected from 2005 to 2007. The primary data collection was implemented in 2005 and 2006. The village and provincial officers in nine coastal provinces from Baria-Vungtau to Kiengiang were interviewed, excluding in Ho Chi Minh City. Participatory Rapid Appraisals (PRA) were carried out in five concentrated areas of major coastal aquaculture systems: (1) Intensive/semi-intensive shrimp; (2) Monoculture extensive and/or improved extensive shrimp; (3) Integration of shrimp and mangroves; (4) Rotation of improved extensive shrimp and rice; and (5) Hard clam culture in open sea water. The designed questionnaires were used to interview 203 aquaculture households in the study area.

FIGURE 1
Location of the Mekong Delta of Viet Nam

Perception of the interviewees was set by the ranking of 1, 2, 3, 4, 5. For example:

- Level of satisfaction: 1 was for Not satisfied at all, to 5 was for Very satisfied.
- Level of agreement: 1 was for Not agreed at all, to 5 was for Strong agreed.
- Level of quality/change: 1 was for Not good at all, to 5 was for Very good.

MAJOR CHANGES AND IMPACTS OF COASTAL AQUACULTURE AT THE COMMUNITY LEVEL

Major changes of coastal aquaculture

Among 954 356 ha of inland water surface or about 32.3 percent of the natural land area of the delta, 50.3 percent is considered suitable for aquaculture. There are a variety of aquaculture farming activities in the delta which are mainly conducted by individual households. However, less than 50 percent of suitable water bodies were used by the end of the 1990s (Ministry of Fisheries, 2002).

In 1999, the Prime Minister issued Decree 224 approving the aquaculture development program for the period of 1999 to 2010 and in 2000 Decree 09 allowing the transformation of the agricultural economy. These have brought many changes in the agriculture sectors of Viet Nam, in particular the aquaculture sector in the Mekong Delta. From 1999 to 2005, an area of 377 269 ha of different types of lands (including 346 700 ha of low efficiency rice land) were converted into aquaculture, of which 95 percent was for coastal shrimp farming, mostly in the Mekong Delta (including the rice-shrimp and mangrove-shrimp systems). By the year 2005, about 93 percent of the total potential area that was suitable for aquaculture of the delta was under utilization (Ministry of Fisheries, 2002, 2005; Department of Fisheries of Coastal Provinces, from 2003 to 2006).

In 2000, the population of Viet Nam was 77.64 million and the average total production of rice per capita was 419 kg while those of the Mekong Delta were 16.35 million and 1 021.9 kg, respectively. By the year 2007, the population of Viet Nam was 85.16 million and the average total production of rice per capita was 421.2 kg while the figures for the Mekong Delta were 17.52 million and 1 063.5 kg, respectively. This means that the transformation of agriculture did not negatively affect food security of the nation nor the delta region. In addition, the average fish production per capita of Viet Nam was increased from 22.8 kg in 2000 up to 48.7 kg in 2007 whilst this number for the Mekong Delta was higher and increased to a greater extent, from 71.5 kg up to 135.3 kg, respectively.

FIGURE 2

Production of rice per capita in Viet Nam and the Mekong Delta (General Statistics Office, 2001 and 2008)

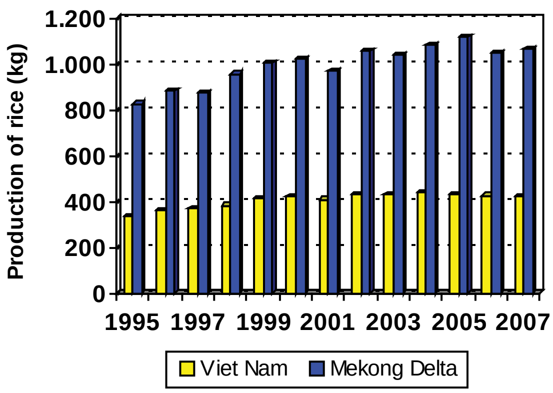
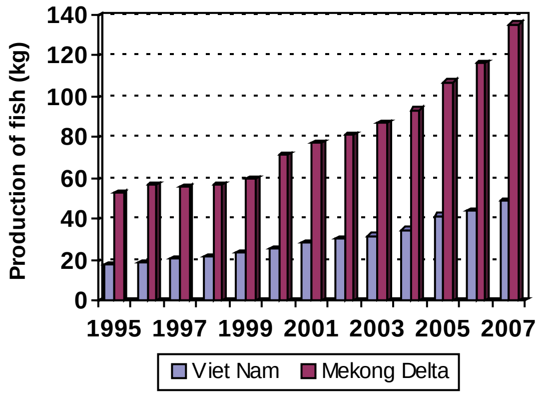


FIGURE 3

Production of fish per capita in Viet Nam and the Mekong Delta (General Statistics Office, 2001 and 2008)



Recently, there have been two trends for shrimp farming, i. e., intensification and diversification. At the end of 1990s and the beginning of this decade, more than 95 percent of the total shrimp culture area of the Mekong Delta was at an extensive/improved extensive level. In 2007, the production using the area under the improved extensive shrimp farming system was still dominant with 84.15 percent, while the intensive shrimp system covered 10.33 percent, and the shrimp-mangrove systems contributed 5.52 percent. About 15 to 20 percent of the total number of shrimp farmers had better conditions in terms of technical knowledge, land quality and finance. Therefore they tended to upgrade their farms into semi-intensive/intensive systems. Many traditional/extensive farms have changed into improved extensive farms or they integrated shrimp culture with other species such as mud crab (*Scylla* sp.), mudskipper (*Gobiidae*), tilapia (*Oreochromis* sp.), spotted scat (*Scatophagus argus*) and/or the blood cockle (*Anadara granosa*). The shrimp-mangrove farmers diversified their shrimp aquaculture by adding these species to their existing aquaculture systems.

Generally, major aspects related to coastal aquaculture were considered acceptable or satisfactory to both the groups of local and sector officers and households. Both of these groups confirmed that production costs for aquaculture have been increasing. Changes in the culture area and farming systems were rated as “good” by the officers (86.7 percent and 84.6 percent, respectively), but were rated very differently by local households (only 32.4 percent and 44.7 percent, respectively, rated the changes as “good”). This type of different assessment between the two groups was also observed for the supply of major inputs such as technical-economic information, seed, credit, feed, use of chemicals/medicines, etc.

The increasing demand for shrimp seed in both quality and quantity has encouraged the development of shrimp hatcheries in the delta since the end of the 1990s. However, until 2005 about 35 to 40 percent of the total amount of shrimp seed were reproduced in the delta, the remaining was imported from other provinces in the Central region of the country (Sinh, 2004; Sinh, Chung and Hien, 2005). Diversification of species for aquaculture is also difficult due to the limitation of commercial reproduction as well as the over fishing of preferred species such as mud skipper, sea bass (*Lates calcarifer*), spotted scat, hard clams or blood cockles (Department of Fisheries, 2002-2006). The stocking area of hard clam in the coastal area of the delta has decreased by about 50 percent in some provinces because of the lack of seed. Therefore, the diversification of species for coastal aquaculture was rated as “good” by 28.8 percent of the interviewed farmers while 86.7 percent of the officers was satisfied with this trend which seems somewhat overoptimistic.

The rapid and spontaneous transformation in the agricultural economy, especially in aquaculture, has brought about a number of concerns on the bio-technical, socio-economic, and environmental aspects for the development process of the Mekong Delta, especially the degradation of both mangrove and Melaleuca ecosystems, as well as the depletion of natural aquatic resources in the coastal areas. The development of agriculture and aquaculture in the delta reduced the coverage of forests down to 5 percent (General Statistics Office, 1994 and 2003). In 2003, of the 610,773 ha used for aquaculture in the delta, about 18 percent was of “good” economic efficiency with total gross income of 50 million VND/ha/year or more (the exchange rate was USD = VND 15 000 in 2003). For a number of years from 1994 to 2007, about 25 to 30 percent of the total number of shrimp households annually reported poor results due to shrimp diseases, reflecting a high level of risk in shrimp farming in the Mekong delta and in Viet Nam (Sinh and Binh, 1996; Ministry of Fisheries, 2000, 2003 and 2007; Sinh, 2004). The increase in household income was reported by 53.3 percent of the officers but was confirmed by only 28.9 percent of the shrimp farmers. The same optimistic view was observed with respect to the level of risk in shrimp farming where

42.9 percent of the officers but 60 percent of the farmers said that the farming of shrimp has become more risky.

Major impacts of coastal aquaculture at the community level

The positive impacts of coastal aquaculture at the community level are mainly reported via the following criteria: (1) income or living standards of the residents in the coastal community has been improved, especially through the success of aquaculture as part of poverty reduction programmes; (2) greater emphasis was given to commercial production in association with better supply of information on both technological, socio-economic and political aspects; (3) higher investments were made on infrastructure for production and social activities, in particular irrigation systems, transportation, electricity, schools, health care stations, and clean water programmes; (4) through the nature of cooperation in production and social activities, local people gained a better perception which helped to improve the participation of local people in the cooperation and linkages; (5) more jobs were created with higher income, especially to well educated workers, and local people had more time for recreation with their family and to participate in the community activities.

On the other hand, the most important complaints about the negative impacts of coastal aquaculture were: (1) the households who obtained continuous losses from shrimp crops after several years could not invest in aquaculture any more, consequently they had to sell or to lease their lands and fell into poverty (especially in places where farmers conducted extensive/improved-extensive monoculture shrimp farming on the former forest or rice lands); (2) the unplanned and very rapid spread of aquaculture led to the pollution of water resources and depletion of underground water; (3) poaching became more common, well organized and more dangerous; (4) the local people seemed to consume more alcoholic beverages, and the losers of shrimp crops seemed to engage more frequently in illegal games of lottery or gambling; (5) the poverty situation, reduction in free water surface and lower quality of public water, as well as the need to diversify species for aquaculture have become the main reasons for overfishing which caused rapid depletion of natural aquatic resources; (6) the decreased level of participation of women and children in economic activities, especially in aquaculture.

Related institutions and the support for coastal aquaculture

Farm housholds conducted all activities on their farms by themselves, but they also received some support from outsiders via different sources: (1) other farmers/neighbours/friends within the community; (2) banks and private lenders; (3) local officers and sector managers; and (4) suppliers of seed, feed and chemicals/medicines. The major categories of support provided included: information, pond design, farming technologies, credit, seed, feed and chemicals/medicines for aquaculture. In comparing the five year interval between 2000 and 2005, the support by outsiders was rated as “better” by 45 percent of the interviewed farmers, but only 35.0 percent of them were satisfied with this support.

The supply of seed and credit for aquaculture were rated as “not good” by 24.1 percent and 19.5 percent of the respondents, respectively. Technical support, as well as the management and application of chemicals/medicines should be given more care due to the increasing need for food safety. The organization and management of production activities were rated as “better” by 66.7 percent of the officiers, but “acceptable” by 37.5 percent of the households. The linkages between the individual stakeholders need to be improved in association with a better development of cooperatives in aquaculture. The cooperation in production and the international certificate approval of hard clams in Ben Tre Province constitutes a good example for development and management of open sea aquaculture.

FIGURE 4
Monoculture of improved-extensive shrimp on the former forest and rice lands in Camau Province

MAJOR CHANGES AND IMPACTS OF COASTAL AQUACULTURE AT THE HOUSEHOLD LEVEL

General characteristics of aquaculture households

The average size of farm households in the coastal areas was the same as that of the entire delta (5 persons ± 1.9). The proportion of family members aging from 15 to 60 and being able to participate in the economic activities was high (3.6/5.0). There was a high rate of in-migration for coastal aquaculture from the end of the 1980s to the end of the 1990s. Of all respondents, 41 percent came from other places to the current location for aquaculture and 37.3 percent were separated from traditional family. Aquaculture-only households constituted 40.6 percent of the surveyed households. The group of households conducting both aquaculture with other agricultural activities such as horticulture, animal raising or forestry, made up 41.2 percent. The remaining were the housheolds who had aquaculture and non-farm activities, e.g. marine fishing

FIGURE 5
Shrimp–mangrove–mud crab system in Ngochien District, Camau Province

or different types of services (18.2 percent). The average length of experience in aquaculture of the farmers was 8.5 years (± 6.2) showing that aquaculture activities were started not too long ago in the coastal areas. Before the year 2000, as much as 22.8 percent of the farms relied on aquaculture-only activities.

Households mainly adopted aquaculture activities spontaneously following other aquaculture farmers in the local area with the expectation to obtain better income through the utilization of available water resources and family labor. A small share (18.2 percent) of the farmers said that they conducted aquaculture activities following the plan of government. This rate was higher in the case of hard clam culture where 51.6 percent of these farmers followed the plan of the government due to the recent change in policy now allowing the sea areas to be used for hard clam culture. The plans for development of aquaculture and fisheries in the coastal provinces up to 2010 were approved in 2001 and 2002. They were reviewed and revised from 2004 to 2006. However, only 34.4 percent of the households confirmed that the related planning activities and policies had been improved.

Major changes in coastal aquaculture at the household level

The development process of aquaculture and the transformation of economic activities in coastal areas led to many changes at the household level. Major changes were: (1) shift from other occupations into aquaculture, as 18.4 percent of the shrimp farming households and 21.8 percent of the hard clam cultivating households changed their occupations to aquaculture after 2000; (2) increase in level of aquaculture intensity, as 40.6 percent of the semi-intensive/intensive shrimp farms started their current systems after 2000; and (3) increase or change in the number of cultured aquatic species, as 15.6 percent of the monoculture improved-extensive shrimp farms and 14.8 percent of the shrimp-mangrove farms added more aquatic species into their shrimp culture area after 2000. Some households may have different aquaculture practices at the same time because they have different plots of land.

The average aquaculture area of the surveyed households was quite stable, except for the shrimp-mangrove system where the average area per household decreased by about 30 percent due to the regulations on the rehabilitation and reallocation of mangrove forests. In the forest lands, the households with less than 3 ha of land might utilize up to 50 percent of the total system area for aquaculture while the rest of the households with 3-5 ha and more than 5 ha were 40 percent and 30 percent, respectively. Comparing the level of investment between the year 2000 and 2005, this increased between 100 percent and 250 percent in all aquaculture farming systems. The investment was increased mainly for better design and more careful construction of the system, as well as for adding new species and also caused by the increase in the price of major inputs. Generally, 67.7 percent of the aquaculture farms increased their investment in aquaculture, while the level was higher for semi-intensive/intensive farms (72.2 percent) and shrimp-mangrove systems (75.0 percent). At the beginning of this decade, the farmers tried to increase the stocking density by 20 to 40 percent, but several years ago they started to reduce the stocking density in order to reduce the production costs and the risks of shrimp diseases. Lack of seed and mortalities of hard clams due to high stocking density were two main reasons for a reduction in the stocking density of hard clams which caused 22.1 percent of the hard clam farms to reduce their investment.

Results from economic activities and living standards of aquaculture households

Aquaculture was the most important activity which covered 94.6 percent of total production costs and contributed 93.5 percent of total household net income of coastal households. The proportion of rich/well-off households increased from 20.9 percent into 44.2 percent while the rate of poor households decreased from 25.8 percent down to 8.8 percent. General living standards improved after 5 years from 2000 of 63.5 percent of the number of households. However, despite of increased investment and information, an average of 22.9 percent of the households obtained a negative profit from aquaculture. The highest level of failure was 34.1 percent in the case of monoculture-extensive/improved extensive shrimp farms. The farmers with shrimp-mangrove or shrimp-rice systems, especially who stocked some seed of other aquatic species, had better results and were more stable than monoculture shrimp farmers. Culturing hard clam had a lower level of risk due to better market conditions and low level of production costs. About 56.4 percent of the households increased the level of investment for aquaculture, but only 40.4 percent of them obtained higher profit. The risks in aquaculture resulted to lower living standards to 22.5 percent of the number of aquaculture housheolds while the remaining of 14 percent could not improve their income level. The increase of risks in aquaculture was confirmed by 60 percent of the respondents due to the following: (1) increased cost of inputs; (2) inappropriate supply of credit for aquaculture; (3) lack of good seed for diversification of species; (4) inadequate and poor quality supply of shrimp seed; and (5) unstable price of products, except hard clams and blood cockles.

The situation seemed to be worse with horticulture where 57.9 percent of the farms increased investment for annual cash crops, but only 28.6 percent of them had a better profit from this type of farming. This might be caused by unsuitable conditions in the coastal areas for cash crops or inadequate technical knowledge by farmers on this farming practice. However, raising animals had better results where 40 percent of the households increased their investment for raising animals and 41.24 percent of them improved their profit.

Living expenditures and savings of the coastal aquaculture households

Average expenditures and savings per capita of the coastal aquaculture households in 2005 were VND 7.96 million and VND 4.68 million, respectively (VND 16 000 = USD 1.0 in 2005). The households conducting monoculture extensive/improved extensive shrimp and shrimp-mangrove systems had negative savings of VND 2.17 to 5.50 million per person per year. Private farms of hard clams and blood cockles often had large farm sizes that helped them achieve the highest level of savings (VND 28.65 million per capital per year). A large difference in the savings also reflects the different level of success in aquaculture of the households within the groups.

The total net income from all sources showed that 79.7 percent of the households had a positive profit for a year. But 61.5 percent of them had negative savings or fell into debts, and 0.7 percent had zero profit while the remaining of 37 percent of the households had only some savings. The worst situation was faced by monoculture extensive/improved extensive shrimp households because 87.2 percent of the households of this group did not have any savings.

The food for daily household consumption was the biggest expenditure item which covered about 33 percent of the total living expenditures of the households. A majority of 73.6 percent of the respondents said that they spent more money for better meals compared with the situation 5 years before. The costs for study/school and other education of the household members ranked second with about 15 percent of the total living expenditure, and this item was said to have increased by 82.3 percent of the households. The purchase of accomodation/housing and the payment for health care contributed 12.3 percent and 7.1 percent of the total living expenditures, respectively. However, it was surprising that the drinking of alcoholic beverages and hosting of parties consumed 17.4 percent of the total living expenditures and was said to have increased. Despite the fact that 61.5 percent of the officers claimed that local people spent their money more appropriately than 5 years before, the officers considered that the expenditures for living activities by coastal households were acceptable but not suitable to the income they achieved.

OTHER SOCIAL ISSUES OF COASTAL AQUACULTURE IN THE DELTA

Participation of women in the households' activities. About 78.8 percent of the respondents confirmed the equal participation of husbands and wivies in decision-making and implementation of aquaculture activities. On the other hand, an unbalance scenario in harvesting and marketing of products (42.6 percent of the number of respondents) and using the money obtained from aquaculture (57. percent in decision-making and 68.0 percent in implementation) was found. However, labor distribution in the coastal households seemed to be traditionally distributed, e.g. men had stronger power in making decisions (75.7 percent) and implementing the activities related to aquaculture (63.6 percent) because they did most of the hard work and participated in most of the training courses for aquaculture.

Among all interviewed officers, 73.3 percent thought that the gender equity in the coastal areas was better than the outcomes of related institutions' activities and therefore resulted in better educational levels, better living standards and better perceptions among the local community. However, 86.7 percent of the officers considered that gender equity was just at an acceptable level. It is difficult or not necessary to change the role of gender in a number of activities, particularly the work that follows good traditions or that is suitable to the biocharacteristics of each gender.

Job opportunity. In general, the expansion of cultivated areas and intensification brought about more job opportunities, expecially for young and trained laborers to work in large and intensive aquaculture farms. As much as 71.4 percent of the local officers said that the laborers were used better than 5 years before. However, about 20 percent of all farmers worried about a possible lower level of wages paid to the hired laborers. In the areas where agricultural lands were converted into aquaculture, 28.6 percent of the local officers mentioned the general jobless situation of female laborers, but this situation also pushed them to find the jobs in different services of aquaculture and fisheries or in the urban/industrial zones. Reduced use of child labour in aquaculture was commonly stated by both groups of the officers and households interviewed.

Opportunity to receive credits for aquaculture. A large and increasing area along the coasts of the delta has been used for aquaculture and required a huge amount of money to be invested. In 2005, the majority (61.6 percent of all aquaculture farms) were able to secure loans from different sources. The proportion of households taking loans was high with those operating the rice-shrimp system (73.4 percent) and the semi-intensive/intensive system (62.0 percent). About 15.5 percent of all farms had to borrow money for aquaculture from non-official sources, often with high interest rates. Shrimp-mangrove farmers had more difficulties to borrow the money from the banks due to the problems related to collateral or the land-use rights of the forest lands. In 2005, more than half (51.6 percent) of the borrowers for aquaculture obtained a negative profit while that figure for the non-borrowed farmer group was 48.2 percent risk in aquaculture. Therefore, it is necessary to conduct further studies on the supply and uses of credit for aquaculture (Sinh, Chung and Hien, 2005).

Opportunity for education (going to the school and training). The large majority (95.6 percent) of the households indicated that the children had more time for study due to an improved level of income and smaller number of children per couple that helped the parents operate better household conditions to take care their children. On the other hand, about 17.1 percent of the households still could not improve their members' educational level, and 11.0 percent of them did not have time to take care of their children. Better conditions for children to study and of labourers' working conditions were confirmed by 92.9 percent and 91.7 percent of the local officers, respectively. However, this figure was smaller in the case of women or female laborers (78.6 percent), meaning that the women had less opportunity to study than the men.

Health care services. Infrastructure including the network of health care stations and clean water programmes have been given priority for a number of years at the provincial and national levels. Improved health care services and clean water programmes compared to 5 years before were mentioned by 93.3 percent and 78.6 percent of the officers, respectively. In terms of the households, 27.1 percent said that their members had more health problems compared with 5 years before. These households were poor or experienced many unsuccessful crops. Therefore, they did not have good financial conditions to improve their nutrition or to take care of their health as expected.

Recreation and tourism. Saving time and money for tourism is not common among medium and poor households in the Mekong Delta. However, 85.7 percent of the local officers said that the time for recreation of coastal community has been improved. About 12.7 percent of the households did not have time for recreation because of their poverty situation forced them to spend all of their time for income generating activities. There are existing institutions and social activities, but their activities were not attractive to local people. Participation in the community activities was difficult to 19.9 percent of the households and that rate for participating in the local institutions was 27.0 percent.

MAJOR CONFLICTS RELATED TO COASTAL AQUACULTURE

Conflicts within the household members. No serious conflicts related to aquaculture were reported by 91.2 percent of the number of households while 86.7 percent of the local officers said that the gender equity and wife-husband relationship in the aquaculture households were at acceptable levels. However, 73.3 percent of the officers considered that the situation was better than before.

Conflicts between the aquaculture farmers: The conflicts which occurred mainly related to the households with different farming systems in the same area, especially at inlets and outlets of water and to the treatment of discharged/wastes from aquaculture areas. About 70.1 percent of the number of households considered that the conflicts have not been solved while only 19.9 percent of them said that this type of conflicts has been mitigated. Better planning and infrastructure at each area of aquaculture hubs where the households grouped together with the support from local government and an improvement of the linkages between the stakeholders may help to solve the problems.

Conflicts between aquaculture and other occupations. The conflicts were mainly shown in the following terms: (1) competition in supply and discharge of water for agriculture and aquaculture in the same location or group of households within a community, e.g. rice and shrimp; (2) competition between shrimp farming and rehabilitation of mangrove ecosystems are common in the coastal areas; (3) depletion and pollution of underground freshwater that is caused by the overuse of this resource for shrimp culture that brings about difficulties for irrigating cash crops and providing clean water for living activities; (4) deteriorating quality of public freshwater supplies caused by many factors, including the wastes discharged from aquaculture, as well as wastewaters released from aquatic product trading and processing sites/companies. Nevertheless, 20 percent of the shrimp farms still discharged all of the wastewaters and mudflat from their ponds into the public waterways/canals directly (Sinh, Chung and Hien, 2005). These factors, in association with the expansion of aquaculture also strongly reduced the opportunities for those households who rely on the fishing of coastal natural aquatic resources. About 69.1 percent of the households said that this type of conflict still exist while only 16.2 percent of them thought that the situation was better than 5 years before.

Security in aquaculture production and community. Poaching of aquatic products has become one of the serious concerns to the management of aquaculture farms and the coastal communities. Cause for concern is that 41.6 percent of the households and 53.8 percent of the local officers complained that the security of aquaculture production has worsened. The thieves become more active and dangerous to the farmers, especially in some places specified as the location of "the robbers of shrimp" or "the robbers of hard clams". This situation can not be improved without good organization and cooperation between the households and the support from different government levels.

Uncontrolled migration. Migration to the coasts for occupying the forest lands and cutting down the mangroves for shrimp farming was rampant from the end of the 1980s to the middle of the 1990s. However, after about 10 years of improved management with numerous issued policies and regulations, the in-migration which was mainly caused by the greater availability of vacant lands, is presently not a problem anymore to the coastal community. On the other hand, about 35.7 percent of the local officers worried about the out-migration of local young people to urban and industrial areas for better job opportunities or for education. This is also reported as a reason for the lack of laborers during the peak season of agricultural-related activities in the rural areas, not only in the delta but also at the national level.

CONCLUSIONS

Coastal aquaculture plays a very important role in the Mekong Delta due to specific comparative advantages, especially from the year 2000 onwards when the Government of Viet Nam issued regulations on the restructuring of agricultural economics and rural development. Increased investment and more care have been given to infrastructure and the organization of both production and living activities, as well as to community development. Most of the coastal aquaculture households have improved their income which helped to bring about better opportunities for education, health care and entertainment to the whole community, including women and children. The conflicts at family and community levels have been generally reduced.

However, coastal aquaculture practices are at a high level of risk due to many factors. About 61.5 percent of the aquaculture households do not achieve enough profit to cover their annual living expenditures and are faced with a number of social issues. For the development of coastal aquaculture in the delta, an improvement in the linkages between the related institutions and stakeholders has been recommended for quite some time. A set of solutions must be synchronized based on the appropriate planning and organization at village and district levels in association with the availability and suitability of investments and support from different levels of government and the private sector. Better management of the environment for aquaculture development should be go hand in hand with the protection and development of natural aquatic resources, as well as mangrove ecosystems and underground freshwater. It is also necessary to conduct further studies on the supply and use of credit, as well as diversification of species for aquaculture.

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Assessment of aquaculture adoption by small farmers using sustainability indicators

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ABSTRACT

This paper describes the rationale for, and the mechanics within, an approach to introducing integrated agriculture-aquaculture for smallholder farm development and for measuring the impact on whole farms using a standardized tool package, termed RESTORE (Research Tool for Natural Resource Management, Monitoring and Evaluation), that was first developed at ICLARM (now the WorldFish Center) since the early 1990s. A systems approach is used, going far beyond the simple unidirectional link, e.g. from livestock manure to a fish pond. It is a participatory process involving the entire smallholder farming system with its natural resources, probing farmers about opportunities for diversification of enterprises and subsequently about possible integration linkages involving recycling flows suitable to their context, both on-farm and between-farms. It is hypothesized that integrated smallholder farming systems which have an aquaculture component and reuse unused waste materials are more sustainable than less-integrated or monoculture-dominated ones. With the research tool, the farm household is accompanied over several years and the whole-farm data is collected and analyzed, producing economic and biological performance metrics and a set of sustainability indicators, for inter-annual and between-farm comparisons. The impact assessment tool has been applied in numerous countries in Asia, Africa and Latin America and over a range of farming systems and farmer livelihoods contexts, from which experiences are presented.

INTRODUCTION

Integrated agriculture-aquaculture systems are generally viewed to be a low-risk entry method for diversifying smallholder farms and enabling an additional product to be grown without much investment of resources (Pullin and Shehadeh, 1980; Molnar , Duncan and Hatch 1987; NACA, 1989; Lightfoot and Pullin, 1995a, 1995b). The fish produced serve both for household consumption but usually for income generation, making more fish available on local markets, thereby contributing to rural development (Edwards, Pullin and Gartner, 1988; IIRR and ICLARM; 1992, FAO, IIRR and ICLARM, 2001).

The assessment of the sustainability of different aquaculture systems emerged in the late 1990s mainly focusing on intensive systems mostly operated in coastal areas, or evaluating other negative effects of rapid unplanned expansion of commercial aquaculture and numerous approaches towards the development of sustainability indicators were undertaken (Gonzalez Ocampo *et al.,* 2003, 2004, 2006; Costa-Pierce 2006; Pullin, Froese and Pauly 2007; Greenpeace, undated).

Smallholder farming systems which operated integrated agriculture-aquaculture were only seldom of interest for assessments of sustainability and the relevance towards rural development, which usually considered the pond component separately (Pant, Demaine and Edwards, 2004) and much more seldom took a whole-farm perspective (Molnar, Rubagumya andAdjavon, 1991; ADB, 2004).

This paper presents an approach developed by the International Center for Living Aquatic Resources Management (ICLARM, today named "WorldFish Center") on sustainability indicators for integrated farming systems, during 1990 to 2006. It specifically focuses on the outcomes of two projects under the Integrated Aquaculture-Agriculture Systems Program (IAASP) which existed between 1992 and 1999 and were based on integrated resources management within farming systems and, among others, developed the RESTORE approach (Research Tool for Natural Resource Management, Monitoring and Evaluation). The second project was on the development of sustainability indicators for integrated agriculture-aquaculture systems. This contribution presents the rationale behind the integrated resource systems approach, the development of RESTORE and its field validation of the farm-level sustainability indicators and the lessons and insights learned from ICLARM's experiences with farmers.

In addition, two approaches are presented in which sustainability indicators for integrated aquaculture-agriculture systems focusing on smallholder farmers in developing countries were tested. These two approaches are based on trophic web and system dynamics theories, respectively.

The indicators developed inform on the sustainability at the whole farm level. Diversified and integrated farming systems are considered to be ecologically more sustainable than single enterprise operations.

BACKGROUND

Rationale of the Integrated Systems Approach

The overall objective of the IAASP, wherein RESTORE was a project, was to improve the productivity of smallholder farms through integration of fish farming and development of methods to assess the sustainability of integrated aquaculture-agriculture. The rationale was the concern for natural resource management by recycling nutrients in form of wastes and by-products in the absence of external inputs such as inorganic fertilizers or pelleted fish feeds, targeting resource-poor farmers and farmer participation (Lightfoot, 1990; Lightfoot *et al*., 1993b; Lightfoot and Pullin, 1995, Pullin and Prein, 1995; Prein, Lightfoot and Pullin, 1995; Dalsgaard and Prein, 1999). The integrated resource systems approach seeks to integrate aquaculture with other enterprises of the existing farming systems, so that from this diversification opportunities for synergism can be exploited (Bimbao, Lopez and Lightfoot, 1995; Edwards, Pullin and Gartner, 1988). It encourages households to see aquaculture as a mechanism to improve overall farm system performance and natural resource management. Furthermore, it adopts a farming systems perspective for interdisciplinary research in close partnership with farmers (Lightfoot and Pullin, 1995). This has led to the development of RESTORE, a set of farmer-participatory-research procedures linked with computer analysis of monitored data to produce farm economic performance and sustainability indicators (Lightfoot *et al*., 1993a).

Development of RESTORE

The RESTORE project started in 1991 as part of a collaborative activity with the International Institute of Rural Reconstruction (IIRR) in Cavite, Philippines and with

BOX 1

Elements of the integrated resource management (IRM) approach

Integrated resources management (IRM)

- Farmer-participatory approach
- Farming systems approach (whole farm, not only component)
- Natural resources management
- Integration/recycling
- Partnerships between farmers, NARS, NGO, GO and researchers
- Multidisciplinary frameworks
- Sustainability concept

=> ICLARM's tool-package: RESTORE

collaboration of ICLARM outreach staff and national institutions in Bangladesh, Ghana, Malawi, Viet Nam and other countries, as our research partners (Box 1). The objectives of this project were to:

1) improve the ways farmers manage their land and water resources through integration of aquaculture and agriculture;
2) develop participatory research procedures for farmers to integrate aquaculture into their farming systems;
3) develop participatory research methods for enhancing farmers' natural resource management skills; and
4) develop an analytical framework of rapid rural appraisal (RRA) and participatory rural appraisal (PRA) procedures, farm household economic data collection, including customized software for monitoring the impact of integration on households, assessing the sustainability of integrated farming systems and providing feedback to farmers.

Whole Farm Natural Resource Management, Monitoring and Evaluation Tool

The development of the RESTORE approach also responded to an explicit demand from NGOs (such as IIRR) and other institutions involved in developing and extending technologies with farmers and rural communities, for a tool or a mechanism to monitor the adoption and assess the impact of their technologies.

Given the diversity, complexity and variability of mixed farms in developing countries, their assessment as discrete components in partial analyses is not useful when the purpose is to assess their utility in enhancing the livelihood of farm households when all other household resources (including land and labor) need to be considered together. Consequently, a whole farm analysis (and material budgeting) was developed as a tool package to enable comparative analyses between farms, and over time (Lightfoot *et al.*, 1993b, 1993c; Lightfoot and Pullin, 1995).

RESTORE is a whole-farm monitoring and evaluation tool for assessing all on-farm and off-arm natural resources accessed and utilized by a particular household, and for measuring and economically valuing material flows in terms of biomass (Lightfoot

FIGURE 1

Village transect as part of first participatory appraisal step in RESTORE, including all natural resource types (NRTs) accessed or used by all members within a village. Note that a transect of an individual farm would usually consist of a subset of the NRTs.

	Upland [Pampaso]	Midland [Nsaneemu]	Road [Kwan]	Villages [Akuraa]	Lowland [Anaa fo]	Stream [Nsuwa]	Fishpond [Nam abura]
Soil type	Gravel [Mmosea] Stony gravel [Aboabo]	Gravel [Mmosea] Loam [Dote-pa] Clay loam [Amete-Dote] Clay [Amete]			Clay [Amete] Sandy clay [Amete rwia]	Clay [Amete] Sandy clay [Amete nwia]	Clay [Amete] Sandy clay [Amete nwia]
Water Resource	Rain [Soro nsu]	Rain [Soro nsu]			Rain [Soro nsu]		Stream [Nsuwa]
Crops	Cassava [Bankye] Maize [Aburo]	Plantain [Brode] Cassava [Bankye] Maize [Aburo] Sugar cane [Ahwerew] Yam [Bayere] Cocoyam [Mancani]		Plantain [Brode] Banana [Kwadu]	Cassava [Bankye] Maize [Aburo] Yam [Bayere] Cocoyam [Manka] Plantain [Brode] Banana [Kwadu]		
Vegetables		Tomato [Amo ntos]		Chili pepper [Maku] Eggplant [Ntrowa] Okra [Nkruma]	Tomato [Amo ntos] Chili pepper [Mako] Bell pepper [Mako] Cabbage [Cabbage] Eggplant [Ntrowa] Okra [Nkruma]		Tomato [Amo ntos] Chili pepper [Mako] Bell pepeer [Mako] Cabbage [Cabbage] Eggplant [Ntrowa] Okra [Nkruma]
Trees	Avocado [Paya] Gliricidia Leucaena [Leucaena]			Mango [Mango] Orange [Akutu]	Bamboo [Pamporo] Oil palm [Abe] Raffia palm [Adobe] Cocoa [Coco] Papaya [Pawpaw] Avocado [Paya] Mango [Mango]		
Forrages					Grass [Sare]		
Animals				Sheep [Odwan] Goat [Aponkye] Chicken [Akoko] Duck [Dabodabo]	Shepp [Odwan] Goat [Aponkye] Chicken [Akoko] Land snail [Nwaw] Land crab [Okoto]	Duck [Dabodabo] Water snail [Abebew]	Duck [Dabodabo] Tilapia [Apataa] Catfish [Adwen]

et al., 1993b, 1993c; Lightfoot and Noble, 1993). It consists of a specifically compiled package of farmer participatory field-based appraisal and data collection techniques, as well as an analytical software package (Lightfoot, Prein and Ofori, 1996). The outputs of the software analyses are production and financial budgets for the whole-farm as well as its management sub-units (termed 'natural resource types') as well as a set of four sustainability indicators (see below).

As a first step, *a priori* assessments (usually on an annual basis) of a range of farms are made before an intervention occurs (e.g. adoption of aquaculture or a major technological improvement to existing enterprises). Subsequently, these farms are monitored over a few years in the same manner and analyzed with the same protocols, enabling the impact assessment of the intervention over time, usually in annual steps. The above mentioned RFDs likewise are one contributing component of the analyses. The approach includes the derivation of sustainability indicators (see below) which enable comparisons across farms and over time.

RESTORE

RESTORE was designed as a tool to help farmers better manage their natural resources and devise ways of integrating aquacultural enterprises and recycling resources within and across natural resource types for the purpose of improving overall farming system sustainability when external nutrient inputs such as inorganic fertilizers or pelleted fish feeds were not affordable or not available.

The RESTORE approach links farmer participatory research outputs in the form of farmer-prepared diagrams via farm recording sheets to spreadsheet templates (Box 2). Thus, farm data is collected in a way that both farmers and researchers find useful and not too demanding, for the purposes of monitoring the integration of farming systems and assessing the impact of integration on natural resource types and farming systems using biological, ecological and economic indicators.

Initially, the field participatory procedures of RESTORE had to be developed and tested together with 19 farmer cooperators in three villages in Cavite Province, Philippines, from 1991 to 1995. The RESTORE process involves four steps: assess, experiment, monitor and evaluate (Figure 1). This operational structure brings farmers and researchers together to: 1) understand how natural resources are currently used and who uses them; 2) brainstorm new ways to rehabilitate degraded natural resources, increase enterprise diversity and bioresource integration; 3) keep track of farmer's experiments in rehabilitation of natural resources and integration of more species and enterprises; and 4) evaluate the direction of farm system transformation in terms of economic and ecological performance through sustainability indicators (Lightfoot, 1990; Noble, Lightfoot and Bage, 1991; Lightfoot and Noble, 1993; Lightfoot *et al.*, 1993a, 1993b).

BOX 2
Major elements of RESTORE

Field operations/data collection
- Farmer-prepared diagrams:
  - Natural resource type transects
  - Bioresource flow diagrams
- Researcher-filled recording sheets

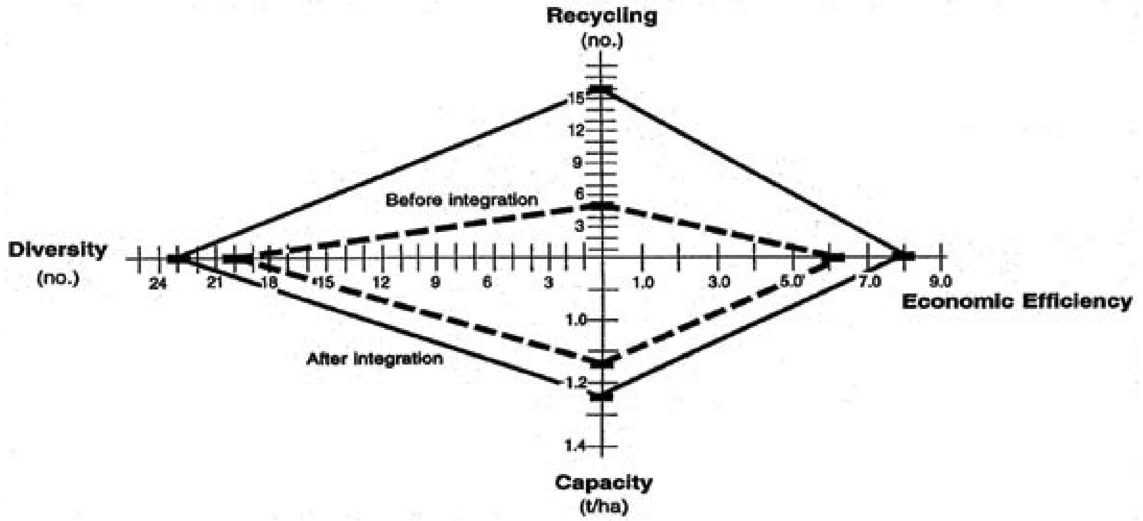
Data processing
- Software for data management and analysis:
  - Economic performance, by natural resource type, and for the whole farm
  - Sustainability indicators for the whole farm

The activities in the assessment phase include: identification and mapping of indigenous categories of natural resource types at the village and farm level (Box 3, Figure 1), use and access rights of resources, and diagramming of biological resource flows between natural resource types and enterprises on the farm.

In the experimentation phase, the bioresource flow diagram provides a vehicle for farmer-researcher brainstorming on options or experiments to rehabilitate water resources, increase the number of utilized species, and recycled by-products and wastes within the farming system (Box 4). Farmers decide which options they would like to try given their particular needs, interests, resources and constraints.

In the monitoring and evaluation phases, both farmers and researchers document how the farming system is performing or changing in terms of four sustainability indicators (Box 5).

FIGURE 2
Sustainability kites composed of four indicators for a case study farm, before and after fishpond integration, Mampong Valley, Eastern Region, Ghana.



Results of farming systems sustainability (Figure 2) and farm economic performance by year are taken back and shared with the farmers using a series of graphic representations, i.e., kites and bar graphs. The discussion and analysis of these results set in motion further changes, thus continuing a process of transformation within the farming systems.

METHODOLOGY

The validation of the sustainability indicators is mainly addressed during the impact and planning workshops. The impact workshop is conducted at the end of the cropping season or the annual farming cycle. Here, the data and results of farm economic performance and sustainability indicators from the past season or year are discussed and analysed. The planning workshop is conducted after the impact workshop and before the coming cropping season or year. During this workshop, the farm economic performance and sustainability indicators of the past years guide farmers on how to plan for strategies to improve their farming systems which will be reflected in drawing their farm plans for the next season or year. The new bioresource flows or planned integration measures will be reflected when they draw their bioresource flow diagrams for the next season or year.

SUSTAINABILITY INDICATORS

The indicators (Lightfoot *et al.*, 1996) are: 1) Species Diversity: number of enterprises, i.e. individual species cultivated or otherwise utilized, approximating stocks (counts); 2) Bioresource Recycling: number of actively managed material flows as identified by the bioresource flow diagram, including a material description (quality); origin/source and target enterprise/flow direction; biomass (usually in kg); frequency of flow; value of material flow (Lightfoot, Prein and Lopez, 1994, 1996; Prein *et al.,* 2002); 3) Natural

Resource Type/Whole Farm Capacity: total biomass of material products, i.e. total biomass output in tons from all enterprises and resource systems within the entire farming system, including both primary produce and by-products, divided by the actual physical farm area (excluding common property and open-access resources) (usually in tonnes/ha); 4) Economic efficiency: the ratio of net farm income or profit to the total cost; profit-cost ratio (approximating "outputs vs. inputs"). These effects are depictable in sustainability indicator diagrams in the form of "radar graphs" (Figure 2).

The approaches focus only on the farms themselves within their agroecological and socioeconomic context and mainly measure the ability of the farm with its enterprises to provide food and income. However, the measurement of the maintenance of an acceptable environment is an inductive process of the application of the tools over time, namely under the assumption that overall production and component productivities should only reduce over a multi-year trend if the environment is negatively affected. Here other additional assessments are necessary, i.e. of additional parameters on the farm and of impacts beyond the farm (e.g. nutrients, agrochemicals and water quality and quantity).

Negative effects of farm management on the environment are considered to lead to negative feedback on farm productivity and, with monitoring over time, be detectable in a farm's sustainability indicators (Lightfoot, Prein and Lopez, 1996; Bimbao and Prein, 1999)

BOX 3

Participatory tools used within RESTORE

Participation
- Advantages
- Disadvantages
- Mechanisms

PRA/Agroecosystem analysis/Drawing diagrams:
- First walk around village and fields
- Recollect data in diagram
- Shyness of farmers: learning process
- Provide materials (paper and pens)

1.Identify indigenous natural resource types (NRTs)
- Local names
- Access (community, exclusive)
- Common property resources
- Micro-environments
- Modern infrastructure
- Visit and see all!

2.Sketch topographical profile of NRTs
- On the ground
- Transfer to paper

3.Make list of all enterprises
- Identify in walkabout
- Local names and translations
- Situation in other seasons
- Other important characteristics

4.Assemble transect from profiles
- Not a true cross-section
- Farmers choose
- Highest elevation on the left
- Capture types, not abundance

5.Construct enterprise matrix
- Below transect line
- Organizes information

Examples

From a case study in Ghana, through the introduction of a fishpond (i.e. diversification of farm enterprises), the level of integration on the farm increased (Prein, Ofori and Lightfoot, 1996; Pullin and Prein, 1995; Ruddle and Prein, 1998). All four performance indicators also increased. The addition of fish species and vegetables lead to an increase in species diversity (Sustainability Indicator # 1). A number of newly introduced flows increased the number of farmer-managed recycling counts on the farm (Sustainability Indicator # 2). Overall farm output in biomass increased only marginally, as these were enterprises of higher value and less weight (i.e. fish and vegetables) in comparison to cassava, maize and plantain (Sustainability Indicator # 3). The production of higher value items was evidenced by a

TABLE 1

Integrated farming systems sustainability indicators: potential and difficulties perceived with experiences with farmers and NGOs (from Bimbao and Prein 1999, expanded).

Indicator	Underlying hypotheses/implications	Constraints/difficulties
Species diversity: How many plants and animals are used? (No. of managed or maintained species)	• More species: more stable ecosystems, more opportunities for increased recycling. • More diversity: lower risk of crop failure from monoculture. • How many new species can be added?	• Numerical counts versus abundance.
Recycling: How many waste products (different biological material types such as manure, compost, leaves, rice-bran, etc.) are being used, i.e., intentionally moved from one enterprise as input to another? (No. of recycling flows)	• More recycling: maintains fertility of resource base, reduces needs for purchases of off-farm resources, particularly chemical fertilizers. • What are new flows of organic wastes? • How much production cost (i.e. cash) could be reduced by substituting for on-farm materials?	• Numerical counts versus abundance. • Difficulty to measure (volume and biomass), particularly for trees or free-roaming animals. • Difficulty to value recycled waste where there is no market. • Need to consider fragmentation of plots.
Capacity: How much is the production per hectare of the farm? (Tons/ha)	• Prompts discussion on techniques for rehabilitating degraded land and water resources, and to increase production. • Consider options for further production increase, in relation to existing natural resource characteristics.	• Difficulty to measure biomass of some products (e.g. grass, leaves, etc.)
Economic efficiency: How much income was generated by each peso invested? (Profit/cost ratio ~ $/$)	• Minimal investments: lower production cost due to on-farm recycling and reduction of off-farm inputs.	• Only considers operating costs for current period (i.e. excludes long-term depreciation costs): investments on production inputs not computed. • Costs and returns expressed in simplified manner to be understandable to farmers and NGOs at the expense of obtaining real costs and returns. • Economics expressed per season or per year, thus, no indication of (monthly) cash flows which is an advantage in integrated farms.
Sustainability kite diagram - interpretation (Four-axis radar graph)	• Represents what happened during a particular season or year. • Farmer-specific result of farm management operations (user's perspectives). • Gives opportunities to reflect on previous farm management: what was learned and what can be done to improve natural resource management. • Makes farmers aware of the complex nature of sustainability (i.e. many factors contributing to a sustainable system); there are trade-offs and complementarities.	• Have no predictive capacity. • Cannot generalize or compare to other farmers since each farmer has a unique set of resource opportunities and constraints. • Cannot tell which specific enterprise is making the most profit or loss. • Cannot help farmers make individual management decisions, e.g. decide how to allocate manure among activities: vegetable plot, rice plot, fishpond, etc. • Resource-poor farmers have no "big plans" for improvement; no capital to invest in new enterprises requiring investment, thus integration through adoption of demanding enterprises may not bring significant increases in income and production. • Since sustainability is a long-term process, farmers find it difficult to appreciate the long- term (e.g. soil fertility) benefits versus short-term (increased production and income) benefits. • Needs close monitoring by researchers and NGOs particularly in level of data required.

considerable increase in net income by 53 percent. This outweighed the 17 percent increase in total costs. This translated into a significant rise in economic efficiency from 6 to 8 (Sustainability Indicator No. 4) which implies that per Ghana cedi (in 1993) invested in the farm, a return of cedis 8, or a gain of more than 30 percent, was achieved.

In the Philippines, where the initial versions of RESTORE were developed, this was mainly applied to smallholder farms in Cavite Province, south of Manila, where farms had either small ponds or concurrent rice-fish systems (Lightfoot *et al.*, 1993a, 1993b). In Quirino Province, in the northern Philippines, the tool was used in the assessment of fish pond and rice-fish integration in upland farms in a forest buffer zone management system (Prein *et al.*, 1999, 2000, 2002).

In the Mekong Delta of Viet Nam, Rothuis *et al.* (1998), Riveros (2001), Nhan *et al.* (2007, 2008) applied elements of or the entire package of the RESTORE tool to analyse the benefit of the aquaculture or rice-fish component to integrated agriculture-aquaculture farm households.

In Malawi, RESTORE was extensively applied in numerous studies, also involving students theses and ex-post impact assessmens (Chikafumbwa, 1995; Brummett and Chikafumbwa, 1995; Brummet and Noble, 1995a, 1995b; Noble, 1995; Lightfoot and Noble 1993; Dey *et al.*, 2007).

In Kenya, the benefit to smallholder farmers of adopting fingerponds along the shores and wetlands of Lake Victoria was assessed by Kipkemboi *et al.* (2007, 2008) using elements of the RESTORE approach.

Experiences

In-house experiences with the application of the RESTORE approach were summarized in Table 1.

PRA/PRA Methods

The utility of applying RRA/PRA methods in

BOX 4

Planning interventions bioresource-flow diagrams (BRFDs) for diversification and integration as the second participatory step within RESTORE

Bioresource-flow diagrams (BRFDs)

1. Sketch natural resource type profiles from transects
2. Sketch symbols for enterprises
   - Record production, costs and outputs
3. Draw arrows for existing flows
   - Origin, destination, type, names, quantity, frequency, value
   - Reasons

Note: do not include external inputs, sales to market, or household consumption.

BOX 5

Monitoring and evaluation within RESTORE

Researcher-filled recording sheets

1. To capture information from transects and bioresource-flow diagrams
2. Facilitates transfer of data into software

Analysis and output

- Farm economics
  - Whole farm
  - Individual natural resource types
- Sustainability indicator kites
- Time series of indicators

Results brought back to farmers

- Discussion
- Farmers plan changes with BRFD or with graphs

Participatory monitoring and evaluation (PME)

- Farmers record data themselves

aquaculture was evaluated in the course of an FAO workshop in Bangkok, Thailand (FAO, 2000; Prein *et al*., 2000). These methods are a key element of the RESTORE process. Two workshops conducted in collaboration with IIRR involving experts from several Asian countries summarized integrated agriculture-aquaculture systems for application by smallholders and the useful participatory approaches used (IIRR and ICLARM, 1992, later revised and published as FAO, 2000b; IIRR *et al*., 2001).

Resource-flow diagrams
The second step of the RESTORE process, the establishment of resource-flow diagrams, is a key element and was been introduced to numerous applications through a tutorial video (Noble, Lightfoot and Bage, 1991) with an accompanying booklet (Lightfoot, Noble and Morales, 1991). This used an approach drawing bioresourceflow diagrams (BRFDs) on the ground. Later experiences, usually with literate farmers or where family members were familiar with writing tools, drawings were prepared on large sheets of paper (Lighfoot, Prein and Lopez, 1994; Lightfoot, Prein and Ofori, 1996).

Several posters were prepared depicting examples of bioresource flows of typical farms within local agroecosystems in English and later translated into local languages, i.e. into Chichewa in Malawi, and into Bangla in Bangladesh (Noble, Lightfoot and Bage, 1991; WorldFish-Malawi Office, 2004; WorldFish-DSAP, 2005).

Distribution
RESTORE was made available in hardcopy (manuals) and on CDROM (database and analytical software) to over 250 partners and recipients which were recorded in a partners database.

Evaluation/reviews
The RESTORE tool package was considered a Beta-Test version and evaluations by this group of recipients were attempted twice through feedback questionnaires. However, the return rate was extremely low.

Two external reviews of RESTORE were commissioned by the WorldFish Centre in 2003. Furthermore, during external reviews of the responsible program in ICLARM (1994, 1997 and 1999) and WorldFish (2004), the RESTORE tool was also evaluated.

Training courses
Several training courses were held, usually covering one week and involving one day of demonstrations of field activities with PRA/RRA tools, BRFDs and data collection: three courses were held in the Philippines, one course in Thailand (Office of Agriculture Research and Development, Ministry of Agriculture), two courses in Bangladesh and Malawi and one course in Viet Nam.

Progress with RESTORE development
Within the WorldFish Centre's USAID-funded aquaculture project in Bangladesh, the software component of RESTORE was reprogrammed in MS-Access 9.0 in 2005 to update the database and analytical routines, which were expanded and enable better analyses and display of results.

Two further approaches to assessing sustainability of integrated aquaculture farms

In connection with the RESTORE approach described above, two further approaches were simultaneously implemented at ICLARM to provide additional measures and insights. These were steady state modeling of whole farms using the ECOPATH tool (Dalsgaard 1995, 1998; Dalsgaard and Oficial, 1995, 1997, 1998; Dalsgaard and

Christensen, 1997) and dynamic simulation modeling of whole integrated agriculture-aquaculture farms (Schaber, 1997).

DISCUSSION

In many developing countries, smallholder farmers must operate under conditions of low external input agriculture (Smaling, Oenema and Fresco, 1999) where on-farm diversification and integration are common approaches towards survival of farming households (Rufino, Hengsdijk and Verhagen, 2001; Tipraqsa *et al.,* 2007; Alayon-Gamboa and Gurri-Garcia, 2008).

The four sustainability indicators within RESTORE are presented in a kite diagram. Table 1 shows details of the rationale for using the sustainability indicators in RESTORE as well as the difficulties encountered by the farmers and researchers/NGOs in using the se indicators. Three indicators (i.e. diversity, recycling and capacity) give insights on the ecological state of the natural resources. A monetary indicator (i.e. economic efficiency) is included in analysing farming system economic performance because the new strategies in integrated resource management should not only bring ecological benefits, but should also generate more income to farmers.

Generally, integration would result in higher values for these sustainability indicators, i.e. the more integrated the farming system is, the larger would be the area of the kite diagram. A further insight could be provided by these sustainability indicators if these are evaluated over time. In a series of kite diagrams across years, farmers and researchers reflect and discuss on the changes in the sizes and shapes of the kites. Some changes are caused by natural factors (drought, pests, etc.), and others by market forces (increased input prices, high product prices, etc.). As such, these diagrams become meaningful tools that help farmers and researchers think about and devise strategies to improve the economic and ecological performance of their farming system.

The underlying hypothesis is that sustainability is not achieved by attaining a maximum value for any one indicator at the cost of the other three, but rather, achieving a balance between them. Each farm within its farming system and its social, economic and governance setting will have its own optimum set of indicators. Perceived relationships between two indicators may be influenced by other factors. For example, increased diversity theoretically should lead to more recycling, but this is unlikely to be the case if the farm household is constrained by labor for the movement of the by-products/wastes.

Recently, an expanded approach for sustainability evaluation of farms was developed involving a larger number of indicators, but also requiring a greater amount of input data to be collected on farms (Studer *et al.,* 2009).

CONCLUSIONS

It should be noted that RESTORE is conceived as a research tool to study individual farm households. It is not a general development tool, not a community decision-making tool and not a general farm planning or modelling tool. There are other existing approaches and tools for these purposes, yet RESTORE can produce important insights for such approaches.

The sustainability indicators in integrated aquaculture farming systems developed by ICLARM within the RESTORE project have evolved following a paradigm shift from the conventional research approach to a resource systems approach undertaken since the late 1980s. The approach took on a change in perspective: 1) from high to low external input; 2) from aquaculture as a single independent activity to integrating aquaculture with other enterprises; 3) from a fish production objective to a sustainable resource management objective; 4) from a focus on the fish production component to a whole farm unit of analysis; 5) from a commodity to a systems perspective; and 6) from a researcher-designed and evaluated technology to farmer-and-researcher-designed development and evaluation.

The sustainablility indicators in RESTORE were designed to assess the impact of the introduction/adoption of improvements of integrated agriculture-aquaculture systems. The set of indicators of sustainability include ecological aspects such as the number of species farmers use, the amount of recycling of farm wastes and the productive capacity of their farms. In addition, an economic measure is included, i.e. cost and returns of farming are computed. These indicators are just the initial ones established from what were perceived as critical factors to assess a sustainable farming system and then, shared and validated with farmers. It is acknowledged that there are more issues contributing towards sustainability, e.g. equity, food security, gender and other agroecological, biological, socioeconomic, institutional and policy factors. It was assumed that farmers consider these according to their own perceptions when making decision about adoption of technologies such as aquaculture. The current indicators were developed following several years of farmer-participatory work. They were perceived to be meaningful and comprehensible to farmers and also when discussed with researchers/NGOs.

Brainstorming on the derived sustainability indicators of their farms results to farmers learning something useful. They can try a new plant to feed their animals, or a new waste they can fertilize soil with. They can learn things they can do together, e.g. impounding or harvest water for irrigation and fish culture. They can learn about natural resources, how to evaluate their productive capacity, value standing biomass and farm wastes and learn about the results of their actions. Furthermore, farmers' discussions with researchers and NGOs go beyond technical issues to topics and fora in which farmers might organize themselves (e.g. cooperatives) to have better access to natural resources and to markets for purchase of inputs and sale of produce. When numerous farmers share knowledge about beneficial technologies and this leads to wider adoption, a positive contribution to rural development can be expected.

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Indicators and standards for responsible aquaculture production

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ABSTRACT

Through a series of roundtable discussions, collectively called the Aquaculture Dialogues, the World Wide Fund for Nature/World Wildlife Fund works with farmers, retailers, non-governmental organizations, scientists and other aquaculture industry stakeholders worldwide to develop standards for responsible aquaculture. These standards are designed to minimize the key environmental and social impacts associated with aquaculture. Through this process, indicators and standards are being developed for salmon, freshwater trout, shrimp, tilapia, pangasius, bivalves, abalone, *Seriola* sp. and cobia. The Aquaculture Dialogues started in 2004 and the first sets of standards, for tilapia and pangasius, are expected to be finalized by early 2010. The broad stakeholder representation ensures that indicators and standards address the breadth of sustainability issues involved with the production of each species group. In view of the importance of small-scale producers in the aquaculture sector globally, special attention is given to this group through the implementation of projects aimed at increasing two-way communication between small-scale producers and the participants of the Aquaculture Dialogues.

INTRODUCTION

It is broadly acknowledged that the demand for fisheries products will increase steadily as the world's population increases. The Food and Agriculture Organization of the United Nation's (FAO) estimates that almost 40 million additional tonnes of fishery products will be required by the year 2030 to satisfy global demand (FAO, 2007). With declining or, at best, stagnating capture fisheries, it is clear that aquaculture will play a critical role in filling this gap. Aquaculture is a diverse and rapidly growing sector which can provide huge benefits to the economy and people's livelihoods, especially in Asian developing countries. However, the sector is not free from a number of significant challenges, such as water pollution and the destruction of natural habitat. For this reason, the World Wide Fund for Nature/World Wildlife Fund (WWF) has convened a series of multi-stakeholder roundtables (called the Aquaculture Dialogues) to develop global indicators and standards that minimize the key environmental and social impacts associated with the production of 12 aquaculture species groups. This paper describes the approach used by the Aquaculture Dialogues and the outcomes of these efforts.

WWF'S AQUACULTURE STRATEGY

WWF's approach towards aquaculture is to identify the key environmental and social impacts associated with major aquaculture species. These are the ones that have the greatest impact to the environment and society, the highest market value and/or the heaviest trading in the global market. An early step in the approach is the identification of the most active players along the value chain with whom WWF then works with to shift the industry. WWF also sees the challenges of the sector as an opportunity for more progressive businesses which could gain from improving their performance.

Building consensus through dialogue among the stakeholders has also been recognized by WWF as necessary to truly address aquaculture sustainability. The concept of sustainability also has to be addressed broadly by taking into account environmental and social issues in the context of economic and food safety challenges.

AQUACULTURE DIALOGUES

The first Aquaculture Dialogue (or subsequently referred to as Dialogue in this paper) – for salmon – began in 2004. There now are seven additional Dialogues: pangasius, tilapia, shrimp, *Seriola* sp. cobia, abalone, freshwater trout and bivalve shellfish (clams, oysters, scallops and mussels). Both the pangasius and tilapia dialogues are expected to finalize standards by early 2010. Standards for other aquaculture species groups are expected to be completed within 2010.

Each Dialogue includes a broad and diverse group of stakeholders (e.g. producers, nongovernmental organizations [NGOs] and scientists) who work by consensus. The Dialogues are the only aquaculture scheme in compliance with the International Social and Environmental Accreditation and Labeling (ISEAL) Alliance's Code of Good Practice. Among other things, the code requires transparency and the opening up of the Dialogues to anybody who wants to participate.

Through the Dialogues, the stakeholders identify:

- **impact/issue:** The problem we want to minimize.
  - o Example – waste in effluents
- **principles:** The guiding principle for addressing the impact.
  - o Example – conservation of water resources
- **criteria:** The area to focus on to address the impact.
  - o Examples – nutrient use and release
- **indicators:** What to measure in order to determine the extent of the impact.
  - o Examples: The amount of phosphorus added and released per tonne of fish produced.
- **standards:** The number and/or performance level that must be reached to determine if the impact is being minimized.
  - o Examples: Phosphorus (P) input or utilization will not exceed 30 kg P/tonne fish produced and loads of phosphorus released into natural receiving waters will not exceed 22 kg P/tonne fish produced.

Whenever possible, indicators are identified to measure performance rather than being prescriptive. This allows the standards to measure actual changes in addressing each key issue of interest. In addition, where possible indicators are selected to vary on a continuous scale rather than just measuring dichotomous events (e.g. yes/no). Through this approach, the standards are expressed as thresholds that distinguish better performers. These thresholds can then be modified and made stricter as the sector grows, therefore leading to an overall shift in the sector's performance.

Pangasius Aquaculture Dialogue

The Pangasius Aquaculture Dialogue (PAD), which started in September 2007, provides a good example of the Dialogue process. The goal of this Dialogue is to develop standards for all pangasius production systems, such as ponds, enclosures and cages. The standards will focus on the production of *Pangasianodon hypophthalmus* (tra in Vietnamese) and *Pangasius bocourti* (basa in Vietnamese), although other pangasius species may be considered by the PAD at a later stage, as the sector develops. Standards are meant to be applicable to any pangasius farm regardless of its location, although the PAD is focused on Viet Nam and to a minor extent on Bangladesh and India, where most of the pangasius production is conducted.

All of the stakeholder groups involved in pangasius production are involved in the PAD which includes farmers, traders, processors, retailers and others (Box 1). Seventy

BOX 1

Stakeholders involved in the Pangasius Aquaculture Dialogue

- Farmers
- Processors
- Traders
  - Exporters/suppliers
  - Importers
- Retailers
- Farmers/exporter associations
- Input suppliers
  - Seed
  - Feed
  - Chemicals
- Researchers
  - Within Viet Nam
  - Outside Viet Nam
- Governments
  - Viet Nam National
  - Viet Nam Provincial
  - Other countries
- Intergovernmental organizations
- NGOs
- Certifiers

to 100 people have attended each of the four PAD meetings that have been held since the process began and more than 60 of these participants have committed time to serving on the PAD's Technical Working Groups.

At the inaugural meeting of the PAD, participants heard presentations on pangasius sustainability delivered by representatives of the main stakeholder groups, including government, producers, buyers and NGOs. The meeting participants then agreed on the main issues needing to be addressed by the standards and the principles to address the issues (Annex 1). They also decided on the process to develop the criteria, indicators and standards for pangasius aquaculture. At the second PAD meeting, the process was further refined and the following bodies were established:

- Process Facilitation Group: This is an 11-person group that is in charge of managing the PAD process.
- Technical Working Groups (TWGs): There is one TWG for each issue needing to be addressed. The TWGs are responsible for developing criteria, indicators and standards to be considered by the full group of PAD participants.
- Full Dialogue: People who attend the PAD meetings have executive power and, as such, make all final decisions on the principles, criteria, indicators and standards, as well as the process and timeline to produce them.

At the third PAD meeting the participants reviewed the PAD standards developed by the TWGs, which were then posted for the first 60-day public comment period (see

Annex 1 for the draft standards that were posted), while the fourth PAD meeting was focused on addressing the comments received.

At the time of this writing, the standards are being discussed by the TWG and will be posted for the 2nd and last public commentary period that will last from October to December 2009.

Addressing the Needs of Small-Scale Aquaculture Farmers

Because of the importance of small-scale farmers in the aquaculture sector, each Dialogue's outreach strategy addresses how to engage this stakeholder group in the Dialogue process. Doing so ensures that their views, especially on the draft indicators and standards, are heard and that they are more likely to be able to comply with the final standards.

The outreach strategy includes the following steps:

- Projects have been implemented in several Asian countries (e.g., Viet Nam, India and Thailand) to educate small-scale producers about the shrimp Dialogue and obtain their input on standards for shrimp farming. WWF also is helping to create small-scale farmer groups in these countries, as this is a unique mechanism to improve the efficiency of their production while reducing their vulnerability.
- Two M.Sc. students from Wageningen University (The Netherlands) and Stirling University (UK) worked for several months as WWF interns in the Mekong delta to explore the constraints of small-scale pangasius producers in complying with the standards and to develop strategies to address their challenges.
- The Dutch government has provided funding for several small-scale pangasius producers to attend and contribute to PAD meetings.
- Several activities have been initiated to link small-scale producers with markets requesting more sustainable products. This is a means to provide the financial incentives necessary to minimize the challenges associated with complying with standards and seeking certification.

CONCLUSIONS

Through the Aquaculture Dialogues, WWF has demonstrated that multistakeholder consultations can effectively lead to the identification of key sustainability issues and of indicators and standards to address them. As recognized by ISEAL, operating in a consensus-based and transparent manner is critical to develop standards that truly address the needs of the sector.

Stakeholders interested in the process are always welcome to join the Aquaculture Dialogues. Further information can be found on the Dialogues Website:

www.worldwildlife.org/aquadialogues.

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ANNEX 1

Main issues considered by the pangasius aquaculture dialogue and status of the PAD as of 23 April 2009, date of submission of the draft PAD standards for public comments (WWF, 2009).

Issue 1: Legal compliance

Principle
Locate and operate farms within established local and national legal frameworks.

Criteria
- Compliance with local and national legal frameworks.

Indicators
1. Documented compliance with local and national legal frameworks.

Standards
The following standards are proposed:
1. Compliance with local and national authorities (e.g., evidence of legal access[1]), and concessions to land and/or water use.
2. Compliance with all land taxes.
3. Compliance with local and national legal frameworks.

Issue 2: Land and water use

Principle
Farms[2] must be located, designed, constructed and managed to minimize negative impacts on other users and the environment.

Criteria
- Compliance with official aquaculture development plans
- Wetland conversion
- Water movement
- Water use

Indicators
1. Location of farm in relation to official aquaculture development plans.
2. Conversion of wetland(s) to establish the farm.[3]
3. Impediment to navigation, the natural hydrological regime or aquatic animal movement.
4. Amount of water abstracted per ton of fish produced.

Standards
1. Farms must be constructed in an area that complies with any approved aquaculture development plans effective in the area.

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1 In Tilapia Aquaculture Dialogue –"evidence of lease".
2 Pond, cage and pen-based.
3 Relevant only to farms established after the PAD standards have been finalized.

2. Farms must not be constructed in wetlands[4] or protected areas, such as national parks or areas listed in the World Database on Protected Areas (www.wdpa.org/). In countries which are flood prone (e.g. Bangladesh), up to 30 percent of the flooded area can be converted.
3. Farms must not impede navigation, the natural hydrological regime or aquatic animal movement. Farms must not present hazards to the transportation of local people. Farms must not occupy more than 25 percent of a water canal.
4. The ratio of water abstracted per unit of fish production must not exceed 5 000 m^3/tonne of fish produced for a given culture period.

Issue 3: Water pollution and waste management

Principle
Minimize the negative impact of pangasius farming on water resources.

Criteria
- Water quality of effluents
- Nutrients in pond sediments
- Sludge discharge
- Water exchange
- Waste management

Indicators
1. Percentage change of total ammonia nitrogen (TAN) between pond and inlet.
2. Dissolved oxygen (DO) concentration in water discharged.
3. Percentage change of 5-day biological oxygen demand (BOD_5) between pond and inlet.
4. Percentage change of total phosphorus between pond and inlet.
5. Percentage change of total nitrogen between pond and inlet.
6. Direct discharge of sludge.
7. Evidence of a sludge repository and sludge use.
8. Percentage change of turbidity between pond and inlet.
9. Percentage of total nitrogen (TN) in pond sediments.
10. Percentage of total phosphorus (TP) in pond sediments.
11. Maximum daily percentage of water exchange.
12. Disposal of dead/moribund fish removed from the pond.

Standards
1. TAN: maximum 700 percent change.
2. DO in water discharged is 3 mg/litre or above.
3. BOD_5: maximum 40 percent change.
4. Total phosphorus: maximum 150 percent change.
5. Total nitrogen: maximum 120 percent change.
6. No direct discharge of sludge in public water bodies.
7. There must be evidence of a sludge repository and of sludge being used.
8. Turbidity: maximum 20 percent change.
9. TN in pond sediments: maximum of 4.3 percent at harvest.
10. TP in pond sediments: maximum of 1.2 percent at harvest.

[4] Wetlands as designated by the RAMSAR convention were of particular concern. Also mentioned for consideration were: (1) national parks; (2) conservation of internal habitats or buffer zones in and around existing farmed areas (possibly measurable by species/unit area) and terrestrial as well as wetland habitat.

11. Maximum daily percentage of water exchange should not exceed 25 percent, except during harvest.
12. Proper disposal of dead/moribund fish removed from the pond (e.g. burial or incineration).

Issue 4: Genetics

Principle
Minimize impacts of pangasius aquaculture on the genetic integrity of local pangasius populations.

Criteria
- Non-indigenous species.
- Genetic diversity.
- Escapees.
- Genetically Modified Organisms (GMOs) and hybridization.

Indicators
1. Farming of pangasius in locations where that species is indigenous or has a self-recruiting stock established.
2. Genetic stock from which seed is sourced.
3. Measures in place to minimize escapes.
4. Use of GMO or hybrid seed.

Standards
1. Pangasius farming shall take place only in locations where that species of pangasius is indigenous or has a self-recruiting stock established.
2. Seed shall be sourced from pangasius populations already established in the river system[5] used by the farm.
3. Farms shall apply better management practices (BMPs) to minimize escapes from production systems (including drainage systems), and to reduce the number of escapes during floods. BMPs include:
   - Bund height above high water/flood levels.
   - Traps on water outlets to catch/kill escapes (e.g., juvenile fish, chemical treatment of effluent ponds).
   - Bund construction/quality/engineering standards.[6]
4. No GMO or hybrid seed shall be used.

Issue 5: Feed management

Principle
Use feed and feeding practices that make efficient use of available feed resources and minimize waste.

Criteria
- Efficient use of fish products.
- Efficient management of fish feed on the farm.

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[5] The term "river system" must be defined to require seed sourcing from appropriately local areas. Otherwise, one could argue that the Mekong River, for example, is one large "river system," and source seed from Lao People's Democratic Republic for a farm in Viet Nam.

[6] Metrics have not yet been defined for this BMP.

Indicators

1. Fish product source.
2. Economic Feed Conversion Ratio (eFCR).[7]
3. Coefficient of Variation (CV) of eFCR for given size of fish.[8]
4. Fish Feed Equivalence Ratio (FFER).[9]

Standards

1. No direct use of fish and/or fish products as feed is permitted. Fish product source must have documented evidence provided that all fish products used as feed, or used in the manufacture of feed:
   - Comes from an approved list (See definitions and formulas in Section 6.)
   - Are not in the "threatened categories" on the International Union for Conservation of Nature and Natural Resources red list (www.iucnredlist.org/), which are Vulnerable, Endangered and Critically Endangered. Also, are not from fisheries that pose a threat to species in these categories.
   - Are from fish stocks that have an average score greater than 7.5 with no individual indicator below 6.0, according to Fish Source (www.fishsource.org/site/fisheries).
2. eFCR must be less than 1.75 for the complete production cycle.
3. CV of the eFCR must be less than or equal to 15 percent.
4. FFER must be less than 0.5.

Issue 6: Health management, veterinary medicines and chemicals

Principle

Maximize fish health; ensure food safety and quality while minimizing ecosystem and human health impacts.

Criteria

- Survival.
- Veterinary medicines and chemicals.
- Record-keeping.
- Fish welfare.

Indicators

1. Survival during the grow-out period.
2. Follow legislation or regulations on the use of veterinary medicines and chemicals.
3. Veterinary medicines and chemicals use.
4. Treatment recording.
5. Maximum fish density.
6. Documented health management plan and farm-book.

[7] Total Feed Used (kg or MT)/Net Fish Production (biomass at harvest – biomass stocked) (kg or MT)

[8] CV is an accepted statistical measure of variability and is calculated as the ratio of the standard deviation to the mean eFCR of the facility. It is calculated using the eFCR value for all ponds harvested in the period between inspections.

[9] FFER is a measure of the efficiency with which fish products used in the feed are converted to live fish. It requires some measure of the effectiveness with which fish is converted to fishmeal and fish oil.
The calculation for the Feed Fish Equivalency Ratio for Fishmeal is:
(% Fishmeal in feed *eFCR) / (% yield of fishmeal from wild fish).
The calculation for the Feed Fish Equivalency Ratio for Fish oil is:
(% Fish oil in feed *eFCR) / (% yield of fish oil from wild fish).

Standards

1. The annual survival rate must be at least 80 percent, on average.
2. Use only veterinary medicines and chemicals approved for aquaculture by relevant local authorities and which are not banned for food fish use in the importing country.
3. The use of veterinary medicines and chemicals shall:
   - only be prescribed and administered by people trained to do so;
   - only be based on a diagnosed condition and follow all label specifications and
   - respect the withdrawal period or apply a period of 750 degree-days for those without documented withdrawal period times.

   In addition, antibiotics shall never be used as growth promoters or for preventive (prophylactic) treatment.
4. Farmers must keep a record of the name, dates, amounts and withdrawal times of all veterinary medicines and chemicals used in hatchery and grow-out facilities.
5. Fish density shall not exceed 15 and 80 kilograms, respectively, per cubic meter for ponds and cages (generally at harvest).
6. Farms must create and implement, under the signed approval of a certified health specialist, a comprehensive health management plan that promotes proactive treatments (e.g., vaccines and probiotics) over chemical and veterinary medicine use. The plan should also include regular monitoring of fish for signs of stress or disease; proper removal and disposal of mortalities; and appropriate storage and handling of chemicals.

Issue 7: Social responsibility and user conflict

Principle

Develop and operate farms in a socially responsible manner that contributes effectively to community development and poverty alleviation.

Criteria

- Conflicts with users and local communities.
- Benefits to local communities.
- Labour rights.

Indicators

1. Freedom of association.
2. Collective bargaining.
3. Transparency in wage setting.
4. Child labour[10] without jeopardizing schooling.
5. Forced labour.
6. Bonded labour.
7. Discrimination.
8. Safety awareness.
9. Corrective actions in response to accidents.
10. Insurance.
11. Minimum wage.
12. Labor contracts.
13. Complaints by employees.
14. Complaints by people in the local communities.
15. Preferential employment within local communities.

[10] Child labour does not include children helping their parents on their own farm, provided that working does not jeopardize their schooling or health.

Standards

1. Employees[11] shall have free access to worker associations or permission to create a worker association if one does not exist.
2. Employees shall have the right to collective bargaining.
3. Employees shall have the right to know the mechanism for setting the wages and benefits.
4. Minimum age of permanent workers shall be 15 years old. Children over 12 years old working outside the hours set aside for school attendance could be employed for light work as long as that work does not exceed two hours per day on school days or holidays. Employing temporary workers[12] below 18 years old should not jeopardize schooling.
5. Employees shall have the freedom to leave the farm premises by the end of their designated work day and not be forced to work overtime.
6. Employees shall not be obligated to stay on the job to repay debt.
7. Employees shall not suffer any discrimination[13] from the employer or other employees.
8. Employees shall be made aware of the health hazards at the work place and how to deal with them.
9. Employers shall record all accidents, even if minor[14], and take corrective action.
10. Employers shall ensure that all permanent workers have health and accident insurance.
11. Employers shall offer 110 percent of minimum wage[15],[16].
12. Employees shall have copies of their labor contract and each labor contract must include a one-month probation period for a permanent job.
13. Farm owners shall draft and apply a verifiable conflict resolution policy for labor that states that conflicts and complaints will be tracked transparently and which responds to all received complaints. At least 90 percent of the complaints should be resolved within one month after being received.
14. Farm owners shall draft and apply a verifiable conflict resolution policy for local communities that states that conflicts and complaints shall be tracked transparently and which responds to all received complaints. At least 90 percent of the complaints shall be resolved within six months from the date of being received.[17]
15. Farm owners shall document evidence of advertising positions within local communities before hiring migrant workers.

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[11] Immediate family members of the farm owner (i.e., children, spouse, parents and siblings) and exchange labour may not be considered as employees.

[12] Three months/year or less.

[13] Race, caste, origin, color, gender, age, disability, religion, sexual orientation, union or political affiliations. No salary discrimination between men, women and children must be allowed as long as they have the same position and working responsibilities.

[14] Accidents that could not be handled in-house and, therefore, the person was taken to the closest clinic.

[15] Minimum wage is mandatory. Incentives for overtime hours or bonus production are offered. The inflation rate should be mentioned, given that the basic needs are fluctuating because the price for food and basic items is going up.

[16] If the country does not have the minimum wage, the method use by SA8000 (SAI, 2008) to calculate minimum wage should be used.

[17] Complaints include the ones coming from other resource users, employees and buyers (e.g. middlemen or processors).

Theory and practice of sustainable livelihood development

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ABSTRACT

The paper highlights the sustainable livelihood framework as a way of thinking that can be very relevant for planning and formulating livelihood systems that aim at sustainability of poverty reduction programs. It looks at a *"livelihood as comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household"*. The capital assets owned, controlled, claimed, or by some other means, accessed by the household are at the center of the framework. It recognizes five main capitals, namely: physical, financial, natural, human capital and social capital. The physical capital can be understood at various scales. At the household level, examples include boats, house, fishing gears; while at the community or citizen level, this means access to infrastructure such as harbors, road networks, and communication. Financial capital includes savings and credit. Natural capital includes the fish stocks, areas of seabed leased or accessed by license, land owned, crops cultivated. The human capital includes the capacity of the people in terms of their education, health, labour, among others. The social capital, on the other hand, would include the kinship networks, associations, membership organizations and peer-group networks that people in a household can use or turn to in times of hardships in order to gain advantage.

INTRODUCTION

The need to balance economic development and environmental sustainability has been rapidly recognized in development work. However, in designing rural development programs, this concept remains to be a challenge to many professionals and development workers. Whilst the need to meet the basic needs of communities remain paramount, it is also imperative to integrate the concerns for sustainability of the rural livelihood systems. Questions such as: how to ensure the continuous production of shellfish in a bay, of fishes in fish cages and fish pens, of timber from forests, of crop yields in farms and plantations? The growing awareness brought about by discourses on sustainable development has been the strongest impetus for development frameworks that attempt to integrate the twin concerns of development and sustainability of natural resources of which rural resource systems are dependent upon.

ORIGIN AND DEVELOPMENT OF SUSTAINABLE LIVELIHOOD APPROACH

The Sustainable Livelihoods (SL) concept has been a product of a number of diverging themes. It was first widely acknowledged when it appeared in the report of an advisory panel of the World Commission on Environment and Development (WCED) in 1987 in the publication Food 2000 (WCED, 1987). The WCED report links SL security to basic human needs, food security, sustainable agricultural practices and poverty, and describes SL as an integrating concept. Since the Food 2000 report, concurrent discourses on poverty, sustainability, livelihood systems and diversity and a focus on participation and the reality of the poor has lead to formalization of the SL concept and approach (Cahn, 2003). Various government, non-government and multilateral organizations, such as the United Kingdom's Department for International Development (DFID), United Nations Development Programme (UNDP), OXFAM and CARE have adopted SL as a basis for rural development research and practice.

The sustainable livelihoods approach

Allison (2004) noted that Sustainable Livelihood Approach (SLA) originated in studies that were concerned with understanding the differential capability of rural families to cope with crises such as droughts, floods, or plant and animal pests and diseases. This was reinforced by other studies that are concerned with the ability of ecosystems and agroecological systems in particular, to maintain productivity in spite of a major disturbance that is caused by an intensive stress (stress over time such as temperature increase) or a large perturbation (one major event like typhoon or drought) (Holling, 1973; Conway, 1985; 1987; Allison, 2004).

On the other hand, livelihood aims to integrate critical factors that influence the vulnerability or strength of individual or family survival strategies. These chiefly comprised the assets possessed by people, the activities in which they engage in order to generate an adequate standard of living and to satisfy other goals such as risk reduction, and the factors that facilitate or inhibit different people from gaining access to assets and activities. Ellis (2000) defined SL as:

"A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household."

The livelihoods approach is a framework that puts together the principal components that are believed to comply with the livelihoods definition and the interaction amongst and between them.

The capital assets owned, controlled, claimed, or by some other means, accessed by the household are at the center of the framework. It recognizes five main capitals, namely: physical, financial, natural, human capital and social capital. The physical capital can be understood at various scales. Examples, at the household level, include boats, house, fishing gears; while at the community or citizen level, this means access to infrastructure such as harbors, road networks and communication. Financial capital includes savings and credit. Natural capital includes the fish stocks, areas of seabed leased or accessed by license, land owned, crops cultivated. Human capital includes the capacity of the people in terms of their education, health, labor, among others. Social capital, on the other hand, would include the kinship networks, associations, membership organizations and peer-group networks that people in a household can use or turn to in times of hardships in order to gain advantage.

Access to capitals is influenced by the transforming structures and processes. These are often referred to as the policy and institutional context of the system of livelihood. The policy contexts provide for the feasibility of access to the assets, e.g. permit system to use the lake for aquaculture purposes. Regulation of use can be found at various levels of government. For instance, while the national government has a policy statement of lake protection and conservation, the local government can provide the implementation mechanism to enable small fishers and aquaculturists to exist in harmony with conservation objectives. This can be made possible through a system of lakewater use zoning. An example is the case of the Laguna Lake or Taal Lake in the Philippines, where a lake zone map or ZOMAP provides implementing guidelines to make small-scale aquaculture to exist side by side with the multipurpose use of the lake, i.e. for commercial fishpens, The ZOMAP is an example of an instrument of an institution that enables access to assets.

Informal institutions can also use social pressures to ensure compliance. For instance, fishermen organizations can set the code of practice of small-scale fishers and be organized to promote the dual objectives of community-based coastal resources management aimed to improve the productivity of the coastal resources and at the same time reduce the negative impacts to the environment. Customary laws are also informal institutions that set the way of utilizing the resources (Sampang, 2006). Allison (2004) cites some cases where social pressures regulate access to resources – the "lobster gangs" of Maine, USA (Acheson, 1988), the Prud'homies of Mediterranean France and the Cofradía of Andalucia and Catalonia (Collet, 1999). Access to resources and how this is implemented are central to fisheries management. According to Allison (2004) the SLA promotes a policy and management intervention that gives full consideration to the range of resources that people can access; and the factors that may influence positively or negatively the attainment of the set outcomes.

The SLA approach also takes into consideration the vulnerability context as influenced by the transforming structures and process. This aspect affects the sustainability of the livelihood strategy. Vulnerability includes shocks, trends and seasonality that are beyond the control of the households. For example, increasing prices of fish, globalization, even climate change, degradation of critical coastal habitats, the increase in the price of coastal property or increased restrictions imposed by planning authorities on coastal building and infrastructure development. Shocks may be in the form of extreme climatic events such as storm and droughts, pollution and outbreak of red tide.

Livelihood strategies can be constructed around access to capitals and the political and economic contexts. Examples of livelihood strategies can be in the form of the fish cage activity which allows poor fishers to invest in aquaculture. Related strategies include fish drying, in the event that there is a boom harvest, or fish processing.

Finally, SLA is clear about the expected characteristics of a sustainable livelihood which includes a strategy wherein the people are able to maintain or improve their standard of living (in terms of "human well-being"), reduce their vulnerability to external shocks and trends, and ensure that their activities are compatible with maintaining the natural resource base (Allison, 2004). Hence, what a sustainable livelihood will likely bring about is the building up of the people's capital assets, e.g. improved savings and access to credit, increased access to education and training, or enhanced ability to invest in their own properties, i.e. vehicle, tractor, draft animals, motorcycle, house or even fishing boats. It also means an ability to sustain and maintain the natural capital that they share with the households, neighborhood and communities, e.g. forest, rivers, coastal areas like mangroves, the marine resources. Investing on fish sanctuary will be a positive sign that the natural capital will likely improve. Another concern is the enhanced "social capital" which means building community organizations that can be powerful vehicle for forging solidarity among farmers, fishers or artisanal workers.

Sustainable Livelihoods Core Principles (Allison, 2004)

Allison (2004) summarizes the basic principles embodied in the sustainable livelihood systems. These include the following:

- Putting the social and economic activities of the people at the heart of the analysis
- Management and development intervention transcends traditional sectoral boundaries such as fisheries, agriculture and tourism; and incorporates over-arching issues that affect all people, irrespective of occupation, such as access to social services (e.g. health, education, social security, legal and judicial services).
- Making links between local issues and wider concerns such as national policy and economic or social change.
- Being responsive and participatory in addressing management priorities. It engages partnership with fishers and other stakeholders in the public and private sectors and promotes a dynamic, adaptive approach to management.
- Sustainability includes the following key dimensions: economic, institutional, social and SL approach and environmental sustainability. These are all important and should always seek a balance between them. This will often mean compromises and trade-offs.

Key Strengths of the Sustainable Livelihoods Approach (Cahn, 2003)

The elements in the SLA are not new and have been discussed, albeit separately, by different scholars of development (Cahn, 2003). What makes this different is the endeavor to bring the elements together to "represent a holistic and realistic view of livelihood systems and to reflect poverty in its broadest sense". It is people centered, participatory and emphasizes sustainability. It also starts with what the people have, i.e. capital assets. It highlights the fact that these assets are influenced by policy and other transforming process; that diverse livelihood can be an option for sustainability and the focus on multi-scalar analysis. The SL framework and its variations are relevant conceptual tools to assist practitioners and theorists to understand the reality of the poor and the complexity of rural life (Singh and Gilman, 1999; Farrington *et al.*, 1999).

Critique of SLA (Cahn, 2003)

Relationships appear to be linear because of the reduction of the complex system or phenomenon such as poverty into a simple and logical framework, the relative importance of some factors and the relationships between the factors are lost. In Ellis (2000) and Scoones (1998), the framework is assumed to be linear with no feedback or other relationships.

While some look at the SLA as a simple and logical framework of understanding a livelihood system, some considered it too complex. It is considered over ambitious and offers insufficient practical guidance on the way forward (Carney, 1999a.). He clarifies that the complexity is in its holistic understanding of complex livelihood systems. It should not be taken as a blueprint for rural development but as an analytical framework that can guide the thinking behind development planning and intervention. It is designed to work across sectors. The main difficulty in this respect is the reality that most government institutions and organizations are operated and funded on a sectoral basis and thus cross-sector development is difficult (Singh and Gilman, 1999).

SL in practice

Sustainable livelihood in the Pacific Islands and in similar environments are influenced and being influenced by culture and tradition. This cultural sphere includes the following elements (Cahn, 2003):

- the risks and vulnerability context;
- influencing structures and processes (such as societal norms, gender roles and relations, organizations, and traditional politics);
- access to and control of resources;

- choice and success of livelihood strategies;
- priorities for livelihood outcomes; and
- the incentives that people respond to.

While culture is often viewed as a context of livelihood systems in the developing world and/or transition economies, it is can also act as a constraint to economic development. Cahn (2003) cites the obligations to community, collective rather than individual motivation, antagonistic feelings towards individual economic gain, commitment to ceremonies and gift giving, sharing and distribution of food and money, the influence of the church, power and status of individuals, and gender issues as the reasons why small businesses fail in Pacific Islands. Others however regarded the need for the culture to be the basis of a more sustainable, equitable form of development. Hooper (1993) describes a model of Pacific societies that includes three inter-linked domains. These domains are distinct "ways of life" and each has a separate but interrelated set of norms, values and culture (Hooper, 1998). The three domains, are:

- government or public,
- private sector (business and the professions), and
- traditional (including gender).

The way in which the domains relate and interconnect are what gives each country its distinct socio-economic profile (Hooper, 1998). In the case of the Pacific study, culture and tradition should have a prominent role in the sustainable livelihood framework. Specifically, Cahn (2003) notes that a Pacific livelihood comprises the capabilities, assets and activities that provide a means of living, i.e. a *sustainable* livelihood works within a traditional and cultural context adapting to and coping with vulnerability, while maintaining and enhancing assets and resources (Cahn, 2003, adapted from Chambers and Conway, 1992).

This is also similar to many countries in Southeast Asia, where culture and tradition are at the heart of the rural livelihood system. For instance, the role of gender in a rural economy must be fully understood as this will become an important aspect in sustainable livelihood systems. For example, a training programme for hog raising activity aimed at augmenting the income (which is declining) from open fishing should consider the gender labor calendar of the family, daily and by season. This is to optimize labor availability in the family to get the expected increased income from diversified economic activity.

The SL framework must also consider the vulnerability context beyond a context, rather something that has an influence over the assets, particularly the capital. For example, shocks from extreme climatic events like droughts, typhoons, landslides and flashfloods, should now be a major consideration that influences the natural asset. This is particularly relevant within the emerging reality of changing climatic conditions, of which rural livelihood systems are most vulnerable to. For example, several World Bank funded programmes on Community Based Natural Resources Management in some regions in the Philippines (Aragon, Penalba and Balangue, 2007) have failed not because of the culture and tradition, nor due to formal government or public institutions. Rather, the natural calamities can swiftly wipe out the five- or ten year gains of the programme with 2 or 3 typhoons in succession. Now, it is imperative that sustainable livelihood strategies must be adaptive to the new realities of a climate that is different from before.

SL in small island ecosystems

Cabili (2008) highlighted that in small island ecosystems, the concept of sustainable livelihood strategy implies integrating conservation of natural assets, with the human, social and economic aspects and the interaction of coastal and marine with terrestrial or land-based economic activities and conservation. Hence, the sustainability of rural livelihood both involves the consideration of these interacting subsystems. Ellis (1999) pinpointed that indeed, the diversity of livelihood reduces the vulnerability of the rural livelihood systems to shocks and stress, both environmental and economic. Diversification of livelihood strategies is common in small island ecosystems, as opportunities are very much limited in space as in the case of Samar in the Philippines (Cabili, 2008). Hence, both farming and fishing, along with other home-based livelihood systems are promoted. In the end, human well being is at the center of the sustainable livelihood approach.

Diversification of livelihood strategies

Small-scale fisherfolk are considered "the poorest of the poor" and that fishing is the "occupation of last resort" for those with no education, skills and access to other livelihood sources (e.g. Allison and Mvula, 2002; Allison, 2003, 2004; Béné, 2003; Neiland and Béné, 2004). Small-scale fishermen are also regarded vulnerable to problems of insecurity of tenure over both land and water resources and to political and social marginalization. Studies have pointed that diversification of livelihood strategies to households particularly living in precarious ecosystems, i.e. areas that are prone to floods and droughts especially. Allison (2004) notes that diversification reduces the risk of livelihood failure by spreading it across more than one income source. Livelihood diversification enables the spread of the use of assets and reduction of risks by spreading the investments in different livelihood activities. This ensures that if ever one loses the hogs from foot and mouth disease, he has still the crops to depend on or the fishing to get regular, albeit small, income to meet the needs of the family. It can also generate additional financial resources in the absence of credit markets, and it confers a host of other advantages in the presence of widespread market failures and uncertainties.

According to Allison (2004) the ability of small fishermen to cross sectors is "overturning previous notions that fisherfolks were marginal specialists stuck in their present occupation and unable to turn to others" (e.g. Panayotou, 1982). It also promotes diverse livelihood strategies as sensible adaptations to the uncertainties of fishing. The diversification can also be considered as adaptations to changes in the quality of the natural capital and in the long term will reduce dependency on the declining fishery resource. In his study of small-scale fishing in Europe, he notes that specialization (on fishing) promotes dependency on the natural capital, now undesirable in the face of declining stocks.

The role of informal and formal institutions in SL

Sustainable livelihood framework can also be used as lens to study how institutions and policies are transforming the capital assets to attain the expected outcomes, mostly articulated in terms of access to education, health services, credit facility, security, and freedom and choice (MA, 2003). In the case of the Allison study, it has also illustrated the way local scale, informal institutions function to attain the outcomes. This is most clearly seen in the case where mobile fish stocks are exploited by migrant fisherfolk, with informal reciprocal access agreements being the main means of controlling movement and exploitation patterns. Formal institutions like fisheries management agencies, unaware of these informal arrangements, have sometimes sought to impose a system of fixed, territorial boundaries on these highly adapted, flexible management systems (Allison and Ellis, 2001). It has also been noted that "community-based management" has also been dominated by elites that are more concerned with perpetuating existing power structures than they are in ensuring fair and sustainable access to resources (reviewed by Ellis and Allison, 2004). This is something that we in the development work should be concerned about. This will certainly reduce the capacity of the SL programme to meet the target objectives.

SL in community-based forest management and social forestry

Decades of experiences in the Philippines and in some Asian countries, e.g. Sri Lanka, India, Philippines, Indonesia and Viet Nam (UNDP, 2008) on community-based forest management and social forestry confirmed that in order for the rural communities to get involved seriously in degraded forest and upland rehabilitation, the efforts must integrate the provision of sustainable livelihoods for the rural poor. Many studies have already shown that extreme poverty and lack of employment opportunities in the remote upland areas pushed farmers and their households to depend on insidious harvesting of forest products, e.g. timber, firewood, non-timber products like orchids and other wild flora and fauna, to survive (Espaldon, Duma and Cruz, 1991; Espaldon *et al*., 1997; Espaldon, 1995; University of the Philippines Los Baños, Land Grant, 2001). This has led to the continuous and gradual deterioration of the forest ecosystem which serves as watersheds to many areas in the lowlands. Within the context of poverty, plain conservation programmes had not been feasible. The then emerging paradigm of social forestry, managing people and nature, became very acceptable. The programme had evolved to include promotion of people's welfare through provision of livelihoods as an integral part of the program, including various types of tenure. This convergence has emerged through the process of thinking and re-thinking the paradigm of tropical rainforest protection and conservation. At present, inclusion and putting human well-being at the heart of many conservation and natural resources management has gained wide acceptance.

At the other end, experiences in resource-based livelihood programmes of development agencies have also shown some insights into the need to have a more integrative frame of thinking. For instance, the impact assessment of the livelihood enhancement for agricultural development of the Department of Agriculture in the Philippines indicated that while many of the livelihood programs targeted increasing the income of the rural communities, the efforts fell short of expectations. After the pullout of the funding program, most of the programs were not sustained. The study showed that one of the reasons for the failure was the inadequate assessment of the human and social capital assets and the great focus on activating the rural economy by funneling funding support to economically feasible enterprises. This was exemplified by the project to provide threading and weaving machine to an upland community in Benguet, in Northern Philippines aimed to jumpstart the traditional industry of silk production. After the project terminated, there was not enough technical support left to the community to do the maintenance and repair of the facility. When the assessment team came, the facility was non-functional and in bad shape. We wonder about the logic of this facility. This is in view of the fact that in the adjacent region of Ilocos Norte, weaving of abaca and silk is already ongoing with the use of indigenous technology. Again, the SL framework points to the importance of building livelihood strategies based on what the people have and utilizing participatory approaches in the conceptualizing, planning and implementation. This process ensures that other assets like human and social capitals are adequately considered in planning.

While some sustainable livelihood systems are discussed at the national or regional level, our current study in Bukidnon in Southern Philippines has documented sustainable livelihood system in action at the farmer and/or household level. Upland farmers who have integrated diverse livelihood activities have illustrated the resilience of the system to vulnerabilities brought about by extreme climatic events (Espaldon *et al.*, 2008) and even to market fluctuations. While this system of integrated agroforestry cum livestock and beekeeping enables to meet the economic objectives, the system has the capacity to recreate a natural multistory system that protect the soil from erosion, and optimize the use of sunlight and water available in the farms. The networking of the farm with other farms has also facilitated the stability of income and at the same time facilitated the dissemination of technologies that work and do not work. At the end of the day, the system enables the improvement of the assets of the farms and the households, and can be gleaned from ability to access health and education, improved transport and communication facility. This generates enhancement of social capital—of networks among neighborhood and fellow upland farmers (Espaldon *et al*., 2007; Espaldon *et al*., 2005). While SL was not explicitly used in the actual planning and development of individual farms studied in Bukidnon, the SL framework further the understanding of the intricacies of sustainability of livelihood systems.

In the study of the transition from tea to coffee in Bao Loc, Central Viet Nam (Espaldon and Ha, 2001), it was indicated that the attempts of farmers to optimize the profit from good international market for coffee triggered individual tea farmers to shift to coffee, without due consideration to the physical characteristics of the soil and land topography. The conversion has raised concern due to massive soil erosion in the hilly lands. However, coffee grown in marginal zones does not produce as much when compared with coffee in prime and fertile flat lands. Coupled with declining quality and oversupply of coffee in the global market, the price of coffee dropped. Hence the profit from coffee production was not optimized. Another crop that is gradually gaining popularity here in Viet Nam is cacao. Marsman, a chocolate company, has now started to invest in cacao plantation (Espaldon *et al*., 2007). To ensure that the expected outcomes of the project, which include provision of viable and sustainable livelihood, it would surely profit from the way of thinking the SL has been promoting.

CONCLUSIONS

The SL approach is still evolving as a framework. It is not a cure-all approach for development challenges. The strengths of this approach, however, lie in its ability to lay down the major components of a sustainable livelihood system the relationships of the components between and among each other and its very clear focus on sustainability. While the theoretical foundation of SL developed parallel to the emerging literature in sustainable development, the SL approach provides a convergence of principles that are very relevant to development practitioners. It can be treated as a "way of thinking", an example of a "systems thinking", where elements are in constant interaction with one another and that the dynamics of each relationship will influence the whole system. It can serve as a powerful analytical tool to guide researchers and practitioners in rural development and poverty reduction.

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Indicators of sustainable small-scale aquaculture development

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ABSTRACT

The indicators of the sustainability of a system differ from the traditional indicators of growth, progress or development. The relevance of this distinction to aquaculture is that aquaculture cannot be expected to contribute to sustainable rural development if it is not itself sustainable. The Sustainable Livelihoods Approach or SLA was used as the framework for drawing up the indicators of sustainability of small-scale aquaculture systems. The dominant definitions and widely acceptable characterization of small-scale aquaculture are reviewed. With SLA as the basic framework, a matrix is created which provides a list of possible indicators, classifies each indicator under any of the five livelihood assets and links the indicators to, on one hand, the three pillars of sustainable development (economic viability, social stability and environmental integrity) and, on the other hand, the four basic goals of a farmer, i.e. higher yield, lower cost, better economic returns and less risk. The emphasis of each indicator in relation to a livelihood capital is described. This matrix is the basis of an expanded list of indicators for small-scale aquaculture in which the importance of an indicator is explained, what it would show, and how it links to sustainability. Sustainability indicators afford a holistic view of the state of sustainability of a farm, household or community. Because they are interlinked, a change in a component can have a positive or adverse impact on the other components. Their practical use therefore is to provide better guides for an integrated approach to planning or problem solving.

INTRODUCTION

This review provides a discussion guideline for identifying sustainability indicators of small-scale aquaculture farms. It lists and briefly explains examples of sustainability indicators for small-scale aquaculture.

TRADITIONAL VS SUSTAINABILITY INDICATORS

The distinction between traditional indicators of economic, social and environmental progress and sustainability indicators have been described by Hart[1], thus: "Traditional

[1] Hart, M. www.rprogress.org/sustainability_indicators/about_sustainability_indicators.htm. Accessed 17 September 2008.

indicators such as profit or water quality measure changes in one part of a community as if they were entirely independent of the other parts. Sustainability indicators reflect the reality that the three different segments are tightly interconnected. As to choice of indicators, such traditional indicators as gross domestic product or profit reflect a faith in growth and efficiency as the primary mechanisms for improving public welfare. A different view is that progress is not measured by the quantity of goods we consume, how fast our economy is growing, or how much financial wealth is being amassed, but by how well we equitably distribute wealth, income, and access to cultural amenities; diversify and stabilize our economic base; protect and restore native ecosystems; and advance social, economic, and environmental sustainability". Examples of traditional indicators versus sustainability indicators appear as Annex 1).

CONCEPTUAL FRAMEWORK

The sustainable livelihoods approach (SLA) is the basis for the proposed sustainability indicators for small farms. An attempt is made to integrate SLA with the "triple bottom line" objectives of economic viability, social responsibility and environmental sustainability and the farmer's four basic goals of higher yield, lower costs, better economic returns and less risk.

DEFINING "SMALL-SCALE" AQUACULTURE

Clearly, the first step towards developing indicators is to define the system to which they are to be applied. In this respect, these characterizations of small-scale or small-holder farms provide a take-off point for discussions and a basis for an agreed operational definition of "small scale" aquaculture:

1. Small-scale aquaculture (SSA) operations are those that are typically family-owned, rather vulnerable, not formalized into business operations and have a small economic turn-over. There are two sub-groups of small scale aquaculture farmers: (i) farmers with little or no significant investment in assets (infrastructure), whose investments are in operational type costs, a little labor, feeding fish in a pond; and probably farm fish as one of several livelihood strategies (i.e. aquaculture is not the most significant source of livelihood or income; and (ii) small farmers whose aquaculture operations are a principal form of livelihood in which the family/ operator has invested significant livelihood assets (as in time, labor, infrastructure, finance (adopted by the Aquaculture Insurance for Small Scale Farmers in Asia-Pacific, Bali, Indonesia, 2006).[2] (Secretan *et al.,* 2007).
2. A simplified characterization of small-scale aquaculture was adopted by the NACA-ASEAN Foundation Project on Promoting the Competitiveness and Sustainability of Small Holder Aquaculture Farmers in ASEAN, as follows[3]:
   - small land and water area,
   - family-scale operations business,
   - mostly based on family labour,
   - often based on family land,
   - rather vulnerable.

   Similar characterizations, which highlight the primary motivation for farming, are provided by Muir *et al.* (2001)[4]:
3. It is a single small production unit such as a pond or a cage, usually individual or family run, with low input levels and limited or no external assistance. The

[2] FAO 2007. Secretan, P.A.D, Bueno, P.B., van Anrooy, R., Siar, S.V., Olofsson, A., Bondad-Reantaso M.G. and Funge-Smith, S., 2007. Guidelines to meet insurance and other management needs in developing aquaculture in Asia. FAO Fisheries Technical Paper No. 496. Rome, FAO. 148p.

[3] Report of the Inception Workshop of the Project, NACA, 5-6 August 2008. Bangkok.

[4] Muir, J. *et al.,* 2001. Development of sustainability indicators: draft working paper for the FAO Expert Consultation on Indicators of Sustainable Aquaculture Development, Rome, 24-27 Sep 2001 (unpub).

farmer's goal is often to produce the family food supply, but selling part of the harvest for additional family income can also be a motivation.

4. One or more small production units, family or communally run; hatchery output scaled up but simply run; low to moderate input levels, limited external labor. Farmers' goal can be both food supply and income from sale of product.
5. Finally, to place small-scale aquaculture in context and outline its boundaries, Peter Edwards and Harvey Demaine contend that "rural aquaculture" is intrinsically small-scale aquaculture by defining it as "the farming of aquatic organisms by small-scale farming households or communities, usually by extensive or semi-intensive, low-cost production technology appropriate to their resource base".[5]

It is also necessary to establish the boundary of the system. The livelihoods framework dictates that the analytical unit should be the farm household. This broadens the analysis from a production unit to a farming system. The first type of system would be a solely aquaculture enterprise; the second an integrated system in which aquaculture is one of two or more farming enterprises; and the third would a system in which aquaculture is one activity in a mix of on- and off-farm employment or sources of livelihood.

THE GOALS OF AQUACULTURE DEVELOPMENT

This section casts the goals of a farm household in the broader development context. The objectives of aquaculture development are aligned with the three national goals of economic development, social development and environmental sustainability. At the operational level, therefore, the development objectives of rural aquaculture are:

1. Economic – to produce wealth, specifically to generate income for rural communities and for the country, increase employment opportunities, and catalyze other economic activities in rural and urban areas that would generate more income and employment.
2. Social – to improve quality of life, specifically to raise living standards by improving livelihoods of people in rural communities, improving food and nutritional security, and minimizing if not removing threats to security.
3. Environmental – to maintain the long-term flow of benefits from the multiple uses of the marine, coastal and inland resources and environments, and from the protection or enhancement of the resources including biological diversity.

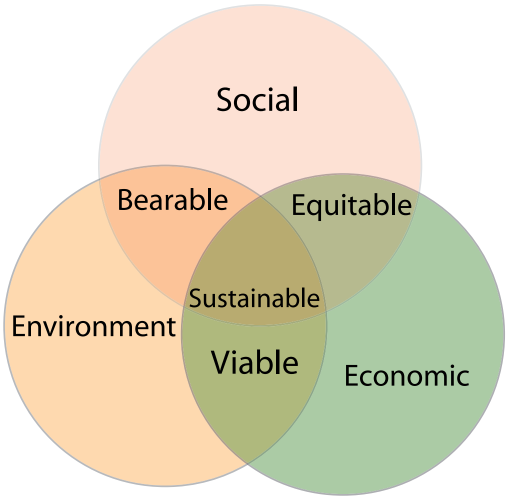
Providing the links among these objectives is their fundamental rationale, as follows:

- Economic viability, or in a narrow sense, profitability, is one of many farming objectives that contribute to long-term sector sustainability.
- Social stability and development improves the climate for economic growth.
- Economic and social development cannot be sustained if economic growth results in a degraded environment and diminished productive capacity of the natural resources.

The linkages of these three pillars (economic viability, social stability and environmental integrity) of development and how their interactions can result in a "sustainable" state are illustrated by the graphics in Figure 1. What it depicts is that the achievement of social and economic goals result in an <u>equitable</u> distribution of social and economic benefits; social and environmental responsibility results in a <u>bearable</u> life and economic success and environmental responsibility assures the pursuit of <u>viable</u> livelihoods. The

[5] Edwards, P., Little, D. and Demaine, H. 2002. Issues in Rural Aquaculture. Rural Aquaculture. CABI Publishing CAB International UK. 358 p.

FIGURE 1
A sustainable state from the interactions of economic development, social stability and environmental integrity



confluence of equitable, bearable and viable conditions results in a sustainable state of affairs.[6]

From an environmental perspective, the goal for sustainable aquaculture is to ensure that society benefits not only from the production of food and materials but also from the maintenance, restoration or enhancement of ecosystems services such as the protection of mangroves and other wetlands, corals, watershed, water resources, soil, and the biodiversity that depends on them (Clay, 2004). This essentially combines the ecological (usually labeled as strong sustainability) and the economic (or weak sustainability) concepts of sustainability. The synthesis has been expressed as follows: "Sustainability is a dynamic condition in which the combined economic and environmental sub-systems meet the needs and wants of the current human population (by producing current output) while maintaining or increasing the resources and productive capacities (or the endowments) that are passed along to future generations".[7] Brought down to a practical level and cast in the farmers' perspective, sustainable aquaculture requires that fish farmers be rewarded for producing food and raw materials and ecosystems services" (Clay, 2004).

The next section discusses the sustainable livelihoods approach framework as the basis for developing the sustainable indicators of a small scale aquaculture farm.

LIVELIHOODS CAPITALS

Livelihood assets (also called livelihood *capitals* when they are being utilized) are as much the foundation of a sustainable farming system or of a farm household as a sustainable community. Sustainable small holder farming is thus predicated on the (i) ability of the farm household to access and use productively the five livelihood assets and (ii) its capacity to maintain or build up the stock of each of these five livelihood assets so that the system (the farm household) continues to produce a stream of products and services, as the left pentagon (Figure 2) illustrates.

From a sustainability viewpoint, the size of the pentagon is less important than its symmetry. An imbalanced livelihood asset pentagon in which one or more of the sides are longer or shorter than the others means that some assets have been depleted or degraded for instance, by shocks that the farm household lacks the capacity to cope with, or because of unsustainable practice, as reflected by the pentagon (Figure 3). Or, the stock of one or more capitals (usually financial and physical are excessively being built up ("lengthened") at the expense of natural capitals, as the third pentagon illustrates.

[6] Sustainability accounting. www.sustainablemeasures.com/Indicators/index.html (accessed 30.10.2008)

[7] Sustainable Development in the United States: An Experimental Set of Indicators. A Report Prepared by the U.S. Interagency Working Group on Sustainable Development Indicators Washington, D.C. September 2001. www.sdi.gov/lpBin22/lpext.dll/Folder2/Infobase/1?fn=main-j.htm&f=templates&2.0

FIGURE 2
The Asset Pentagon
Five sides of equal length depict a sustainable livelihood system

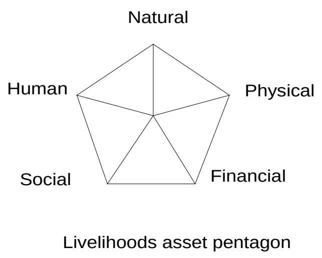
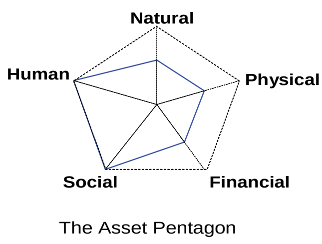
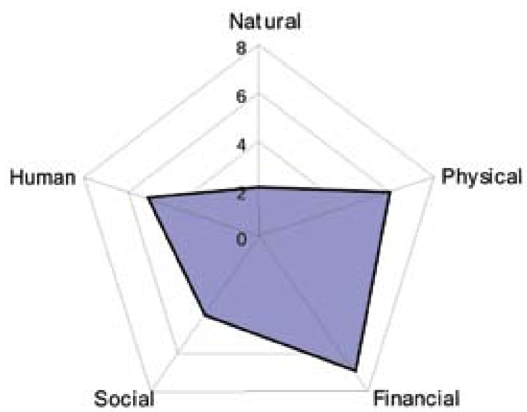


FIGURE 3
The unequal sides of the pentagon indicates an imbalance in the build up and/or use of livelihood assets



The same logic applies at the farm level. Should the capacity of the natural resources on which the farm depends becomes overwhelmed, it can reach the point beyond which it is not possible to restore its original productive capacity. If the farmer lacks the skills or the technology, or his health is such that it does not match the physical requirement of working in the farm, or S/Le has no access to skilled and quality labor, the performance of the farm suffers. On the other hand, there is the possibility of trade-off or substitution between renewable and some non-renewable natural resources on one hand and built capital or technology on the other. Physical capital may be manufactured that substitutes for natural capital. In other words, this built capital can provide approximately the same services or benefits as natural capital. Some non-renewable natural resources however, such as soil and water, are extremely difficult if not impossible to substitute because their exhaustion would mean the end of the flow of benefits to the farm and society. Or at least they have no immediate viable replacements.

FIGURE 4
Imbalanced pentagon shows that the build up of financial capital as well as physical capital has been made at the expense of the natural assets, i.e. soil, water or biodiversity



The five types of livelihood capitals (DFID, 1999), are described below. The exercise of developing the indicators should focus on the priority goals of the small farm household. The purpose is to list a small number of indicators that would best represent these objectives rather than drawing a lengthy list, which could be expensive to obtain and measure and whose linkages and relations are not easily seen.

1. **Natural capital.** The natural resource stock from which resource flows useful to livelihoods are derived. It includes the characteristics of the local resource base and implies the ability of household to gain access, which is influenced by rights, ownership, and entitlements and the availability of technologies to use the resource potentials.
2. **Social-political capital.** The set of social relationships upon which people draw in pursuit of livelihood. It includes the range of contact networks, membership of groups and organizations, relationships of trust, access to wider institutions, as

well as the services, technologies, information, markets, credit, and other factors of production.

3. **Human capital.** Consists of skills, knowledge, and ability to work, good health and ability to pursue livelihood activities. It has two elements, namely, quantity or the number of productive individuals and quality or what individuals know and skills they possess and how hard they are able to work.
4. **Physical capital.** Consists of the basic infrastructure for transport, buildings, water management, energy, and communications and productive capital (tools, machines, farm structures, etc). Also called built capital, these are owned (such as buildings and facilities on the farm) , or accessed (such as roads, irrigation systems, electricity and telephone networks, etc.) and either provided by government or the private sector, are free or paid for.
5. **Financial capital.** It has two elements, namely: (a) sources, which include savings, supplies of credit, regular remittances and pensions, social security payments or insurance, etc. and (b) purposes, which are to enable different livelihood options, for capital investments, for production inputs, and for responding to the effects of different shocks, such restoring and reconstructing livelihoods.

The purpose of improving livelihoods is to tackle not poverty but its causes and the other factors that predispose people to poverty or exacerbate it. These include vulnerabilities, insecurity, poor adaptive capacity and low social and ecological resilience. In the context of sustainability, the inability to get out of poverty or a descent into poverty is a broad indication of lack of sustainability. In this regard, the links between livelihood and the conditions for a poor means of livelihood (i.e. poverty) need to be understood. These are described in Annex 2.

INDICATORS OF SUSTAINABLE SMALL-SCALE AQUACULTURE

One of the biggest problems with developing indicators of sustainability is that frequently the best indicators are those for which there is no data, while the indicators for which there is data are the least able to measure sustainability, which usually leads to the choice of traditional data sources and measures for indicators. However, there is a danger that traditional data sources and traditional indicators will focus attention on the traditional solutions that created an unsustainable community in the first place. Discussions that include the phrase "but you can't get that data" are not going to lead to indicators of sustainability. If you define a list of indicators and find that the data is readily available for every one of them, you probably have not thought hard enough about sustainability. Try to define the best indicators and only settle for less as an interim step while developing data sources for better indicators (Hart, M. op cit). A comparison between traditional and sustainability indicators is provided in Annex 2, from which Table 2 below is adapted. The table identifies provisional indicators of sustainability for small-scale aquaculture.

This matrix links the sustainability indicators with the four basic objectives of a farmer (listed on the right column, namely, *higher yields, better economic returns, lower cost and less risk*) and the pillars of development (left column). This depicts the relations between the farmers' objectives and the indicators of sustainability of his farm. In practical terms, the farmer farms because of expectation of being justifiably rewarded, although his farming practices should not stress his resources to the point of losing permanently their capacity to support production. The third column, which highlights the emphasis of each indicator, refers both to sustainability issues and farmers' objectives. It should be cautioned that depending on the type of small-scale farm, some indicators may not be applicable. Subsistence farms may not have savings, for instance, but small-scale cages of, say, groupers and lobsters as well as small-holder shrimp farms may have sufficient turnovers that allow them to save and

TABLE 1

Linkages of the sustainability indicators with the broad goals of development and the farmer's goals

Broad goals/or development pillars	Sustainability indicators (Examples)	Emphasis of indicator	Relation to basic farming objectives
Economic viability	Investment into farm improvements	Productive use of savings or loan Farm resilience (Built capital)	Expand farm enterprise; higher returns
	Loan repayment/loan default	Profitability of operation Economic resilience (Financial capital)	Better credit worthiness,
	Percent of farm gate price to retail price in local market	Farmers' share of the margin Value addition Good market access (Financial and social capital)	Higher financial returns
	Farm workers wages compared to other sectors	Sector's importance to local economy (Human capital)	Reliability of labor supply
	Diversity of farm products	Economic resilience Good farm risk management (Financial capital)	Less household risk from crop failure
	Multiple use, recycling of water	Adding value to water (Natural capital)	Lower cost per unit of water volume
	Ready availability of farm workers/non-seasonality of labor	Quality and quantity of human resources in the area Resilience of the job market (Human capital)	Better returns from a higher labor productivity with an efficient labor force
Social responsibility	Lack of conflicts	Equitable access to resources Socially responsible farming Good security (social capital)	Less social risk
	Membership in an active farmer association or group	Stakeholder participation; social cohesion (social capital)	Less probability of outside threats i.e. less risk
	Rapidity and prevalence (among farmers) of adoption of new practices	Credibility and reliability of support services (social capital)	Higher yield Less risk from unproven technology
	Children of schooling age in school	Attention to human development (human capital)	Better quality of life of the family; more efficient labor force in the future
	Preference for the products of the farm	Trust in the farmer (social capital)	Better returns
	Percent of recycled farm waste	Efficient use of farm resources (natural capital)	Probably better returns
Environmental sustainability	Percent energy cost to total production cost	Efficiency in energy use (natural capital)	Lower cost
	Lack of conflicts	Environmentally friendly farming Good sector management (zoning, planning) (social capital)	Less social risk
	Frequency, severity and prevalence of diseases	Ecological diversity/resilience Effectiveness of environmental management Effectiveness of sector planning (natural capital, also financial)	Higher yields
	Non-use of antibiotics and chemicals	Good management practice Effective regulations (natural capital, also social)	Less social (from food safety issues) and environmental risk; better market access
	Use of certified seed	Good risk management practice (financial)	Less risk, higher yields
	Adoption of code of conduct/ BMPs	Good risk management strategy (social)	Less environmental risk
	On farm soil and water conservation structures and practice	Ecological resilience (physical/ natural capital)	Less environmental risk

re-invest. Likewise, subsistence farmers may not be borrowing money for production, nor would they be hiring workers.

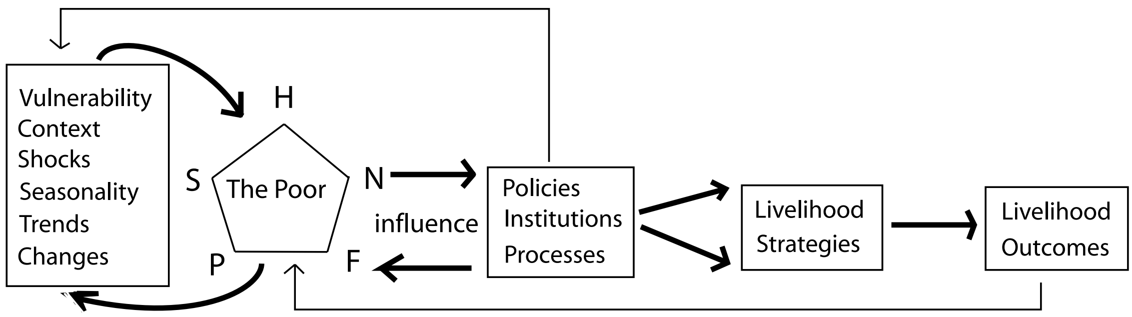
The above matrix is re-structured in Annex 3 to illustrate the (i) importance of each indicator, (ii) what it would show and (iii) how it relates to sustainability.

WHAT TO DO WITH "INSTITUTIONAL SUPPORT"?

The above matrix fails to reflect policy and regulations and the access to, availability and adequacy of institutional services such as markets, inputs supply, credit, insurance, technology, and training. An ADB (2004) study of small-scale freshwater aquaculture used a modified sustainable livelihood approach model to enable a study of the se factors, which are called transforming processes and structures in the model. ADB's framework "to analyse channels of effects" is modified from Carney (1999) and recognizes the importance of access to capital assets and the key transforming processes that include markets and prices; labour market; public and private institutions; facilities, infrastructure, and services; legal framework and development policies; aquatic resources management and the environment; and various safeguards, including biosafety and aquatic health (Figure 5).

FIGURE 5

A model is used to analyze the influence of policies, institutions and processes (collectively called transforming processes) on livelihood outcomes



The framework recognizes seasonality, shocks, and trends that influence outcomes. The importance of access to different kinds of capital assets can vary with specific and local circumstances. However, some conditions, especially access and tenure rights to land and water, are essential for all scales of aquaculture.

There are two ways of assessing these influences: (i) use a separate tool other than sustainability indicators such as measuring their individual and collective impacts on aquaculture development using standard measures of institutional effectiveness, or (ii) they are expressed as sustainability indicator statements. An example of this second option would be to state each as "The capacity of the farmer to access, say, market information" or the "capacity of the farmer to access and apply technology or technical advice". This second approach would lengthen the list of sustainability indicators. On the other hand, it would give a better assessment of the social and human capitals of the farming community such as the presence of, membership in, and strengths of farmer associations, the farmers' capacity to identify, diagnose and solve problems, resourcefulness, and other indications of human capital. It could also lead to better indications to the links between farmers and external sources of advice and technology.

MEASURING THE INDICATORS

Measures and data sources

While they can be as varied as the types of systems they monitor, good indicators have certain characteristics in common: **relevant**, they show you something about the system that you need to know; easy **to understand** by people who are not experts; **reliable** in that you can trust the information that the indicator is providing; and based on **accessible data** in that the information is available or can be gathered in time to be useful.

Table 2 lists the possible measures (quantitative, scalar and yes/no responses) and the data sources of indicators.

Reporting and interpreting the results: way forward

There are two important issues to address in reporting and interpreting results of the exercise: whether sustainability indicators (i) can have a definitive reference value or (ii) can be measured against a standard. A reference value indicates a particular state of an indicator corresponding to a situation considered as *desirable*, undesirable or for urgent *remedial action*. A standard consists of criteria which have been formally established and either enforced by an authority or offered for voluntary adoption in consideration of certain benefits (the benefits can include better market access or premium price for organically farmed products, better image for adhering to a code of conduct, or all of the above such as in the adoption of ecolabels or social labels). Unlike traditional indicators such as particulates in the air or level of phosphorous in discharged water to indicate acceptable pollution level, the first in terms of human health, the latter of environmental health, sustainability indicators do not lend themselves easily to being measured against standards. Another way of reporting is based on a base year (=100), as with government economic indicators, in which progress is measured. Clearly, at this point when the project is only just being initiated, a base point is not available. The study will need to rely heavily on weakly reliable recall data.

A way forward for this workshop is to design a pilot study or studies to (a) test the validity of the sustainability indicators coming out of the meeting and (b) devise and test reference points for sustainable and unsustainable systems in the same pilot studies. The latter would be based on the state of the indicators of livelihood capitals.

CONCLUSIONS

A general conclusion from this review is that sustainability indicators do provide a holistic view and understanding of the state of sustainability of an entity such as a farm, farm household, a farming community or a commodity industry sector such as. shrimp farming or tilapia farming. Indicators of sustainability are not static, independent indicators of separate components of an entity. They are interlinked and one change in a component can have a positive or adverse impact on other components.

The practical use therefore of sustainability indicators is that they provide guides to an integrated approach to problem solving. This avoids a piecemeal approach to problem solving at both the farm and community levels. It would also be a useful basis for a similarly holistic policy and development planning that is focused on small-scale farmers.

TABLE 2
Examples of indicators, their measures and possible data sources

Sustainability indicators	Measures	Data sources
Investment into farm improvements	Quantitative on farm information	Farmer, farmer's wife.
Loan repayment/loan default	Quantitative — No. of farmers; percentage repayment	Bank, financial institution, lenders
Percent of farm gate price to retail price in local market	Quantitative — on farm and market information	Farmer, local market, traders
Farm workers wages compared to other sectors	Quantitative — community information	Government labour office, job brokers, farmers
Diversity of farm products	Quantitative on farm information	Farmer, local market
Multiple use, recycling of water	Qualitative and quantitative on farm information; diagram of water uses, number of water re-use on-farm (refer to RESTORE Model, World Fish Centre)	Farmer
Ready availability of farm workers/non-seasonality of labor	Qualitative expressed in a scale: Low-Medium-High	Key informants, farmers
Lack of conflicts	Quantitative (frequency) or scale (Low-Medium-High); Number, nature of and intensity	Local government, key informants in community
Membership in an active farmer association or group	Quantitative: presence of association and membership; also qualitative such as status of association and even motivations for membership.	Farmer association officers; key informants
Rapidity and prevalence (among farmers) of adoption of new practices	Qualitative: adoption rate and speed of adoption; quantitative: adoptors and non-adoptors	Extension workers, farmers, key informants
Children of schooling age in school	Quantitative, household information	Farmer; farmer's wife, community school
Preference for the products of the farm	Qualitative: Scale or Yes/No	Traders, buyers, local market
Percent of recycled farm waste	Quantitative on farm information	Farmer
Percent energy cost to total production cost	Quantitative on farm information	Farmer
Lack of conflicts	Quantitative (historical frequency) or Scale: Low-Moderate-High	Key informants, farmers
Frequency, severity and prevalence of diseases	Qualitative: Low-Moderate-High	Extension workers, farmers
Non-use of antibiotics and chemicals	Yes/No; If Yes, in which operations are they used?	Farmer, extension worker, traders
Use of certified seed	Yes/No	Farmer, hatchery, extension worker
Adoption of code of conduct/BMPs	Yes/No	Farmer, extension worker
On farm soil and water conservation structures and practices	Yes/No or Low-Medium-High	Farmer, extension worker

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ANNEX 1

TRADITIONAL INDICATORS COMPARES WITH SUSTAINABLE COMMUNITY INDICATORS (FROM HART, M.)

Economic indicators

Traditional indicators	Sustainability indicators (SIs)	Emphasis of SIs
Median income Per capita income relative to the US average	Number of hours of paid employment at the average wage required to support basic needs	What wage can buy Defines basic needs in terms of sustainable consumption
Unemployment rate Number of companies Number of jobs	Diversity and vitality of local job base Number and variability in size of companies Number and variability of industry types Variability of skill levels required for jobs	Resilience of the job market Ability of the job market to be flexible in times of economic change
Size of the economy as measured by GNP and GDP	Wages paid in the local economy that are spent in the local economy Dollars spent in the local economy which pay for local labor and local natural resources Percent of local economy based on renewable local resources	Local financial resilience

Environmental indicators

Traditional indicators	Sustainability indicators (SIs)	Emphasis of SIs
Ambient levels of pollution in air and water	Use and generation of toxic materials (both in production and by end user) Vehicle miles traveled	Measuring activities causing pollution
Tons of solid waste generated	Percent of products produced which are durable, repairable, or readily recyclable or compostable	Conservative and cyclical use of materials
Cost of fuel	Total energy used from all sources Ratio of renewable energy used at renewable rate compared to nonrenewable energy	Use of resources at sustainable rate

Social indicators

Traditional indicators	Sustainability indicators (SIs)	Emphasis of Sis
SAT and other standardized test scores	Number of students trained for jobs that are available in the local economy Number of students who go to college and come back to the community	Matching job skills and training to needs of the local economy
Number of registered voters	Number of voters who vote in elections Number of voters who attend town meetings	Participation in democratic process Ability to participate in the democratic process

ANNEX 2

LINKAGES BETWEEN LIVELIHOODS, POVERTY, VULNERABILITY, SECURITY AND ADAPTIVE CAPACITY AND RESILIENCE

1. **Poverty:** Poverty is not an economic condition (indicated by subsisting on less than 1 or 2 USD a day) but the lack of basic capabilities; thus the elements of poverty are:
   - inability to satisfy basic needs,
   - lack of control over resources,
   - lack of education and skills,
   - poor health, malnutrition,
   - lack of access to water and sanitation,
   - vulnerability to natural and economic shocks,
   - lack of political freedom and voice in policies.

These lack of capabilities correspond to or directly reflect the lack of access to any one or two or all of the five livelihood assets.

2. **Vulnerability:** The (in)ability to avoid, prevent, cope with or recover from harmful impacts of factors that disrupt lives and are beyond the people's immediate control. Factors can be sudden such as a war, natural hazards, collapsing markets, or gradual, such as gradual environmental degradation, deteriorating terms of trade, oppressive systems. It is both a <u>condition</u> and a <u>determinant</u> of poverty: the poor are vulnerable, they are vulnerable because they are poor.
3. **Security:** The extent to which people can live their lives and conduct their livelihoods free from threats (to well-being such as shortage of food and to life such as hazards). Security is achieved by reducing vulnerabilities and improving resilience.
4. **Adaptive capacity:** The ability to respond and adjust to actual or potential impacts of natural and economic shocks in ways that moderate the adverse impacts or take advantage of any opportunity such impacts may offer. It can be simply defined as the resilience of a system to unpredictable shocks.
5. **Resilience:** The ability to withstand the impact of shocks and trends, absorbing them and maintaining function. It can be achieved by maintenance or build up of livelihood assets, sometimes facilitated by external support.

ANNEX 3

SUSTAINABILITY INDICATORS FOR SMALL-SCALE FARM HOUSEHOLDS

Criteria	Indicator	Why is it important?	What would it show? (equivalent to a standard in a traditional indicator)	How does it relate to sustainability?
Economic viability	1. Investment into farm improvements	More built assets or physical capital on-farm strengthens production base; it indicates productive use of savings or loan.	More and/or better farm facilities and equipment; a higher inventory and value of physical assets.	Investment in on-farm capital improvements such as treatment ponds, power source, storehouse, aeration, etc., improves farming efficiency that results in better economic and environmental performance – a positive impact on natural capital. Farm endowments are increased which offset depreciation or reduce the use of natural assets.
	2. Loan repayment/loan default	Farmer has a ready source of money for capital investments and operation; it indicates profitability of the farm and the farmers' management ability.	High repayment rates, low default rates. Low incidence of indebtedness. Better economic viability of the farm.	Credit sources do not impose onerous terms; production loans are invested wisely; or enterprise is profitable to enable farmers to avoid heavy indebtedness that could force them to abandon or sell the farm. It gives resilience to the farm household against economic shocks, which improves human capital.
	3. Percent of farm gate price to retail price in local market	A higher share of the margin by the farmer indicates a good market mechanism that enables producers a fair share of the margin between farm gate and retail.	The share of the margin between farm gate and retail market is fair to the farmer. Value addition. Quality product.	An efficient market mechanism that enables a fair price to farmers improves farm profitability and competitiveness. Also indicates that trust – rather than opportunistic behavior – prevails along the value chain, which enhances social capital.
	4. Farm workers wages and skills compared to other sectors	Wage levels in a sector show the sector's importance to local economy. Competitive wages offer greater opportunities to work force. Labor productivity is one of the capacities that makes economic prosperity possible–along with natural financial and physical assets.	Wage rate in aquaculture do not significantly vary with those in agriculture and fishing. Levels of education comparable to those in agriculture especially in livestock husbandry	A good wage structure would attract better skilled workers. It provides incentive to labor market entrants to improve their skills – a positive impact on human capital. It helps avoid labour conflicts.
	5. Diversity of farm products	Crop failure in one enterprise does not jeopardize the welfare of the household; it also enables higher farm productivity.	Greater variety of farm products. Higher cropping intensity.	Multiple cropping increases the efficiency in the use of production resources; it indicates better management ability (more than one crop increases farm management complexity). It improves household economic resilience. Even as it improves productivity and economic returns, it makes optimum use of natural and physical capitals.
	6. Multiple use, recycling of water	It is virtually adding value to water on top of conserving water supply.	Higher production per unit water used. Less discharge of waste water. On-farm facilities for water storage and conservation.	Efficiency of water use contributes to conserving water supplies such as from aquifers and streams. The carrying capacity of the water source is not strained (on land, withdrawal rate is less than ability of source to recover; on coastal waters and lakes and reservoirs, the assimilating capacity for waste is not overwhelmed, i.e. no pollution or eutrophication); less pollutants are discharged into receiving waters – all positive impacts on natural capital.
	7. Ready availability of farm workers/non-seasonality of labor	Better returns from higher labor productivity with an efficient labor force; Less cost from not having to pay much higher rates for scarce labor, or not being able to raise a crop at all.	Higher labour productivity. No or less delays in the timing of farm operations. No idle lands. No idle production facilities.	A reliable supply of farm labor allows undisrupted operations. The job market is resilient, most likely from perception of good opportunities (a steady demand) in the sector, which improves farm productivity (economic performance) and enhances human capital.

Criteria	Indicator	Why is it important?	What would it show? (equivalent to a standard in a traditional indicator)	How does it relate to sustainability?
Social responsibility	1. Conflicts	Conflicts disrupt production, reduce farming effectiveness and increase costs. Serious conflicts can paralyze operations or lead to abandonment of farms.	Less or no violation on properties (for example little or no incidence of poaching). Less or no challenges to the farm from the public. An effective stakeholders' participation.	Indicates good governance as well as socially responsible farming. A reduction in conflicts improves the climate for investments and reduces costs – with positive economic impacts. Conflict mitigation and resolution mechanisms abet better farming.
	2. Membership in an active farmer association or group	Active participation in farmer associations is an indicator of the vitality of stakeholder participation. It also shows social cohesion.	Presence of farmer association(s) or groups or clusters. Number of registered and active members.	It increases economy of scale of small farmers; strengthens their bargaining power; improves capacity for adoption of better management practices; increases social capital but also translates to greater economic viability and environmental responsibility. Increasing the participatory capacity of individuals in concert with government institutions facilitates the ability of these institutions to respond to environmental, social and economic challenges.
	3. Speed and spread of adoption of new practices	It is a proxy indicator of the credibility and reliability of support services (social capital); and the quality and relevance of new technology.	Time lag from introduction of innovation to adoption. Lower rejection rate of innovation by farmers.	Translates to higher yields and less risks from unproven technology. The presence of credible technology support institutions improves farmers' competitiveness and sustainability.
	4. Children of schooling age in school	Educational attainment is a proxy measure of human and social capital.) High levels of educational attainment are related to positive gains in civic responsibility, health, income, life expectancy, quality of life and other variables that intersect economic and social well-being.	More children of farming households enrolled in school. Low drop-out rates. Low incidence of unacceptable child labour.	Education is correlated with social capital. Attention given by the family to the education of their children will eventually enhance human capital; results in better skills and thus better opportunities for the future generation. Sustainable development is abetted by a well-educated population. Better educated children, however, may eventually opt to look for employment outside the farm; on the other hand, should they decide to carry on farming, their higher education would likely translate to better farm management skills and receptivity to innovation.
	5. Preference for the products of the farm	It indicates quality farm products, and/or environmentally friendly farming.	More buyers. Probably higher prices for the products of the farm.	Trust in the farmer by buyers is an important social capital that can translate to better profitability. Better market access improves competitiveness and sustainability of farms.

Criteria	Indicator	Why is it important?	What would it show? (equivalent to a standard in a traditional indicator)	How does it relate to sustainability?
Environmental sustainability	1. Percent of recycled farm waste	The disposal of accumulated waste can stress the environment as well as adds to costs. Using it for production turns it from a liability to a farm asset.	Less waste materials in farm premises. Lower or no disposal cost.	Recycling improves environmental performance and may even increase farm profitability. Waste, which productivity is otherwise low, zero or negative, is transformed to something that adds to farm productivity.
	2. Percent energy cost to total production cost	Energy efficient operations may contribute to energy savings and certainly to less GHG emissions per unit of food produced.	Lower energy cost.	Efficiency in energy use helps conserve natural capital even as it improves economic and environmental performance.
	3. Environment-related conflicts	It indicates environmentally responsible and friendly farming; also a proxy indicator of better sector governance (i.e. zoning, planning) and the adoption of COCs , GAPs and BMPS.	No or low incidence of challenges to the farm from the public and from government.	Environmentally friendly farming. Good sector management (zoning, planning) (social capital); less social risks (challenges to the farm from the public).
	4. Frequency, severity and prevalence of diseases	Indicate better farm management, effective health management protocols, and a greater biodiversity.	Successful harvest. Lower cost from non-use of chemicals, drugs or therapeutants.	Ecological diversity/resilience. Effective environmental management, health management, and a higher biodiversity promote sustainability and contribute to the protection of natural capital. These also enhance farmers' economic performance.
	5. Use of antibiotics and chemicals	Non-use or prudent use is an indication of good management practice and/ or effective regulations and their enforcement.	Lower seed mortalities. Appropriate stocking density.	Less social risk (from food safety issues) and environmental risk (from pollution or contamination of the environment); improves market access; improves yields.
	6. Use of certified seed	Also an indication of good risk management practice.	Less disease incidence. Less mortality. Higher yields.	Farmers' widespread use also encourages seed producers to adopt seed certification standards. This improves overall productivity and sustainability of farming.
	7. Adoption of code of conduct/BMPs*	It is an indicator of good risk management strategy; as well as the effectiveness of the farmers association. Self-regulation and –management by farmers complement legal measures.	Compliance/adherence to provisions of the COC, GAP or BMP.	Less environmental risk, less social risk which translate to less transaction costs for farming community (from having to spend time and resources resolving conflicts); increases social capital through farmer interactions between themselves and with service providers.
	8. On farm and area soil and water conservation	Erosion and water abstraction that are greater than tolerable levels seriously threaten productivity. On-farm S&W conservation practice indicates good farm management; area or landscape-level S&W structures and practices indicate good cooperation among farmers and social cohesion.	Land that is not degraded. Better quality and volume of water supply. Presence of effective landscape and on-farm physical and biological structures for soil and water conservation.	Conservation of these resources improves on-farm and community sustainability; increases ecological resilience. Preserves or enhances natural capital even as it improves economic performance.

*BMPs, GAPs or COCs would already include such practices as use of certified seed, non-use of banned drugs and chemicals, recycling of farm waste, soil and water conservation, and other practices, but using them separately as indicators would highlight their relevance to the state and prospects of small farmers' sustainability.

Development of an indicator system for measuring the contribution of small-scale aquaculture to sustainable rural development

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ABSTRACT

The contribution of small-scale aquaculture (SSA) to poverty alleviation and thus to sustainable rural development (SRD) has long been recognized, but, with the exception of research studies and donor-funded projects, there has been limited hard data to substantiate the claims made for it. As a result, resources to support the small-scale sector has not been forthcoming. In an attempt to address this problem, the Food and Agriculture Organization of the United Nations (FAO) organized an expert workshop in Nha Trang, Viet Nam in 2008 with a view to developing an indicator system for better assessment of the contribution of SSA to SRD. This paper summarizes the process adopted at this workshop and its outcomes. Based on a series of invited papers, it started by characterizing SSA, its features and positive contribution, then examined trends in the concept of sustainable development and reviewed work on indicators of sustainability. It then reviewed the possible conceptual frameworks for analyzing the contribution and the reasons for the selection of the Sustainable Livelihoods Approach (SLA) as the basis for developing indicators. The paper describes how the workshop moved from characterizing the contributions of SSA to a short list of indicators based on an agreed framework and criteria to a design of case studies for testing of the indicator system. From a free listing of some 50 indicators, the expert workshop narrowed the list to 20 and finally to 14 indicators that will assess the contribution of SSA to SRD using SLA as the analytical framework (natural, physical, human, financial and social capitals) and three criteria, namely, accuracy, measurability and efficiency or AME. The indicator system, referred to as the Nha Trang Small-Scale Aquaculture Indicators include a detailed indicator definition (contribution, indicator name, explanation, means of verification and methods for data collection).

INTRODUCTION

Aquaculture continues to be the fastest growing animal food-producing sector with per capita supply from aquaculture increasing at an average annual growth rate of 6.9 percent between 1970 and 2006 (FAO, 2009). In 2006, aquaculture contributed 47 percent of fish for human consumption. Further growth in the availability of fish for human consumption is expected to come mainly from aquaculture, which may already have overtaken capture fisheries as a source of food fish (FAO, 2009). World aquaculture is dominated by the Asia-Pacific region, accounting for 89 percent of production in terms of quantity and 77 percent in terms of value. This is mainly due to the production from China, but India, Viet Nam, Thailand, Indonesia, Bangladesh and the Philippines were among the top ten aquaculture producers of food fish in 2006.

Aquaculture provides an important source of livelihood for the rural poor, generating income through direct sales of aquatic products, in processing and by providing ancillary services. Employment figures in aquaculture are hard to come by (FAO, 2006). However, in 2006, the estimated number of fish farmers was nearly 9 million people, with 94 percent of them operating in Asia. In China, from 1985 to 2003, the aquaculture industry generated 4.3 million full-time jobs for rural farmers. In India, 300 000 jobs have been generated from the brackishwater aquaculture sector alone.

Aquaculture in Asia is dominated by small-scale producers. In Viet Nam, aquaculture is operated by small-scale farmers who are operating 85–90 percent of shrimp farming area involving more than 300 000 small-scale farmers as well as many small-scale businesses involved in the shrimp supply chain. In Thailand, aquaculture in coastal and inland areas is dominated by small-scale farmers, where 85 percent of the more than 33 000 shrimp farmers are classified as small-scale. In Bangladesh, the contribution of freshwater aquaculture sector alone, whose farmers are mostly small-scale, directly employs 800 000 people (part-time) and probably more than 3 million if related services are included and about 4.36 million estimated for the whole aquaculture sector (ADB, 2004). An example of a regional estimate is from Latin America where aquaculture directly employs an estimated 221 500 workers and excluding Chile, more than 60 percent are small-scale producers (FAO, 2006).

In the last ten years, the contributions of small-scale aquaculture (SSA) to global aquaculture production and rural livelihood development have become more recognized. These include food security and improved nutrition, efficient use of water, farm materials and other resources, diversification of livelihoods, generation of rural income and employment, utilization of family labor, fostering of social harmony, and women empowerment (Edwards, 1999). However, while these contributions have been recognized, there is a scarcity of quantitative evidence on how SSA actually contributes to SRD and no systematic assessment available which clearly measures the contribution. As pointed out by Demaine (2009) in this volume, much of the evidence on this contribution have been derived from research and development projects which may have been atypical in the resources that they have been able to invest in aquaculture development and in which there has been no ex-post evaluation of impact. This lack of hard information has been a constraint in persuading policy makers to invest resources in the development of the small-scale sector, unlike in large-scale commercial aquaculture. In sum, there is a need to understand better the contributions of SSA to SRD to guide interventions to support the sector.

It was in this context that the FAO Expert Workshop on Methods and Indicators for Assessing the Contribution of Small-Scale Aquaculture to Sustainable Rural Development was held from 24 to 28 November 2008 at Nha Trang University (NTU) in Nha Trang, Viet Nam (Bondad-Reantaso and Prein, 2009). The aim of the expert workshop was three-fold:

(1) to better understand the general concepts and principles behind sustainability indicators and their application to various sectors and specifically to small-scale aquaculture (SSA);

(2) to draw-up a list of indicators as well as methods to evaluate and appraise the contribution of SSA to sustainable aquaculture and to rural livelihood development; and

(3) to prepare a number of case study concepts using the identified indicator system for the purpose of pilot testing.

In fact, as will be seen below, the actual focus of the workshop deviated slightly, particularly from the first objective, where the focus was shifted on the contribution of SSA to sustainable rural development, as agreed by the experts, rather than on sustainability indicators.

This paper provides an overview of the process that was followed in the workshop to develop an indicator system to measure the contribution of SSA to SRD.

METHODOLOGY

The consultation adopted the workshop approach. It consisted of: plenary presentations of commissioned review papers, supported by contributed papers; working group discussions and working group presentations; and a summary and concluding session.

Session 1 aimed to lay the basis for a common understanding of the objectives of the workshop, the key concepts and principles to be addressed, the major issues, and the methodology of the expert workshop. Sessions 2 and 3 were dedicated, respectively, to the development of an indicator system for measuring the contribution of SSAs and the preparation of concepts for carrying out case studies for pilot testing the indicator system. Each session, with an elected chaiperson and rapporteur, had specific objectives and expected outcomes and was followed by working group break-out sessions (with same or multiple tasks) and feedback presentation. A plenary concluding session presented the achievements and conclusions of the workshop and the way forward.

Nine papers were presented in plenary to achieve the objective of Session 1, i.e. setting the scene in order to have a broader understanding of the general concepts and principles of sustainability, indicators and sustainable development indicators (SDI), SSA and sustainable livelihoods and broad considerations concerning the application of sustainability indicators to SSA (e.g. general principles, context, terminologies and scale of operation). These papers were divided into three thematic areas: (i) concepts and principles of sustainable development and indicators of sustainability (Espaldon, 2009a) (ii) the nature, characteristics and key issues in SSA and its development

(Jolly, Umali-Maceina and Hishamunda, 2009; Demaine, 2009; Siar and Sajise, 2009; Wattage, 2009); and (iii) case studies of attempts to measure the social and economic impacts of SSAs (Hishamunda, 2009; Morales, 2009; Prein, 2009; Sinh, 2009).

Session 2 was informed by two reviews (Espaldon, 2009b and Bueno, 2009). The first described the various models of assessing sustainability; the second provided examples of sustainability indicators of SSAs.

The process and the series of steps used in the development of the indicator system, undertaken during Session 2 followed a linear process and included the following: (1) understanding the subject of measurement, (2) identifying an analytical framework and criteria, (3) developing a list of contributions of SSAs, (4) categorizing the contributions on the basis of the analytical framework and criteria and (5) devising/defining and organizing the indicators for measuring contribution.

Session 3 charged the working groups with the task of developing concepts for case studies, identifying SSA systems, developing the methodology for the collection of data, including the kind of information which had to be gathered for each indicator in order to measure contribution, the kind of expertise needed for design of the study and data collection and the means of assessing the effectiveness of the indicators.

The work begun in Session 3 continued after the workshop. The researchers involved in the selected case studies further refined the indicator system based on pre-testing and then carried out the pilot studies over a period of six months. The results of the pilot studies were then presented at a second FAO workshop organized at Tagaytay, in the Philippines, in August 2009, with a view to further refine the methodology.

PROCESS AND OUTCOMES OF THE WORKSHOP

Session 1

Session 1 of the workshop focused on achieving a common understanding of the focus of the workshop in two dimensions:

a) defining the subject of the workshop, namely SSA, and its key characteristics in terms of contribution to sustainable rural development;
b) developing a clear understanding of the definitions, concepts and principles related indicators for the measurement of sustainability.

Small-scale aquaculture

The discussion of SSA centred around its scope, based on the presentation by Demaine (2009). This paper reviewed the concept of "rural aquaculture" introduced by FAO in the early 1990s, emphasizing its focus on rural development as an element of poverty alleviation. Thus, rural aquaculture, as characterized by low external inputs and low-cost technologies accessible to the poor, was mainly aimed at improving their subsistence and was just one of several enterprises on the farm which might be integrated to a greater or lesser extent. This "Type I" rural aquaculture was set in contrast to "Type II" small-scale commercial or artisanal aquaculture, which although small in scale and usually family-operated, often involved external inputs, was often a more specialist enterprise and was mainly oriented toward market. Several participants questioned whether such a categorization was helpful and argued the need for a more flexible spectrum of SSA systems. This was emphasized in the paper of Jolly, Umali-Maceina and Hishamunda (2009). This study recommended applying dynamic rather than static evaluation methodologies because of the dynamic setting and nature of aquaculture development. It was pointed out that the nature of the aquaculture system that a farmer adopts depended on the objectives of the farm household, whether as a means of subsistence or a major element in livelihood. The farmer's objective could change over time, according to the changing circumstances and needs of the family.

It was also stressed in the discussion that SSA could not be seen as separate from the wider farm systems, that a systems approach involving a participatory process should be an essential element in aquaculture development by smallholder farms where the entire smallholder farming system is involved with its natural resources, including identifying opportunities for diversification of enterprises and sectoral integration (Prein, 2009).

After due discussion, the workshop agreed that, seen as a continuum, the two types offered a simple basis for discussion, that SSA encompassed both of these types and that indicators to measure their contribution to SRD would need to be broad enough to include both types. On this basis, the workshop moved towards an agreed working definition and characterization of SSA as set out in Box 1. It will be seen that the characteristics of the two types, i.e. Type I and Type II, differ in a number of aspects.

Discussion of SSA also related to its sustainable development. The paper of Demaine (2009) had also underlined the importance of institutional sustainability in promoting and maintaining SSA systems and this was later supported by Sinh (2009) who added the perspective from the Mekong Delta that efforts to improve and strengthen linkages among relevant stakeholders, through appropriate planning and organization at village and district levels, in association with availability and suitability of investment and support from both public and private sectors, can benefit long-term development of coastal aquaculture. The paramount importance to sustainable aquaculture development of firm access rights to land and water was stressed (Siar and Sajise, 2009). A particular issue related to property rights was the terms of lease to land;

BOX 1

Agreed working definition and characterization of small-scale aquaculture (SSA)

Small-scale aquaculture is a continuum of:

1) systems involving limited investment in assets, some small investment in operational costs, including largely family labour and in which aquaculture us just one of several enterprises (known in earlier classifications as Type I or rural aquaculture); and
2) systems in which aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labour, infrastructure and capital (this was labeled as Type II SSA system).

The following elements and characteristics of SSA guided the discussion in clarifying and finalising the above SSA working definition that will guide the selection of SSA pilot case studies.

The common elements identified were: (a) ownership of or access to an aquatic resource; (b) ownership by family or community; and (c) relatively small size of landholding.

Small-scale aquaculture can involve both low and high value species, be conducted in a variety of containment (ponds, cages, pens, raceways, barrels, bottles, jars) and be practiced as monoculture, polyculture or integrated systems.

Other typical characteristics or attributes of small-scale aquaculture are listed below:

- mostly based on family labour (Type I)
- informal management structures (Type I)
- a certain degree of vulnerability (Type I)
- often limited access to physical and technical resources (Type I)
- limited technical expertise (Type I)
- limited access to information, including market information (Type I)
- limited investment (this attribute does not necessarily apply to Type II)
- usually limited value of sales (not necessarily for Type II)
- low household income (not necessarily for Type II)
- may or may not contribute significant proportion of total household income
- contributes to family food supply (not necessarily directly in the case of Type II)

the length and security of tenure affect the willingness of a farmer to invest in capital improvements on the farm.

The lessons from a case study of value-addition to aquaculture products showed that the measures of economic, financial, social and environmental valuation are helpful in appraising the contributions of SSA to rural society, but cannot be applied universally (Jolly, Umali-Maceina and Hishamunda, 2009).

Sustainable development and sustainability indicators

The discussion of sustainability indicators centred on the paper presented by Espaldon (2009a). This paper showed that the concept of sustainable development has undergone many re-interpretations since its emergence in the early 1990s, with different emphasis on "what is to be sustained" and "what is to be developed". As a result, there is also a vast range of sustainability indicators, differing from country to country according to conceptual framework adopted and also according to scale, i.e. global, national and local. Most sets of indicators have been developed at the national level and involved a combination of economic indicators, social indicators and environmental indicators corresponding to the so-called "three pillars of sustainable development". It was also noted that, at the local level, indicators tended to focus on SRD, involving a holistic approach seeking to develop measures reflecting economic viability, ecological soundness, social justice and cultural appropriateness.

The discussion was also informed by the reference to the paper by Maureen Hart quoted in the review by Bueno (2009); Hart (www.sustainablemeasures.com/index.html) pointed out the crucial distinction between indicators of sustainability and traditional indicators of economic, social, and environmental progress. Traditional indicators – such as profits and water quality – measure changes in one part of a system as if they were independent of the other parts. On the other hand, sustainability indicators reflect the reality that the three different segments, i.e. economic, social and environmental progress, and are tightly interconnected. She argued that progress is not measured by the quantity of goods produced or consumed, how fast the economy is growing, or how much financial wealth is being amassed, but by how well "we equitably distribute wealth, income, and access to cultural amenities; diversify and stabilize our economic base; protect and restore native ecosystems; and advance social, economic, and environmental sustainability". The pitfall of traditional indicators and traditional data sources is that they tend to focus attention on the traditional solutions which created an unsustainable community in the first place.

The ensuing discussion focused on the issue of what should be sustained/developed and decided that it should concentrate on the local/community level and therefore that the group should be focusing on the sustainability of rural livelihoods. In working groups, a number of key terms were also defined to assist mutual understanding (see Table 1).

TABLE 1
Considerations on some key terminologies used during the consultation

Terminology	Considerations concerning their definitions
Sustainability	Besides the conventional economic-environmental emphasis, there should also be consideration of social and institutional factors, involving the issue of self-reliance of households and grassroots organizations and considerations of the sustainability of development initiatives. Inclusion of these issues would be consistent with the Sustainable Livelihoods Approach.
Sustainability Indicators	A simple definition was agreed, i.e., a numerical measure to assess where we are, which way we are going, and how far we are from the goals of sustainability.
Sustainable livelihood	The original definition was considered appropriate for use in the consultation. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.
Resilience	The attribute of self-reliance should be added.
Poverty and freedoms	It was suggested that this element of poverty could be more specifically addressed if it were placed in the operational context of the poor having no voice in policy formulation rather than seen from the broad perspective of lack of freedom.

Finally, based on the review of sustainability indicators, the working groups attempted to define the guiding principles for development of SSA by which it might be able to contribute to sustainable rural livelihoods (SRL) (Box 2).

Session 2

Identification of an analytical framework

Session 2 of the workshop built logically on Session 1. Given the agreed working definition of SSA and the clarification of what aspects of sustainability the group was trying to measure – sustainable rural development or livelihood – the first question of this session was the identification of an appropriate analytical framework within which to design the indicator system.

In addressing this issue, the group turned back partly to the paper by Espaldon (2009a) in which several different conceptual frameworks had been discussed, namely:

- pressure-state response model
- human well-being or the ecosystem framework, which was linked to the Ecosystem Approach to Aquaculture (EAA) recently under discussion in FAO (FAO, 2009)
- issue- or theme-based frameworks
- capital accounting system

BOX 2

Provisional guiding principles for development of the small-scale aquaculture sector

Goal

- Aquaculture should improve human well-being and promote equity for all relevant stakeholders and in society in general.

Context

- Aquaculture development and management should consider other ecosystem functions and services (provisioning, regulating, cultural, support) and should not threaten the sustainability of these functions and services.
- Aquaculture should be developed in consideration of the policy and goals of other sectors.
- Aquaculture development is dynamic and highly contextual with spatial and time dimensions.
- Trade-off and substitution operate as options for aquaculture development.
- Aquaculture development must be within the carrying capacity of natural resource base.
- Aquaculture development should build on the assets or capital endowments of the farm, household and community.

Sustainability

- Aquaculture development should be economically, environmentally, socially and, institutionally sustainable and aligned with sustainable livelihoods approaches.
- Sustainability at one level could be affected by a higher hierarchical level.
- The sustainability of aquaculture depends on the ability of the system to effectively respond to pressures. Responses may be in terms of social, institutional and technological.
- Vulnerability is the inability of a system to avoid or prevent shocks and stresses, mitigate and recover from their impacts, which translate to lack of sustainability.

Measure of success

- There should be measurable indicators of success and their measurement should be cost effective.

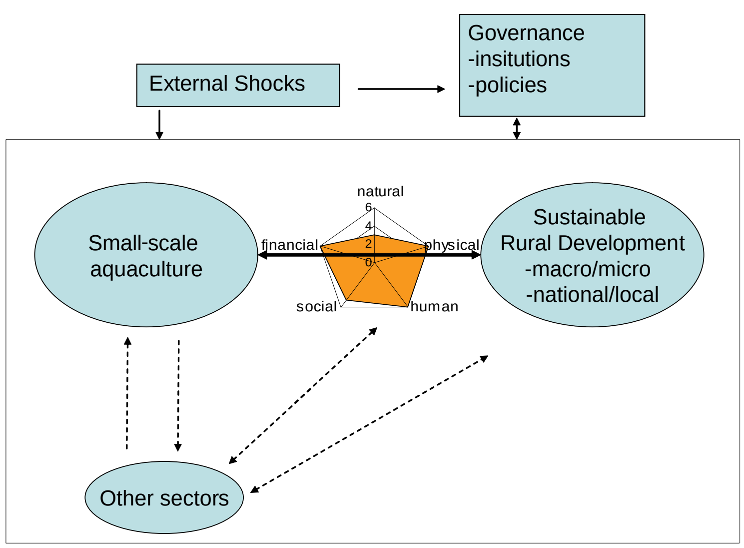
In addition, other frameworks were reviewed, including development pathways, the triple-bottom line framework, the analytical hierarchy framework (Hishamunda, 2009) and, in greater detail and related to papers by Siar and Sajise (2009), Espaldon (2009b) and Bueno (2009), the SLA framework.

From the preceding discussion, it will be observed that the outcomes of the first day seemed to point to an adoption of an analytical framework that closely models SRL. Further review of the SLA against other possible analytical frameworks examined the strengths and limitations of SLA and its applicability in assessing the contribution of SSAs to rural development. Review of the other conceptual frameworks suggested that these were either narrower than the SLA in their consideration of sustainability factors (the capital accounting framework and the triple-bottom line framework) or, while conceptually similar, were largely descriptive (pressure-state-response model, human-ecosystem well-being model). It was recognized that there was often an over emphasis of the SLA on the level of the farm household or community. In that sense, it was important to consider the wider scales emphasized in the EAA and take into account the full range of ecosystem functions and the broader sectoral context in assessing sustainability. However, it was also argued that these issues could be addressed through the vulnerability context and the consideration of processes, policies and institutions within the SLA.

Support for the SLA framework came from the one impact major study presented at the workshop. Morales (2009) presented the participatory rapid appraisal (PRA) techniques in identifying and ranking impacts and the application of sustainability indicators in assessing aquaculture adoption by smallholders in the study that ICLARM (now WorldFish Center, WFC) had employed for the evaluation of various Asian Development Bank (ADB) projects in small-scale freshwater aquaculture in Bangladesh, the Philippines and Thailand. The methodology had used a combination of a modified SLA and ADB's own Design-Monitoring Framework. An important data collection issue was also addressed in this study: the lack of baseline information was resolved by the use of recall questionnaires and, in the Philippines, use of a control group.

After extensive discussion, it was decided that SLA indeed offered an appropriate conceptual framework to address the contribution of SSA to SRD. It was concluded that its strength lay in its ability to describe the relations between and the interactions among the five basic components of a sustainable livelihood system (natural, physical, social, human and financial capitals). The framework can depict the constant interactions among the components and therefore, can account for changes in the system as well as changes in the context of aquaculture. As an analytical tool, it was deemed powerful and suitable for the appraisal of SSAs sustainability and contributions to SRD. The conceptual framework adopted is illustrated in Figure 1.

FIGURE 1
Conceptual framework for assessing contribution of SSA to Sustainable Rural Development



Developing a list of contributions of small-scale aquaculture

On the basis of the analytical framework adopted, the workshop then moved to the core issue of the workshop, the identification of indicators through which to assess the contribution of SSA to SRD. The first step in this part of the process was to make a free listing of contributions (see Table 2), based on experts' experiences and also based on several of the review papers presented on the first day (Jolly, Umali-Maceina and Hishamunda (2009), Sinh (2009), Prein (2009). Some of those contributions are listed in Box 3. A review of the list was made to determine which contributions could be merged and which ones would already reflect similar or associated contributions. It will be noted that negative as well as positive contributions were identified, particularly in relation to wider ecosystem functions.

Categorizing the contributions

The merged list of contributions was then categorized, first on the basis of the triple-bottom line framework, i.e. contribution to economic development, social development and environmental sustainability. These contributions were further classified under each of the five livelihood assets, i.e. natural, physical, human, financial and social capitals. This finer classification was meant to reflect SSA's contribution to SRL and thus to SRD.

One general issue raised at this stage was that some contributions might impact on more than one livelihood asset. The workshop agreed that a contribution should be categorized under the asset on which it was considered to have the major impact.

Defining and organizing the indicators of contribution

The statements of contributions are basically qualitative descriptions. However, the core issue of the workshop was to find indicators which would measure these contributions to SRD. In this task, the review paper by Bueno (2009) offered useful discussion guidelines for developing the indicator system. This paper relied a good deal on Maureen Hart's definition, purposes and characteristics of indicators:

"An indicator is something that helps you understand where you are, which way you are going and how far you are from where you want to be. A good indicator alerts you to a problem before it gets too bad and helps you recognize what needs to be done to fix the problem…. An indicator is something that points to an issue or condition. Its purpose is to show you how well a system is working. If there is a problem, an indicator can help you determine what direction to take to address the issue. Indicators are as varied as the types of systems they monitor".

The workshop also attempted to define what constituted a "good indicator". The classic characteristics of a SMART indicator were proposed: specific, measurable, attainable, relevant and time-bound. This discussion was also informed by Hart (see Bueno, 2009) who proposed that effective indicators should have the following characteristics:

- **relevance** - they show you something about the system that you need to know. Indicators must fit the purpose for measuring.
- **ease of understanding** - even by people who are not experts. We need to understand clearly what the meaning of the indicator and what it is telling us so that we will be guided on what action is required.
- **reliability** - you can trust the information that the indicator is providing. An indicator does not need to be precise but it needs to give a reliable picture of the system it is measuring.
- **data accessibilility** - the information is available or can be gathered while there is still time to act. Indicators must provide timely information.

TABLE 2
Free-listing of indicators of contributions of small-scale aquaculture to rural development

1	biological control of pests e.g. mosquitoes	24	number of social conflicts reported and resolved
2	pest population size	25	diversification of products (risk management)
3	reduction of incidence of animal and human diseases harboured in aquatic environments e.g. bilharzias, dengue	26	number of species of aquatic products
4	frequency (prevalence and incidence) and severity of diseases	27	additional cash income
5	recycling of household wastes and nutrients	28	total household income
6	significant re-use/ disappearance of farm wastes	29	proportion of income from SSA and derived from SSA
7	change in diversity of aquatic products	30	change in the number and strength of allied enterprises
8	provision of water supply for production of vegetables and fruit trees	31	export earnings
9	change in amount of water used	32	total export earnings
10	reduced time for watering crops	33	proportion of export earnings from SSA
11	change in amount of vegetables and fruit produced	34	contribution to gross domestic product (GDP)
12	quantity of out-of season vegetables produced	35	percentage of GDP from SSA
13	change in the quantity of aquatic products	36	food security and improved nutrition
14	utilization of under-utilized resources	37	change in aquatic product consumption
15	increase in total farm production	38	human capital enhancement (extension services)
16	increase in farm productivity	38	number of farmers receiving extension services
17	recycling of household wastes and nutrients	40	number of farmers who are members of active farmer associations and/or community organisations
18	significant re-use/disappearance of farm wastes	41	proportion of aquatic production from SSA
19	sectoral linkages	42	conversion of aquatic production types to protein
20	change in the number and strength of allied enterprises	43	utilisation of family labour
21	inter-household exchange of products	44	return to labour of household members
22	change in product transfer among households	45	enhanced social capital
23	reduction in migration from rural areas to towns	46	social harmony

Identifying indicators and means of measurement

Obviously, these ideas overlap and it was decided in the first instance to use the SMART criteria as the basis of assessing the quality of the indicator. With this is mind, the meeting turned to development of an indicator list based on the identified contributions of SSA. Candidate indicators derived from working groups were elaborated and their rationale, nature and purpose explained. In the course of the review, it was also decided that the criteria for indicator selection could be distilled down to three, namely:

- **accuracy** (incorporating relevance and specificity: the indicator did accurately reflect the supposed contribution)
- **measurability** (data were available and reliable)
- **efficiency** (could be collected in a timely and cost effective manner. To some extent this latter issue is an extension of the characteristics mentioned above, but was seen to be important in the context of ensuring that any pilot data collection exercise could be replicated on a larger scale)

The experts agreed by consensus on the 20 potential indicators, namely: (1) flows/enterprises, (2) off-farm nutrient use/farm products (input/output ratio), (3) enterprises' contribution to cash income, (4) productive use of pond water, (5) return to land capital and labour; trends in physical asset used for SSA, (6) income from SSA and derived from SSA, (7) SSA contribution to gross domestic product, (8) farmers who are members of active farmer associations or community organizations, (9) household consumption of fish, (10) seasonal distribution of fish consumption, (11) womens' access to resources and benefits of SSA, (12) women engaged willingly and as active decision-makers in SSA (including post-harvesting), (13) batch testing

BOX 3

Some examples of contribution and effects of SSAs

Contribution of small-scale aquaculture

- food security and improved nutrition
- diversification of products (risk management)
- animal and plant protein source
- additional cash income
- utilization of family labour
- utilization of under-utilized resources
- recycling of household wastes and nutrients
- investment of social capital
- inter- and intra-household exchange
- export earnings
- water supply for crops/vegetables/fruit trees
- biological control of pests, e.g. mosquitoes
- sectoral linkages
- human capital enhancement (farmer to farmer extension services)

Negative effects and factors that could negate the positive impacts of SSA

- traceability of products would be difficult
- environmental problems
- quality and food safety (during production and post-harvest)
- disease threat
- marketing difficulties
- limited economy of scale
- resource use conflicts
- limited supply of product to market
- weak cooperation and linkages
- limited accountability (for instance in the misuse of chemicals)
- under-utilization of production resources (for example, abandoned ponds)

for banned chemicals or poor quality aquatic products aquatic, (14) farmers adopting better management practices (BMPs), (15) farmers involved in traceability system, (16) export earnings, (17) employment generation, (18) disease, (19) vulnerability, and (20) resource use conflicts.

From these potential indicators, a matrix was developed showing the rationale for the indicator, the means of measurement and the methods of data collection. This matrix is presented as Table 3. It may be observed that the means of measurement mainly involved primary farm household survey, including both questionnaire survey and tools of participatory rural appraisal such as key informant interviews and focal group discussions. It was recognized that little secondary data would be available, essentially confirming the problem being addressed by the workshop in the first place.

Table 3, in fact, reduces the list of indicators from 20 to 14 to be used in preparation for the field testing after the workshop. The reasons for this will be discussed in more detail below.

Session 3: Developing country case study concepts

Session 3 of the workshop was dedicated to the preparation of country case study concepts as the basis for pilot testing of the indicator system. A number of issues came up in the deliberation. One issue related to the identification of the SSA systems to be included in the case studies. It was felt that the pilot tests should include a wide range of cases in order to test the robustness of the indicators in terms of their applicability to a wide range of systems. Thus, the selection of pilot areas should allow inclusion of at least two different SSA systems. The other issues related to the survey design and approaches, the kind of information that had to be gathered to measure each indicator, the expertise or mix of expertise needed for the study, and the effectiveness of the tools and methodologies for data gathering.

Through working group discussions, the workshop produced a short list of potential SSA systems which might be considered for pilot testing of the indicator system, mainly related to those areas well known to and can be easily accessed by workshop participants. It was deemed useful to have the case studies conducted by experts who had been involved in the Nha Trang workshop for their familiarity with the concepts, methodologies and tools proposed by the expert workshop and the process that led to the development of the indicator system. The short list of systems is in Box 4.

BOX 4

Examples of small-scale aquaculture systems in Asian countries which may be considered for pilot testing of the Nha Trang SSA indicator system

Indonesia
- shrimp culture in ponds

Bangladesh
- rice-freshwater prawn-carps, vegetables
- rice-fish rotational systems in seasonally flooded rice fields

Philippines
- tilapia cage culture
- seaweed culture

Thailand
- *Clarias* sp. pond culture
- Mixed finfish sp. culture in trench (orchards and gardens)

Viet Nam
- lobster cage culture
- marine finfish and penaeid shrimp integrated farming
- pond/orchard ditch; rice-fish/shrimp
- small scale pond (shrimp and others)
- mud-flat culture of mollusc
- *Pangasius* sp. culture

Session 3 also developed the (i) table of contents of a generic survey design (including background, objectives, methodology, results, analysis, conclusions, recommendations on the adoption of indicators and future work, and (ii) discussed possible approaches (e.g. face to face interview, group meeting, resource mapping along the lines of the WFC's RESTORE model (Prein, 2009), recall questionnaires, etc.).

Post-workshop follow-up activities

The activities begun in Session 3 continued into the post-workshop period. There were two final steps in the process, namely refining the indicator system based on pre-testing and actual pilot testing of the indicators. These two activities began immediately following the Nha Trang workshop.

Refining the indicator system based on pre-testing

Shortly following the Nha Trang workshop, in December 2008, three country case studies were commissioned by FAO to pilot test the developed indicator system. Three Project Teams from Kasetsart University (KU) in Thailand, Nha Trang University (NTU) in Viet Nam and the University of the Philippines at Los Banos (UPLB) were assembled. Each team was comprised of a team leader, an aquaculturist, an economist, a social scientist and field researchers. As an initial step in the process, a draft survey questionnaire was developed by the KU team.

A meeting of the Project Teams was organized by FAO in March 2009 in Bangkok, Thailand. In this meeting, FAO provided further guidance in the implementation of the pilot tests. The outcomes of the pre-test carried out by the KU Project Team became the basis for finalising the indicator list. A revised list of indicators was developed and elaborated, as recommended in Nha Trang, and which again included an indicator definition consisting of a description of its contribution, an explanation of the indicator, means of verification, information sources, and some other considerations (Table 3). The indicators were classified according to the different asset categories in the SLA framework.

The final indicator list was reduced from 20 to 14. Nine indicators were dropped in this exercise as follows[1]:

- #2 off-farm nutrient use/farm products
- #6 income from SSA or derived from SSA (seen as overlapping with #3)
- #11 women access to resource and benefits of SSA (combined with #12 as a variable entitled women empowerment)
- #13 batch testing of banned chemicals or poor quality aquatic products
- #14 farmers adopting better management practices (BMP)
- #15 farmers involved in traceability system
- #16 export earnings (decided that it was impossible to measure the specific contribution from SSA as opposed to aquaculture as a whole)
- #18 incidence of disease
- #20 resource use conflicts

and three added

- #N4[2] types and number of rural infrastructure induced by SSA (to widen #5 which measures only the physical increase in the number of farms)
- #N5 types and numbers of rural infrastructure induced not purposively for SSA, but benefiting SSA (similar)
- #N13 fostering Social Harmony: (1) Number of SSA households that share fish products and other farm resource; (2) Number of activities in which farmer work together to improve the shared resources in the community

In addition, the emphasis in some indicators was changed. Thus:

- #7 SSA contribution to GDP was changed to contribution to provincial economy
- #17 employment generation was changed to social safety net:ratio of family labour who previously worked in non-SSA now working in SSA to total family labour

[1] Numbers refer to original list in page 10 above.
[2] Refers to numbers in Table 2.

The shift from the original indicator list to the final list indicates several problems with the original. First, certain indicators developed in Nha Trang were clearly overlapping indicators. Second, certain indicators were seen only as relevant to particular small-scale commercial systems selling produce in the international market (#13, 14, 15). Third, there were few indicators in the original list relating to certain asset categories, especially physical capital. Fourth, the pre-test revealed that there were contributions of SSA, particularly in low-input, Type I systems, which were not captured by any indicator, such as social harmony and the social safety net created by employment. Fifth, some indicators required major extra resources for measurement - such as incidence of disease and off-farm nutrient flows – over and above the main chosen instruments for data collection, the socio-economic household survey, complemented by some PRA techniques.

Pilot testing of indicators
The pilot testing of the Nha Trang SSA indicator system was undertaken between February 2009 and June 2009. The following seven SSA types in three countries (Philippines, Thailand and Viet Nam) were used in the pilot tests:
- Philippines: tilapia cage culture (Taal Lake) and seaweed farming (Calatagan, Batangas Province)
- Thailand: pond polyculture of freshwater species and catfish farming (Ang Thong Province)
- Viet Nam: lobster cage culture and fish/shrimp pond polyculture (Nha, Trang Province) and black tiger shrimp farming (Ben Tre Province)

The outcomes of the pilot tests were presented during a second workshop, FAO Expert Workshop on Indicators for Assessing the Contribution of Small-Scale Aquaculture to Sustainable Rural Development, held in Tagaytay, Philippines from 6-8 August 2009.

CONCLUSIONS
To summarize its fundamental achievements, the expert workshop enabled a better understanding of the contribution of SSA to SRD. This understanding was the key to the identification and adaptation of the analytical framework and criteria and the subsequent development of methodology and tools to measure that contribution. The core purpose was achieved, which was the drawing up of a provisional indicator system to measure the contribution of SSA to SRD. This should offer a more quantitative dimension to the assessment of impacts of SSA, which, combined with descriptive measures would improve the precision and quality of assessments.

The processes and steps in the development of the indicator system may have useful application when used to other relevant exercise to develop indicators for measuring other contributions or impacts. Much of the documentation on indicators does not indicate the process through which these were established.

The follow-up work on pilot tests is an important activity that emerged from the workshop. The pilot tests have the following methodological and strategic purposes: (i) to inform the methodology for similar case studies on other SSA systems; (ii) to provide the conceptual and methodological guidelines for national level studies on SSAs; (iii) to indicate the expertise and the capacity building needed for the conduct of case studies or scaled-up studies; (iv) to provide the indicators for appraisal of proposed projects as well as ex-post evaluation of projects to develop SSA; and (v) to identify the additional types of data and information that governments need to include in their aquaculture statistics, which are envisaged to constitute national data sources for refining the indicators.

An additional purpose, which is specific to the seven case studies conducted in the Philippines, Thailand and Viet Nam, is that their outcomes now provide a baseline reference for a future assessment of impact in the same areas.

To conclude, seen from the perspective of earlier and ongoing efforts from many organizations and individuals to promote the interests of the SSA farmers, the initiative taken at the Nha Trang workshop on indicators offers an important step forward. The development of the indicator system achieved in Nha Trang and the pilot tests that followed comprise the first phases in the process. The next steps taken in Tagaytay include evaluating the test results, refining the indicator system and the wider testing and use of indicators, followed by evaluation, learning and adaptation of the approach, the framework, the indicator set, the methodology and, ultimately, the practical application of the indicators.

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TABLE 3
Nha Trang Small-Scale Aquaculture Indicators (FAO, 2009)[3]

Contribution	Indicators	Explanation	Means of Verification	Methods for data collection
Natural capital				
1. Efficient use of materials and energy saving	1. Types and number of nutrient flows	Recycling of household and farm waste and by-product among various farm enterprises improve material use and save energy.	Farm survey - questionnaire	- Ocular observation of farm - Develop a schematic diagram with farmer that depicts material flows in the farming system - Use the RESTORE model as a template (Prein, 2009)
2. Efficient use of water	2. Number of farm production uses of water	Reuse of water in a farm indicates an efficient use of water resource. This contributes to environmental sustainability.	Farm survey - questionnaire	- Ocular observation of farm - Develop a schematic diagram with farmer that depicts the flow of water uses in the farming system.
Physical capital				
3. Build up of SSA farms and farm assets in rural area	3. Number of SSA farms and farm areas increased over 3 years in the study area	Increase of SSA farms and expansion of farm areas indicate growth in physical capitals due to SSA Remarks: - This contribution can be induced by programmes not solely targeted at SSA. - The trend might be contraction.	- Key informant survey - Farm survey - questionnaire	- Discuss with village head on Number of SSA farms and farm areas increased over 3 years in the study area - Ask farmer about farm enterprises and land use changes over 3 years (2006-present)
4. Build up of rural physical assets	4. Types and number of rural infrastructure investment induced by SSA	SSA induces a building up of rural physical assets (such as water system, rural market, rural road, and energy distribution system).	- Key informant survey - Farm survey - questionnaire	- Discuss with village head on number and types of rural infrastructure investment induced by SSA - Cross-check by asking farmer about types of rural infrastructure investment induced by his/her SSA business
5. More efficient use of built physical assets in rural area	5. Types and number of rural infrastructure investment induced not purposely for SSA but benefit SSA	More sectors including SSA using the built infrastructure would lead to a more efficient use of the assets.	Farm survey - questionnaire	Ask farmer about the village infrastructure being used and shared with other households.

[1] The Nha Trang Small-Scale Aquaculture Indicators was developed by some 25 experts who participated in the FAO Expert Workshop on Methods and Indicators for Assessing the Contribution of Small-Scale Aquaculture to Sustainable Rural Development, held from 24 to 28 November 2008 at Nha Trang University (NTU) in Nha Trang, Viet Nam. The indicator system was further developed in March 2009 and elaborated to include a detailed indicator definition (name, brief description, unit of measurement) description as well as information on its importance and relation to sustainability, what it measures and how it can be measured, now reflected in this table and which became the basis for the FAO-commissioned pilot tests carried out in the Philippines, Thailand and Viet Nam between February and July 2009.

Contribution	Indicators	Explanation	Means of Verification	Methods for data collection
Human capital				
6. Food and nutrition security	6. Per capita annual consumption of fish in SSA household (only fish for their own SSA harvest.)	The high per capita consumption indicates a more food and nutrition security that SSA provides.	Farm survey - questionnaire	Ask farmer about the amount of fish harvest and the allocation of the harvest for household consumption that included fresh and processed products.
7. Seasonal food security	7. Season of the year when household relies more on their own harvest than on fish from other sources	SSA contributes to seasonal food security if there is a season that household consumption much relies on their own fish harvest rather than on buying or fishing.	Farm survey - questionnaire	Ask farmer: - Which months in a year when farmer harvests fish for household consumption and how much for each month - Substitution fish or protein sources when farmer does not harvest fish (processed fish, get from friend and relatives, fishing, eat other proteins, etc.)
Financial capital				
8. Household cash income	8. Percentage of cash income from SSA to total household cash income	This indicates reliance of the household on SSA for its cash income i.e. liquidity	Farm survey - questionnaire	Ask farmer to indicate the percentage rather than the absolute amount of income.
9. SSA serves as a source of household economic security	9. Economic return from SSA to household	This indicates the household economic value obtained from SSA when both cash and non-cash returns/ /opportunity and economic forgone are considered.	Farm survey - questionnaire	- Ask farmer on economic costs and revenue from SSA operation. Cash (tangible costs and revenue) and non-cash (intangible costs and revenue) data are classified. - Cost-return analysis (amount/unit/year)
10. Contribution to provincial economy	10. Percentage of economic value from SSA production to the value of production from all aquaculture in the province	This measures the relative importance of SSA in provincial aquaculture sector.	Government statistics	- From the statistic data, classify the SSA systems and species in the study province - Estimate the SSA production value by systems and species - Calculate the sum of the SSA production value and the percentage can be calculated.

Contribution	Indicators	Explanation	Means of Verification	Methods for data collection
Social capital				
11. Social participation	11. Percentage of farm households who are active members of SSA programs/ associations/ organizations	The higher the percentage indicates the higher social participation brought by the SSA programs/ associations/ organizations	- Key informant survey - Farm survey - questionnaire	- Discuss with DOF local official and village head on the SSA programs/ associations/ organizations existing - Ask farmer about programme/ association/ organization participation and then ask about type of activities, time spent, number of meeting per year participated, cost and benefit from being member. - From the above information, the active SSA household members can be noted for the calculation of the percentage.
12. Women empowerment	12. Percentage of number of SSA farm activities in which women take the major decision-making role	The degree to which the women are involved in various activities associated with SSA and in decision-making pertaining to SSA operations and household management	Farm survey – questionnaire by checklist of activities	Develop a checklist of decision-making in farm and household operation activities: 1) starting the farm business; 2) taking care of the farm operation; 3) buying/procuring farm inputs; 4) selling/ distributing of the harvest; 5) keeping income and record; 6) allocating household expenses; and 7) borrowing money
13. Fostering social harmony	13.1 Number of SSA households that share fish products and other farm resources 13.2 Number of activities in which farmers work together as to improve the shared resources in the community (such as water system, road and reservoir)	Sharing of farm products, farm resources and cooperating in community activities foster social harmony	Farm survey – questionnaire	Interview farmer on: 1) share of the fish products and other farm resources with other community members 2) types of activities in which farmers help each other to improve the shared resources in the community
14. Providing social safety net	14. Ratio of family labours who previously worked solely or mainly in non-SSA (incl. off-farm jobs) but now work in SSA (X) to total family labours (Y)	Increase family labour in SSA indicates the importance of SSA as a fallback employment/an opportunity to non-SSA and off-farm jobs and an alternative source of income.	Farm survey - questionnaire	- Check list of family members and employment status over 3 years - Calculate X:Y ratio

While the contribution of small-scale aquaculture (SSA) to rural development is generally recognized, until now there has been no systematic assessment to clearly measures its contribution. The FAO Expert Workshop on Methods and Indicators for Evaluating the Contribution of Small-scale Aquaculture to Sustainable Rural Development held in Nha Trang, Viet Nam, from 24 to 28 November 2009, attempted to develop an indicator system to measure the contribution of SSA. The workshop used a number of processes and steps in the developping the indicator system, including: (i) understanding the subject of measurements; (ii) identifying an analytical framework and ratting criteria (iii) developing a list of SSA contributions; (iv) categorizing the contributions; (v) devising and organizing the indicators of contribution; and (vi) measuring the indicators. The major outcome was the development, through an iterative process, of an indicator system which can provide a good measure of the contribution of SSA based on agreed criteria (accuracy, measurability and efficiency) and the sustainable livelihood approach analytical framework which consists of five capital assets (human, financial, physical, social and natural) and can be used for various livelihoods options.

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