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FOREWORD

The world's population is becoming increasingly urbanized.By 2050 it is expected that more than six billion persons, which will make up nearly 70 percent of the population, will reside in urban areas. Fifty years ago, two- thirds of the world's population lived in rural areas and only one-third lived in urban areas. Migration, primarily rural to urban, is a key driver of this growth. However, together with natural growth, reclassification of rural areas is also an important contributor: every year millions of people become city dwellers even without movement, as their communities have transformed into cities because of rapid urbanization.Specifically in Asia, although urban population is just 42.2 percent, in the last twenty years Asia's cities have grown at a faster rate than any other region: 13 of the 20 most populated urban areas in the world are now in Asia. Asia is urbanizing at an unprecedented speed and it is anticipated that two-thirds of the growth in the world's cities will occur in Asia in this decade alone, raising its urban population by another 411 million.

As the cities rapidly expand, so do the food needs of urban families. The urban poor were hit hardest by the financial and food price crises in the recent past as urban consumers were exclusively dependent on food purchases. Changes in life style and dietary habits have further contributed to increased urban malnutrition and non-communicable diseases.

In 1999, during the meeting of the Committee of Agriculture (COAG) in Rome, the member countries reviewed and discussed the role of urban agriculture in the context of the urbanization process, and recommended that FAO develop an integrated approach to assist the member countries in dealing with the UPA issues at the policy and technical level. Since then, various initiatives have been taken by FAO in this area. These include,implementing a project called *Growing Greener Cities* to promote urban and peri-urban-horticulture (UPH), with a multi-stakeholder approach to ensure a stable policy and community support; support to establishing a number of school gardens in a number of countries; programmes to improve water quality which is also used for urban horticulture and launching the Food for Cities programme in 2000.In November 2011, a workshop entitled "Ensuring resilient food systems in Asian Cities" was organized by the FAO Regional Office in Bangkok, wherein urban and peril-urban agriculture was covered in various presentations, although this was not the main focus of that workshop.

In the current workshop, the focus has been on urban and peri-urban agriculture. More than 50 senior representatives from 12 countries representing various sectors – health, agriculture (horticulture/livestock), fisheries, agricultural marketing, agricultural policy planning, urban development, NGOs, academia and industry were present at the workshop. Participants and resource persons shared experiences and ideas on various topics covering policy, planning, global and country perspectives, research priorities, development initiatives and multi-stakeholder collaborations amongst others.The deliberations led to sharing of experiences through case studies and country presentations as well as discussions through working group sessions to bring out recommendations which would guide further activities in the area.

The proceedings of the workshop have been brought out in two volumes, namely:

Volume I Key Notes, Country Presentations and Recommendations, and
Volume II Case Studies, Best Practices and Field Studies

I hope that the proceedings will provide useful guidance to countries and stakeholders in implementing the UPA approach in their countries and thereby reducing food insecurity.

I take this opportunity to convey FAO's appreciation to Dr. Prem Nath Agricultural Science Foundation, Bangalore, India for supporting us in the organization of this workshop. I also express my gratitude to the Ministry of Agriculture and Cooperatives, Ministry of Public Health and Ministry of Urban Development, Government of Thailand for their support and to all the resource persons and participants for their contribution to this important regional workshop.

Hiroyuki Konuma
Assistant Director-General and Regional Representative
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Volume - II: CASE STUDIES, BEST PRACTIES and FIELD STUDIES

SUMMARY

The Regional Workshop on Strengthening Urban & Peri-urban Agriculture towards Resilient Food Systems in Asia was held on January 28-30, 2013 in Bangkok, Thailand. The workshop was attended by more than 50 participants from Bhutan, Bangladesh, Laos, Cambodia, India, Indonesia, Malaysia, Myanmar, Thailand, Viet Nam and S. Korea. The workshop provided a forum to share experiences, debate issues and come out with key recommendations. The workshop covered inaugural addresses, keynote presentations, country presentations, case studies, reviews and prospects as well as working group sessions.

The report of the workshop has been published in two volumes. The Volume I covers the inaugural addresses, the keynote addresses, country presentations, working group sessions and the recommendations. Volume II covers case studies, reviews and prospects, best practices and field visits.

The Volume II gives a detailed account of the following eight case studies:

1.1. Application of Horticulture in Improving Urban and Peri-urban Agriculture Towards Enhancing Food Production in Bangkok City by Dr. Grisana Linwattana, Horticultural Research Institute, Bangkok, Thailand

1.2. Contribution of Small Livestock in Developing Resilient Food Systems for Urban and Peri-urban Agriculture in Thailand by Dr. Sansak Nakavisut, Department of Livestock Development, Thailand

1.3. Towards Sustainable Wastewater-fed Fish Culture in Kolkata, India by Dr Peter Edwards, Emeritus Professor, Asian Institute of Technology and Advisor, Sustainable Farming Systems Programme, Network of Aquaculture Centres in Asia-Pacific, Thailand

1.4. Integrated Homestead Farming Systems for Improving Nutrition Status of Urban & Peri-urban Populations – Case study/ Experiences from Selected Asian countries by Dr. Lalita Bhattacharjee, Nutritionist, National Food Policy Capacity Strengthening Programme, FAO, Bangladesh

1.5. Urban and Peri-urban Agriculture (including organic agriculture) for Ensuring the Safety of Foods by Dr. A Thimmaiah, Advisor, Bhutan Agriculture and Food Regulatory Authority (BAFRA) ; Bhutan

1.6. Impact of Waste Management and Utilization in Improving Urban and Peri-urban Agriculture by Dr. Permpong Pumwiset, Office of Public Health and Environment, Thailand

1.7. Vegetables Farm in School at Sisa Ket Province by Ms. Jirapa Austin, Sisaket Horticultural Research Centre, Muang, Sisa ket, Thailand

1.8. The Woodfuels Integrated Supply/Demand Overview Mapping (WISDOM) methodology by Mr. Roger Steinhardt, FAO Regional Office for Asia and the Pacific, Thailand

A special session on Reviews and Prospects of UPA was organized in which two papers were presented which highlighted on multi-stakeholder collaboration and investment, and development initiatives undertaken in food production, utilization and mechanism of management in implementing UPA. The first paper was on “Enhancing Multi-stakeholder Collaboration and Investment in Urban and Peri-urban Agriculture” and the second on “Development initiatives in food production, utilization and mechanism of management in developing Urban and peri-urban Agriculture in Asia”. This Volume contains both the detailed papers.

Based on the country papers, case studies on UPA as well as discussions on these, some good practices were identified as 'Best Practices' and have been covered in this Volume. These are covered under three heads namely Commodity-based, Production-based and Theme-based UPA best practices.

A field visit was also organized on the third day which added to the practical aspects of UPA as well as some of the case studies presented. This included visits to waste management and water treatment, rooftop garden, waste fed fish culture, peri-urban vegetable plantation and a street market. It is hoped that the proceedings will provide useful information to those having an interest in urban and peri-urban agriculture.

1 CASE STUDIES

1.1 APPLICATION OF HORTICULTURE IN IMPROVING URBAN AND PERI-URBAN AGRICULTURE TOWARDS ENHANCING FOOD PRODUCTION IN BANGKOK CITY

Grisana Linwattana*

EXECUTIVE SUMMARY

The paper was derived from reviewing, rapid interviewing and system analysis for paper presentation in the regional workshop on strengthening urban and peri-urban agriculture (UPA) towards resilient food systems in Asia, 28-30 January 2013, Bangkok Thailand. The study reveals that its role in food security attainment is crucial. Different types of UPA has been found in the city, from very simple to high technologies, as open fields, in home gardens, schools garden, hospitals, in prisons kitchen gardens, on vacant public lands, etc. in varying scales. The study also indicates the application of horticulture in urban and peri-urban agriculture towards enhancing food production approach make Bangkok city somewhat satisfy in solving malnutrition. Therefore, towards enhancing food production in UPA is considered important activity for long term planning as a rapid growth rate of the city population. This well planning, at the same time will benefit mitigation waste and reduce pollutant. Several organizations were established to encourage urban agriculture from public and private. However, there is, for a better harmonization one of the important immediate future actions of Bangkok city administration has to organize more of a well-staffed and equipped urban agricultural development bureau.

INTRODUCTION

Thailand's gross domestic product (GDP) is approximately 6 trillion baht. The agricultural sector contributes 13% of the total GDP, these are crops 68%, livestock 11%, fisheries 8%, simple processing 9%, agricultural services 3%, forestry 1%, respectively. The agricultural sector employs about 56% of the country's population. The total land area of 51 million ha, farm holding land is about 21 million ha, consisting of 5.67 million farms, with an average farm size of 3.7 ha. The value of agricultural products exported in 2007 was 1,128,060.6 million baht which was ranked sixth in the world; imports were valued at 456,708.4 million baht. Thai rice is well known world-wide, a few other agricultural productions are giving to this country a predominant place above all, i.e. cassava, rubber and shrimps etc.

Bangkok, the capital city of Thailand is located in central plain of the country which are considered being the fastest developing and yet surrounding still the major area for rice cultivation due to its favorable sub-ecosystem water resources from Chao Phraya river and some other rivers, allowing up to 2 or 3 cropped cycles per year, is also the framework of an intense urbanization phenomenon, centered on Bangkok (DORAS project, 1997 as cited in Buntoon Chunnasit *et al*., 2011). Increasing growth rate of about 35-40 % during the 2004s, Bangkok and its population of about 11 million people are considered rapidly inducing deep and often irreversible changes in the Central Plain agricultural and socio-economic landscape (Eiumnoh and Parkpian, 1998 as cited in Buntoon Chunnasit *et al*., 2011). Hence, the need for food and nutrition to

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serve daily demand for such huge population is considered importance. Vegetables and fruit products mainly from local market where central market like "Talad Thai" play role as main supplier.

The environmental degradation especially within big cities through the relocation of resources to serve urban populations like Bangkok has inspired the implementation of different schemes of urban agriculture across the developed and developing countries. To designs for new productive city farms, the idea of locating agriculture in or around the city takes on many characteristics. However, community wastes has been used in ancient to feed urban farming. In Machu Picchu water was conserved and reused as part of the stepped architecture of the city, and vegetable beds were designed to gather sun in order to prolong the growing season. There is still need for study particularly in the field of production environment, so as to understand origin of local low productivity area. Physical parameter, i.e. natural resources quality and availability, but also socio-economic one must be considered and their incidence on farmers' behavior and production results will have to be defined. Another study aiming at supporting city development project has already stressed the importance of ethnic origin and farmers' history in cropping system adoption *(*Buntoon Chunnasit *et al*., 2011).

General objective of the study is to provide information/recommendation relating urban and peri-urban agriculture to be inspired those policy maker both public and private sector where specific are:

- To integrate/encourage stakeholder urban agriculture to make preparation as well as be paid more attention on securing food farm families incorporating on waste management addressing urban food security, environmental greening, job creation and reutilization of urban wastes in Bangkok and surrounding city.
- To encourage planners, architecture to come up the idea of urban agriculture as per they are planning for city development or design for building.
- To stimulate local stakeholders/initiatives regarding identification and formulation of projects on the development of urban agriculture in the tow

METHODOLOGY USED

Several methods have been used in this report, mainly derived from reviewing, rapid interviewing and system analysis. Many tools were combined i.e. qualitative and quantitative information, statistics and survey. Secondary reviewing data were obtained from several published and unpublished literatures. Central Statistical Authority, Bangkok City administration was among the best sources of the secondary data for this research.

In order to collect qualitative and quantitative information on Urban Agriculture, different disciplinary foci have been used to study the dynamics such as urban development and land use; strategies of urban farmers involved in production, natural resource management, production systems, commodity and food systems. Many approaches aim to involve different actors by consultation through questionnaires, survey, interviews or participatory methods.

Recommendations made from this study will be inspired those policy maker both public and private sector for making preparation as well as be paid more attention on urban and peri urban horticulture targeting to secure food farm families incorporating of waste management.

FOOD PRODUCTION THROUGH URBAN HORTICULTURE IN BANGKOK CITY

Proportion of area of green represent urban agriculture, spatial distribution for vegetable, fruit and buildings infrastructure has shown in Figure 1. Increasing of population in capital cities affecting food security, many findings have indicate different information. Urban farming is generally practiced for income-earning or food-producing activities, though in some communities the main impetus is recreation and relaxation

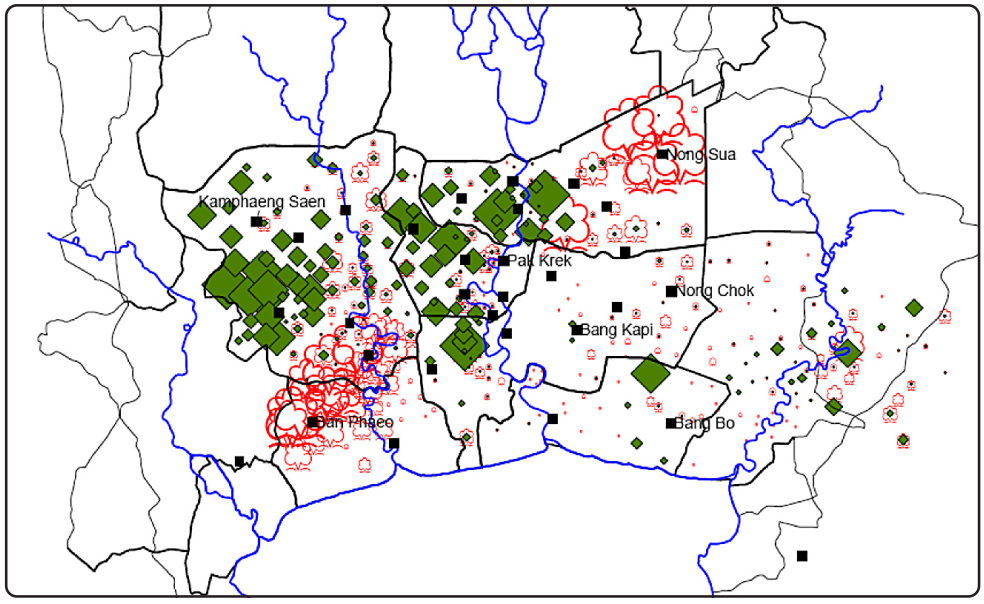

Figure 1. Production spatial distribution for vegetable and fruit.
Tree symbol: fruit production Square symbol: vegetable production *(*Source: Buntoon Chunnasit *et. al*., 2011)

(*http://en.wikipedia.org/wiki/Urban_agriculture#cite_note-3#cite_note-3*). Urban agriculture contributes to food security and food safety in two ways: first, it increases the amount of food available to people living in cities, and second, it allows fresh vegetables, fruits, and meat products to be made available to urban consumers (*http://en.wikipedia.org/wiki/Urban_agriculture#cite_note-3#cite_note-3*). In Bangkok and peri urban, both food security and food safety seem to contribute to increasing urban and peri urban farming for increase both the amount and it around fresh. The vegetable and fruit production in the city has long been evident, however their type were change as per time goes by. Type and sustainable of faming in Bangkok city was developed from simple open yard to vertical culture and roof garden accordingly to building design as well as depend mainly on availability material locally. Another aspect of urban farming, especially in densely populated Bangkok cities, is the use of grow-bags to raise a wide range of crops. Many apartment dwellers with no yards to speak of, or people with very small yards, will set up these bags on a balcony or thin strip of land. Also, many types of hanging bags are available to plant, expanding the area available for planting. The bags themselves are made from a variety of materials, including canvas, weed barrier fabric, and polyester, all having semi-pours properties so the soil can drain adequately.

IMPROVING URBAN AND PERI-URBAN HORTICULTURE THROUGH ESTABLISHING TRAINING CENTER BY DIFFERENT ORGANIZATIONS IN BANGKOK CITY

The Garden in Honor of Her Royal Highness Princes Sirindhorn, Department of Agriculture (DOA)

In order to enhance/run the urban peri-urban garden program more beneficiaries like any others, DOA has established The Garden in Honor of Her Royal Highness Princes Sirindhorn to facilitate people in Bangkok

and peri urban so as training center which is located in Kaset Sart University Chatuchack, Bangkok. The garden was provided with training, agricultural tools, seeds/seedlings and continuous technical support. In addition all the beneficiaries were trained in gardening, vegetable production and mushroom, nutrition as well as fruit trees management. During the past three years, more and more visitors run vegetable garden plots and many grower bags have been established so as to produce different vegetable and fruit products. With this regard, beneficiaries were able to grow different vegetable types for at least two times per year. As a result, their families have been fulfilling their household vegetable demand from the farm and make money by selling extra vegetable produces. Some beneficiaries were also getting extra income and start other businesses. In addition it contributes for better health and leading their everyday life creating new job opportunity and happy. Most children were also fulfilling the stationary, uniform and other needs by selling vegetable products from their farm. (bridge@ethionet.et or at bridgebie@yahoo.com)

Bangkok Metropolitans' UPA support

In Bangkok city, an on-roof and vertical urban farming were established originally from the metropolitan officer "KorTorMor" (or Bangkok). Of this, a 10years example is running very well at Lak Si District Provincial Hall serving as a training center open for publication. They are producing mainly vegetables and some small fruit crops. Simple cultural practices are use with taking more in organic farming aspect. Vegetables such as lettuce, kale, tomato, chilli, cucumber, pumpkin and lufha etc., had well planned schedules harvest timely interval. In addition, waste management has incorporated and makes use as organic fertilizer as well as supplement nutrient. Earthworms is also growing up to produce organic fertilizer, at the same time to mitigate waste such as used paper littering and so on.

This activity is targeting to achieve at, the model of an on-roof and vertical urban farming, which contain small animals and plants/crops such as vegetables and herbs upward and on top of buildings. The vertical garden greens the buildings and provides food items to their own family, restaurants and supermarkets on the buildings. Moreover, farming on-roof fishponds and pot-flowers could be lucrative businesses and valuable tourist attractions where the shoppers and other visitors rest and refresh. Vertical urban plantation is also assumed to mitigate the micro-climatic condition of the town by moderating the greenhouse gases being pumped into the atmosphere from the use of fuels and other related sources.

Non-government Organization

Thai City Farm Project (CFP) (Limpakooptathaworn, 2012) is one of the non-government organization running for encourage UPA. The objective dreams to sustainable society urban and rural people must to support together. CFP is now growing 96 communities divided in to 22 poor communities, 46 class groups, 14 educational institutions, 11 private organizations, and 3 temples. CFP is also running urban garden training centre taking more in organic farming approaches beyond food sufficiency. Venue of the centre mainly in Bangkok at i.e. Lak Si, Sukhumvit, Ladprao, Viphavadee, Rajburan, Bangplee and including Mobile unit.

Aside from **enhancing food production**, other activities of CFP are sharing seeds among the members, make city friend as well as create in social and ecological benefits aspect e.g. creating family activity, garden therapy, promote school garden, clean and green city and zero food waste management.

DIFFERENT TYPES OF UPA IN BANGKOK CITY

In general, agriculture i.e. fruit tree and vegetable production has long been practiced before urbanization since the 19th century. Evident has found represent green area in Bangkok city (Figure 2). Type of urban

and peri-urban crop production such as open fields, in home gardens, schools garden, hospitals, in prisons kitchen gardens, on vacant public lands, etc. in varying scales, input levels and degree of market orientation i.e. subsistence, mixed subsistence/market, small commercial, large commercial and using different technologies which indigenous or exotic species, seasonal or year round production; type of irrigation techniques used, under plastic cover, greenhouses, hydroponics, organo-ponics, vertical gardens, roof top gardens, etcetera.

Farm management, crop choice and production techniques have to be adapted to the specific urban conditions like the little space availability, the low quality of the soils, higher risks that water and soils are contaminated by industry and traffic, closeness to dense human populations and potential public health risks, closeness to consumer markets, perishable products, competing demands for the land and other factors (*http://www.ruaf.org/taxonomy/term/40,68/all*).

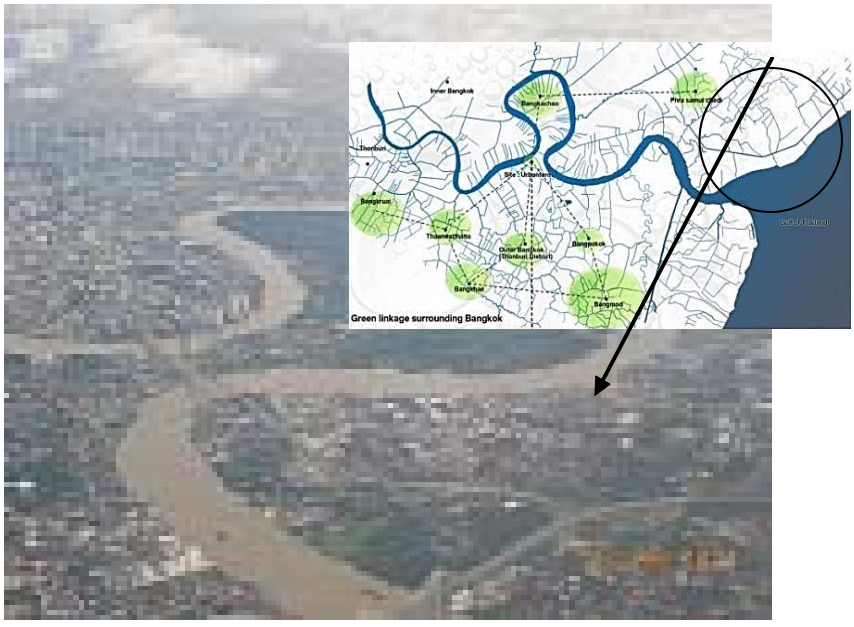

Figure 2. Geographic distribution of green areas represent UPA (small figure above) in Bangkok metropolitan.

Is UPA Play Role in Supplying Potential for Household Food Insecurity?

Table 1 shows different vegetables production comparable which surrounding/peri urban province like Nakhon Pathom is 120,411 ton of vegetable product where Bangkok produce 24,930 ton. However, all most of the product finally supply for Bangkok city. The household strategy to respond to both chronic and emergency food insecurity is that of home garden agriculture. The supply response to those two conditions is driven by different factors that chronic food insecurity develops from structural problems, declining food affordability and growing urban poverty, whereas emergency urban food production arises quickly in response to breakdowns in normal mechanisms for food distribution. Manny examples show the potential for UPA to better emergency food shortage situations.

Urban and peri urban agriculture was providing significant role in vegetable needs including live stock in the cities. The conditions across cities are enormously variable, and no research exists to measure the maximum supply potential of Urban and peri urban agriculture.

Nugent (2000) has discussed the key contributions of UPA to household food security and nutrition in the aspect of accessibility, health diet and employment and income rather in nutritional. He further gave the

evidence of the impact of UPA on household food security and nutrition is very simple: what is being produced, by whom, and who consumes it. It is also important to determine how the food is being produced (in a safe manner?) and the seasonality of UPA production.

Most directly, UPA reduces food insecurity especially fresh nutrient-rich food. The literature indicates that UPA increases access to food for low-income groups (Ruel, Haddad, and Garrett 1999).

Table 1. Different vegetables production comparative in Bangkok and surrounding province (Source: adapted from Buntoon Chunnasit et. al., 2011)

Product (T)	Chachengsao	Nakhon Pathom	Nonthaburi	Pathum Thani	Samut Prakan	Samut Sakon	Bangkok
Whole production	15 173	120 411	41 029	43 600	8 004	13 975	24 930
Range of products	Up to 26	Up to 37	Up to 38	Up to 15	Up to 3	Up to 11	Up to 12
Chinese keys		13 510					
Galangal	1 523						
Baby corn		10 461					
Chinese kale	3 262	13 936	13 905	14 413		6 566	4 855
Acacia insauvis		11 356					
Cucumber	1 292						
Yard long bean		5 403					
Sacred basil							3 577
Sweet basil							6 271
Water mimosa					6 843		
Pakchoï		7 188		7 793		3 056	
Water convolvulus			2 537	4 676			3 217
Green wax gurd	2 620						
Eggplant		5 954					
Chilli		6 351					
Lettuce			2 759	7 647			
Chinese radish			3 135				

CONCLUSION AND RECOMMENDATION

The study indicates the application of horticulture in urban and peri-urban agriculture towards enhancing food production approach make Bangkok city somewhat satisfy in solving malnutrition. UPA, in Bangkok is found to have multifaceted importance. The study reveals that its role in food security attainment is crucial. The small-scale producers have been found to attain the minimum nationally set dietary energy requirement, 2100 kcal/person/day, from their urban food grain production alone. Some of them even supply their products to the local consumers and vendors. The sector has been found contributing greatly to environmental greening, job creation and urban waste management. It is also prone to lack of and absence of structural organization in the administrative structure of the city. Valuable recommendations and policy implications can be drawn from the study results so that urban agriculture could play its optimal role in creating a more food secured, environmentally friendly, green, attractive and livable Bangkok city. One of the important immediate future actions of Bangkok city administration has to organize more of a well-staffed and equipped urban agricultural development bureau. This bureau will have the responsibility of identification, registration, organization and administration of full and part-time urban agricultural producers. It may also provide technical supports to the farmers and facilitate ways to have access to new technology services. The urban agricultural development bureau could also be entrusted with the responsibility of

informing all about urban farming to the urbanites and the reutilization of urban organic wastes for soil fertilization. The bureau will also have the responsibility to identify and establish intensive specific agricultural production zones. The bureau can also aware all the urbanites all about the techniques and importance of urban farming and encourage them to take part in planting and taking care of plants along roadsides, railway-sides, outdoors, balconies and even on the roofs of their houses/buildings. Moreover, the bureau will have the responsibility to initiate and encourage concerned bodies such as engineers, urban planners and architects to give appropriate attention to urban farming whilst they plan for, design and construct urban physical landscapes such as roads, railways, residential areas, buildings, recreation areas and stadiums

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1.2 CONTRIBUTION OF SMALL LIVESTOCK IN DEVELOPING RESILIENT FOOD SYSTEMS FOR URBAN AND PERI-URBAN AGRICULTURE IN THAILAND

Sansak Nakavisut*

Executive Summary

Livestock production in Thailand is important in the international market. Urban and peri-urban livestock production is predominantly for domestic consumption to provide food for local communities and efficient use of cheap by-products from other urban activities. However, farm activities cause adverse effects on communities. A preliminary survey of livestock production in urban and peri-urban areas in Thailand revealed that goat and broiler farms had long been in the areas before city encroaching. Considering current situation, goat farms are likely to coexist with urbanization while broiler farms require a major adjustment to cope with social pressure in the peri-urban of big cities in term of pollution releasers. Other species are scarce or no longer maintained in cities and outskirt of the cities. The suitability and feasibility of livestock production in urban and peri-urban areas need to consider key factors of species, breed, housing, feeding, processing, health and sanitation.

A well-balanced strategic planning for livestock production is specifically required for urban and peri-urban areas from the Department of Livestock Development and urban planning and implication by community authority and related municipal administrative bodies.

Research and development are urgently required to find effective but not costly solutions for reduction of adverse environmental impacts and social conflicts from livestock production in the urban and peri-urban areas

Title: Overview of Livestock Production in Urban and Peri-urban Areas of Thailand

Objectives: This article is to provide general information on a survey of livestock production in urban and peri-urban areas in Thailand including meat and dairy goat farming in the out skirt of Bangkok and odor reduction from broiler farms in a peri-urban area in a big city in Thailand.

Background

Thailand is one of the largest livestock producing and exporting countries in the world with a GDP of US$584 billion in 2010 (NESDB, 2011) and population of 68.1 M. The agriculture and livestock sectors account for 11.4% and 2.5% of the GDP. The major livestock species in Thailand are chicken, ducks, swine and cattle (Table 1). Broiler chicken is the main commodity for export while other species are for domestic consumption and small scale international trading

Table 1. The number of important livestock species in Tha[1]iland from 2002 to 2011

Year	DairyCattle	BeefCattle	Goat	Buffalo	Swine	Chicken	Duck
2011	560,659	6.6 M	427,567	1.2 M	9.7 M	317 M	32 M
2010	529,572	6.5 M	380,277	1.2 M	8.3 M	266 M	29 M
2009	483,899	8.6 M	383,796	1.4 M	8.5 M	282 M	27 M
2008	469,937	9.1 M	374,029	1.4 M	7.7 M	256 M	23 M
2007	489,593	8.8 M	444,774	1.6 M	9.3 M	283 M	25 M
2002	358,440	5.5 M	177,944	1.7 M	7.0 M	229 M	25 M
%Change*	56%	20%	140%	-29%	39%	38%	28%

* Department of Livestock Development, Bangkok, Thailand

Source: Information and Statistics Group, Information Technology Center, Department of Livestock Development (DLD, 2011); *the percentage of livestock numbers in 2011 compared to those in 2002; M: Million

Import- export values from Thailand livestock in 2009 sector are presented in Table 2. Thailand imported large amounts of ruminant species products including dairy cattle, beef cattle, sheep and goat whereas products from non-ruminant species have been exported in a large volume. Farming of exported species such as chicken, swine and ducks are mostly modernized with high inputs of concentrate feeds and sanitation system with high standards and breeding stock. Therefore, such farming activities are not likely to be co-existed within the ever expanding urban and peri-urban areas. Small livestock species that requires small piece of land and feed that are available in urban areas are the animal of choice, for example goat and sheep to partly replace the imported volume and chicken for domestic consumption purpose especially for feeding the metropolitan areas.

Table 2.Import-Export values of livestock species in Thailand in 2009 in million Baht.

Species	Import value	Export value
Dairy Cattle	10,124	4,136
Beef Cattle	4,921	1,502
Sheep	515	13
Goat	4	0.07
Broiler	428	50,408
Swine	172	3,192
Duck	36	2,851
Layer	134	1,174
Buffalo	138	210

Livestock production is among the most effected activities in agriculture by the expansion of urban areas due to the odor, noise, dust, solid and liquid waste from livestock farming. Over the last decade the combined effects of urban and rural residential expansion, increased environmental awareness, significant growth in meat consumption, the need for individual farms to expand to remain competitive, and the absence of effective planning strategies or controls have increased the risk of conflict.

Increasing land prices limit the capacity of existing livestock farms to acquire additional buffer areas and the substantial investment in existing infrastructure inhibits relocation. Careful identification and management of environmental and amenity concerns, particularly odor, is vital for the sustainability of individual farms and the current industry.

The livestock farms that supply processing plants have been located in rural residential areas on the outskirts of big cities for economic reasons related to transport costs. Farms in many of these areas have suffered from urban encroachment by people looking for cheaper land and a rural lifestyle. Consequently, interference to community amenity particularly through odor is an important issue. Even with very well managed farms, odor will still be generated and may be detected off-site. This off-site impact however, can be minimized with appropriate planning and management.

Strategy and Scope, Inputs and Output expected

This article is intended to explore possibility to improve livestock production in the urban and peri-urban areas in Thailand concerning choice of species, breed, feed, housing adjustment and farm wastes management opportunity to be able to minimize the adverse effect and to avoid conflict with the community. Among all livestock species raised in Thailand, dairy goats and meat goats have been associated with Muslim communities around outskirt of Bangkok and they are still a very important agriculture activity until now. Broiler production has been situated far from big cities however the situation now when the cities are

expending very rapidly, farmers have to decide whether to relocate, to renovate or to give up. The scope of this paper therefore to give basic information of adaptation or investment in goat and chicken farm due to the urbanization in Thailand.

Meat and Dairy Goat farming in outskirt of Bangkok and big cities

As shown in Table 1 goat farming is among the popular livestock production activities, the number of goats has been increased more than doubled in the last ten years from 180 thousands goats in 2002 to 430 thousands goats in 2012 and there are a number of goats raised in big cities like Bangkok and Nonthaburias compared to other parts of the country as shown in Table 3.

Table 3 Distribution of goats in Thailand by regions in 2012

	Meat Goat			**Dairy Goat**			**Total**	
region	**Male**	**Female**	**Farmer**	**Male**	**Female**	**Farmer**	**Goat**	**Farmer**
reg 1 (central)	14,017	35,474	1,414	2,578	8,684	394	60,753	1,674
Bangkok	1,313	2,161	210	1,174	2,630	167	7,278	323
Nonthaburi	762	1,355	147	345	1,254	90	3,716	219
reg 2 (East)	2,816	6,484	514	318	906	82	10,524	572
reg 3 (lower NE)	4,299	8,507	657	357	654	52	13,817	695
reg 4 (upper NE)	1,080	2,115	314	100	97	25	3,392	331
reg 5 (Far N)	3,979	7,131	870	259	596	54	11,965	912
reg 6 (lower N)	8,401	20,713	757	411	706	56	30,231	791
reg7 (West)	25,740	64,698	2,282	854	4,864	105	96,156	2,348
reg 8 (upper S)	18,313	39,748	5,150	663	1,483	178	60,207	5,281
reg9 (Far S)	60,917	137,382	34,220	2,016	4,419	1,089	204,734	34,863
Total	**139,562**	**322,252**	**46,178**	**7,556**	**22,409**	**2,035**	**491,779**	**47,467**

Source: Information and Statistics Group, Information Technology Center, Department of Livestock Development (DLD, 2012);

The examples of adaptation made by farmers raising goats in big cities are as followed;

Feeding

- Even though city is expanding shrub and weed are still plentiful. A lot of forage crops are still readily available to be used to feed goats.
- Peels and by-products from a large amount of consumption in the city i.e. by-products from soybean-curd, fruit and vegetable peels from fresh markets and factories which are located in the Bangkok outskirt as well. This is to increase the capacity of goats to use by-products and residues from other primary industries. These products can be a cheap feed source for goat feeding as compared to those farms in the remote areas.

Breeding

- Saanen is the most common dairy goat breed found in Bangkok. A lactating goat gives on average 1.0 – 2.5 kg of milk per day. The breed is suitable for this kind of production system where the animals are fed on cut and carry forage crops and grasses supplemented with concentrate. They need only a small area for housing as pasture is not practically available.

- Bucks are not commonly raised for breeding and genetic improvement purpose. Farmers need male replacement from other farms once a year or every two years. They keep only one or a few bucks only for production.
- Milk yield is not routinely recorded. Nevertheless, trading and pricing of milking does depends largely on daily milk production. The common and approximate rate of buying selling a does is roughly 10,000 Baht per liter of daily milk produced.

Milk processing and marketing

- Raw milk is commonly kept frozen in a deep freezer with the price of fresh milk ranging from 14 to 20 baht per 250 cc bottle from the farm and 100 -120 Baht per kg of retail price.
- Homemade cosmetic products such as soap, lotion, cream are produced using goat milk as an important ingredient.
- Food products are made from dairy goat milk.

Housing and sanitation

- Goat houses in urban and peri-urban areas are mostly of slatted and highly elevated floor.
- Slatted floor and highly elevated goat houses are for good ventilation and sanitation. Manure and liquid waste can easily be swiped off and cleaned often to reduce the odor and gases emission to neighbors and the community.
- Frequent cleaning is strictly required and effective microorganism is used to reduce odor from goat farms.
- Installation of mosquito net in order to protect goats from flies and pests which are manifested in city.

Farm management

- There are some practices to reduce noise from goats, i.e. providing buck mating on time for estrous females, feeding enough feed with punctuality.
- Prevention of pets such as dogs and cats from entering the farm.

Broiler farming in outskirt of big and expanding cities

Thailand is among the largest exporters of chicken meat. The export value of chicken product is the highest of all other livestock products in Thailand with a value of 50 thousands million Bath per year. These exported products are mostly from highly developed and high standard farms with little impacts related to urbanization. However, a large volume of chicken products are for domestic consumption and processing and these products are from some of chicken farms that are affected by expansion of city. Farmers facing the problem normally have three choices whether to abandon the farm, to relocate or to renovate the farm. The most outstanding problem from broiler farms is the odor. How to reduce the unpleasant odor from chicken farm needs some extra capital either to renovate or to relocate. Some of the method to reduce odor and hence conflict with neighbors from chicken farming has been practiced by farmers.

Generally, three different approaches can be distinguished in order to reduce the emission of gaseous compounds from animal houses to the atmosphere.

(1) feed management
(2) adaptation of housing system design, including inside manure storage
(3) end-of-pipe air treatment

- Odor control principles

Resolving conflict is difficult and costly. Preventative actions include minimizing the number of people that may be affected by appropriate site selection and shed orientation (including fan direction), purchasing additional buffer lands, or using effective land use planning controls to prevent encroachment. The most effective strategy is to manage odor-generating processes at the source and maintain positive communication with neighbors and some other available options can be considered according the specific location and conditions.

- Minimizing odor at the source

The critical factors influencing odor generation are temperature, humidity, ventilation and the management of litter. Appropriate management of stocking rates, diet and waste products may also be relevant as outlined in the following sections. Where feasible, the number of birds should also correlate with the available separation distances.

- Air scrubbers

Air scrubbers cause exhaust gases to absorb into a liquid stream and are an effective means of removing airborne contaminants and odors from broiler house exhausts. Acid scrubbers are based on the entrapment of ammonia in acid liquid that is recirculated over a packed bed and the frequent discharge of the resulting ammonium salt solution at a concentration of about 150 g/L. Usually sulfuric acid is applied and pH is kept between 2 and pH 4. There has been a report on average ammonia removal efficiencies of 96% for farm-scale operated acid scrubbers. Reported average removal efficiency for odor was only 31% and showed a large variation.

- Communication

Even on well-managed poultry farms, odor will be generated. Keeping in touch with neighbors can reduce the risk of conflict by helping them understand the poultry production process, the steps being taken to reduce potential problems and practical limitations.

Open communication channels also allow feedback and provide an opportunity to reduce odor, noise or dust problems before significant conflict occurs. Relatively minor adjustments to the timing of shed clean-outs, litter-spreading, management standards or vehicle movements may be all that's necessary. It may be possible to also avoid the coincidence of peak odor risk periods or activities with special social events planned for a neighboring property by mutually adjusting either the timing of poultry operations or the event.

Meat chicken farms in proximity to existing residences are encouraged to maintain a daily log of weather conditions (prevailing wind direction and strength, temperature) and farm activities to assess the cause of any reported conflict incident more accurately. This is particularly important where there might be many odor sources or an existing history of conflict. If future expansions are proposed, complaints and activity logs can also demonstrate the effectiveness of current management practices in avoiding conflict.

Methodology used

1. Goat production in outskirt of Bangkok

We conducted an interview of goat farmers and a survey of goat farms in Bangkok and the greater Bangkok areas to investigate breeds, feed, management, housing, markets, and measures to prevent conflicts with neighbor and community

2. Broiler farm in peri-urban of a big city

A preliminary trial was conducted to investigate the reduction of unpleasant odor from broiler farm at the peri-urban of a big city using sulfuric acid air scrubber technique when the broiler chicken were 38 days of age. The concentration of NH_3 was measured, installation cost was estimated and levels of unpleasant odor at different places around the farm were tested by smell testing panel.

Application and targeted beneficiaries

The results can be used for strategic planning for livestock production in urban and peri-urban areas in Thailand. Government agencies can apply appropriate measures to help farmers to be able to cope with environmental and community pressures while continuing their careers. Farmers can adopt technology and measures to secure their income while having less impact to neighbors. Social security, sustainable development and environmental concern can be achieved from urban and peri-urban farming.

Study Results

I. From goat farming survey and interview, we found that goat farmers in outskirt Bangkok are facing the following obstacles,

1. Complaints and non-acceptances from surrounding communities,
2. Lack of information and knowledge dissimilation,
3. Lack of knowledge in case of new goat raisers,
4. Lack of Buck breeders or breeding stocks, inbreeding problem due to a small number of goats in a flock and a small number of flocks in the areas,
5. Lack of pasture and public areas,
6. Lack of networking among goat raisers,
7. Lack of capital for investment.

Despite the above mentioned obstacles, farmers disclosed the advantages of raising goats in the outskirt of Bangkok such as there are great demands for goat products; live goat, meat, and goat milk and goat milk processed products. They have no limitation in term of selling products and market is expanding. Feed and forage are available. Cheap agriculture and factory by-products are abundantly available.

II. From a preliminary trail of using acid scrubber from a broiler farm in peri-urban area

The concentration of NH3 was found to be effectively reduced after the scrubbing treatment with sulfuric acid from 4 ppm untreated to around 1 ppm after the treatment. However, the level of odor tested by the panel was not significantly different at 20 – 50 meters away from the rear of the chicken house. This is possibly because of the untreated concentration of NH3 was rather low as compared the sensitivity of the test panel (10) and small is not only from NH3 but could also be from other sources that were not measurable in the trial.

Table 4. Concentration of NH_3in ppm and level of smell detected by test panel

Measurement	Morning		Afternoon	
	Before treatment	air scrubbed	Before treatment	air scrub
NH_3in ppm in exhaust air (2 m) at the rear	4.33 ± 0.52	1.33 ± 1.15	3.50 ± 0.58	1.00 ± 1.15
Level* of smell at 2 meters from the rear	3.03 ± 1.83	2.69 ± 2.02	4.32 ± 2.25	3.66 ± 2.22
Level* of smell at 20 meters from the rear	1.77 ± 2.26	0.17 ± 0.30	0.37 ± 0.80	0.32 ± 0.61

* Scale from 0 to 10, from no unpleasant smell detected to very strong smell.

Elements of success for duplication and expansion and key actors.

Livestock production in the urban and peri-urban areas can be improved by putting forward the following key factors into action;

- Strategic planning for livestock production specifically for urban and peri-urban areas from the Department of Livestock Development.
- Well-balanced urban planning and implication by community authority, municipal administration.
- Networking among producers and integration effort from all stakeholders including researchers, producers, communities, scientists, breeders and officials.
- Meat shops and retailer require to improve the operation to meet a standard
- Research and development are needed to find effective but not costly solutions for reduction of adverse environmental impacts and social conflicts from livestock production in the urban and peri-urban areas.

Major constraints

- Urban and peri-urban areas are not targeted areas for livestock production, therefore, lack of support from policy makers and government sector.
- Urban planning act 2518 (1975) enforcement in cities.
- Limitation of land use.
- Lack of capital to improve sanitation and recording system to meet standard farm practice to GAP, good agriculture practice.
- Unavailability of breeding and genetic improvement.
- Being small holders of livestock in a big city without a strong networking and livestock being alternative career, therefore, lacking of motivation for improvement of livestock farming.

Conclusions and Recommendations

Livestock production in Thailand is important in the international market. Urban livestock production is important for domestic consumption to provide food for local urban community and efficient use of cheap by-products from other urban activities. However, farming activities cause adverse impacts on neighboring communities.

Government agencies require a well-balanced strategic planning for livestock production specifically for urban and peri-urban areas from the Department of Livestock Development and urban planning and implication by community authority and related municipal administrative bodies.

Research and development are urgently required to find effective but not costly solutions for reduction of adverse environmental impacts and social conflicts from livestock production in the urban and peri-urban areas

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1.3 TOWARDS SUSTAINABLE WASTEWATER-FED FISH CULTURE IN KOLKATA, INDIA

Peter Edwards*

Executive Summary

The only large-scale wastewater-fed fish culture system still operating and with prospects for continued operation and expansion is in the East Kolkata Wetlands (EKW) in peri-urban Kolkata, India, the focus for this review. Historically, it is and always has been the largest single wastewater-fed fish pond system in the world. It provides considerable environmental benefits (low-cost wastewater treatment, storm water drainage and a green area for the city as well as a haven for wildlife) and social benefits (employment for fish farmers, service providers such as fish seed, and people involved in fish transport and marketing). Although it is under threat from pressures of urban expansion and has declined in area from about 8,000 ha to about 3,500 ha, it may continue as it has been declared a protected area under the Ramsar Convention on Wetlands based on the wise use of the area through the traditional low-cost wastewater treatment through agriculture as well as aquaculture.

An overview of wastewater-fed fish culture is presented comprising characterization and current status, benefits, constraints and public health aspects. The case study of the EKW system comprises historical development, current status and recent project support. Wastewater reuse through aquaculture is in decline elsewhere so the factors behind the continued operation of the EKW warrant close examination. The EKW presents an alternative approach to conventional wastewater treatment and the major elements of success are outlined so that lessons may be learned for dissemination elsewhere.

1. Overview of wastewater-fed fish culture

1.1 Characterization and current status

The use of human excreta as a fertilizer to produce fish and aquatic plants has a long history in several countries in East, South and South East Asia, especially in China, India, Indonesia and Vietnam where it is traditional practice but on other continents the practice is insignificant (Edwards and Pullin, 1990; Edwards, 1992, 2000, 2005a). **W**astewater-fed aquaculture is integrated with sanitation to provide nutritional inputs as sewage is a fertilizer that produces natural feed for fish, especially phytoplankton that colors pond water green. Wastewater-fed fish ponds function in a similar way to engineered wastewater maturation ponds, the terminal ponds in a series of waste stabilization ponds, the primary purpose of which is to destroy pathogens and which are always aerobic. Farmers maintain a healthy environment in wastewater-fed ponds to ensure good fish growth and production.

Wastewater-fed aquaculture was developed empirically by trial-and-error by farmers and local communities before the relatively recent manufacture of agro-industrial pelleted feed upon which modern aquaculture is based. Traditional wastewater-fed aquaculture systems were commonly developed in low-lying peri-urban areas subjected to flooding that had not been built upon but which received city wastewater by gravity flow.

Research has provided a scientific basis for the key parameters in wastewater-fed fish culture and revised guidelines have recently been published for the safe use of wastewater and excreta in aquaculture (WHO, 2006; WHO, IDRC, CRDI and IWMI, undated).

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Wastewater-fed aquaculture was thought to have great potential for the future a few decades ago but it is generally in decline and has been, or is being, actively phased-out (Edwards, 2005a, b). A major exception in the EKW in Kolkata, India which is presented below as a case study of successful practice (Bunting *et al*., 2005, 2010a, b. Wastewater-fed aquaculture continues in several other countries, mostly in Asia, but is generally informal cultivation of fish and aquatic plants in surface waters contaminated with wastewater. There has been little to no introduction of formally designed and engineered wastewater reuse systems (Edwards, 2000, 2005a, b).

1.2 Benefits

Wastewater reuse through aquaculture, if properly planned and managed, provides social, economic and environmental benefits:

- Relatively low-cost fish for the peri-urban and urban poor
- Direct employment for the poor on-farm and indirect employment through provision of inputs such as fish seed and transportation and marketing of fish fingerlings and harvested fish
- A low-cost method to treat wastewater providing that land is available at reasonable cost
- Reduction of surface pollution which would occur if the wastewater were not used but discharged into rivers or lakes as is widespread practice in developing countries
- Reduced requirements for artificial feed for fish with a concomitant reduction in energy expenditure and industrial pollution elsewhere
- Produce of fish meal as an ingredient for formulated livestock and fish feed
- Conservation or more rational use of freshwater resources, especially in arid and semi-arid areas
- Increased peri-urban biodiversity
- General improvement of environmental quality through peri-urban 'green' areas with clean air and recreational space for tourism

1.3 Constraints

Wastewater-fed aquaculture is being increasingly constrained by:

Reluctance or opposition, even in societies in which it is traditional practice with improving social and economic status high opportunity cost and therefore limited availability and rising prices of peri-urban land associated with today's rapid urbanization increasing industrialization is a public health concern with increased mixing of domestic with industrial wastewater intensification of aquaculture to produce higher yields per unit pond area than is possible in wastewater-fed ponds increasing consumer demand for high-value fish rather than low-value fish from wastewater-fed ponds, with consumers changing from consuming relatively low-value herbivorous and omnivorous fish to high-value carnivorous freshwater and marine fish as living standards rise

1.4 Public health aspects

The World Health Organization (WHO) has recently published revised guidelines for the safe use of wastewater in aquaculture (WHO, 2006; WHO, IDRC, CRDI and IWMI, undated).WHO recognizes that the use of wastes in aquaculture can help communities to grow more food, increasing household food security and improving nutrition for poor households in farming communities and urban areas and make use of precious water and nutrient resources, helping to achieve the United Nations Millennium Development Goals 1*: Eliminate extreme poverty and hunger,* and *7: Ensure environmental sustainability*.

WHO recommends that practices and targets should be based on local social, cultural, environmental and economic conditions and be progressively implemented over time depending on current reality and existing resources, leading to continual improvement of public health? This is because introducing overly strict standards may not be sustainable and, paradoxically, may lead to reduced health protection because they may be viewed as unachievable and thus be ignored.

Various hazards are associated with waste-fed aquaculture: excreta-related pathogens (bacteria, helminths, protozoans and viruses), skin irritants, vector-borne pathogens and toxic chemicals. Fish passively accumulate microbial contaminants on their surfaces but they rarely penetrate into edible fish flesh or muscle except trematodes. The relative risk of disease from bacteria e.g. *Salmonella*, Protozoa e.g. *Giardia,* and viruses e.g. hepatitis, is low to medium although there are always high concentrations of microbes in the gut of fish. The major health hazard associated with wastewater-fed aquaculture is from food borne trematode worms (intestinal, liver and lung flukes) and schistosomes (blood flukes). Fortunately, their restricted geographical range excludes India. The risk from vector-borne pathogens e.g. malaria, is nil to medium, with no specific risk associated with aquaculture as mosquito larvae are readily consumed by fish.

Regarding the risks from chemicals, that from antibiotics is nil to low as they are not usually used in wastewater-fed aquaculture. The risk from heavy metals is low as most are likely to be removed by settling in the anaerobic wastewater canals supplying the fish ponds and by precipitation in the alkaline water of the fish ponds. Although they may accumulate in fish, concentrations of heavy metals from fish raised in wastewater-fed aquaculture do not usually exceed levels recommended by the Codex Alimentarius Commission. The Government of West Bengal is making steps to prevent the discharge of industrial wastes into municipal wastewater and is relocating polluting tanneries from the city. The risk from halogenated hydrocarbons is low as they are generally in low concentrations in wastewater and fish raised in wastewater usually show only low concentrations.

A variety of health protection measures can be used to reduce health risks to fish consumers, workers and their families, and local communities. It is recommended that reduction in the risk of exposure to pathogens be achieved by a combination of interventions or barriers i.e. constructing "multiple barriers" to prevent exposures to pathogens and toxic chemicals.

There is rapid die-off of pathogens in wastewater-fed "green water" ponds due to intense phytoplankton photosynthesis and high pH which is lethal to enteric pathogens so it is recommended that wastewater flow into fish ponds be suspended before harvesting fish to allow for die-off.

Aquaculture workers should limit their exposure to wastewater, in either the feeder canals or in ponds in which wastewater is being introduced. They should rinse their skin thoroughly with clean water after contact with wastewater or pond water contaminated with wastewater. Aquaculture workers as well as local communities should be provided with access to safe drinking water and adequate sanitation facilities. They should practice good personal hygiene, especially thoroughly hand-washing with soap and water prior to food preparation and eating, after defecation and after cleaning a baby's faces.

Market hygiene should be improved by provision of clean water to transport fish and to handle fish at the market, as well as provision of adequate sanitation facilities at markets. Although pathogens rarely occur in fish muscle they may occur in fish intestines so prevention of cross-contamination with other food in the kitchen is essential when fish are being prepared for cooking. Cross-contamination of foods in the kitchen is the greatest risk which is reduced by hygienic processing and cooking.

The risk from infectious diseases from wastewater raised fish is also significantly reduced if the fish are thoroughly cooked before being eaten as with Bengali cuisine

2. East Kolkata Wetlands case study

2.1 Historical development

Wastewater from the city of Kolkata was discharged into the so-called 'salt lakes' or brackish water lagoons to the east of the city from the middle of the 19th century (Bunting, 2005; Bunting *et al*. 2011). With a decline in salinity due to the wastewater, freshwater fish colonized these lagoons and fish stocking was probably undertaken but the earliest attempt at more organized wastewater-fed aquaculture was by a farmer in the early 20th century. As discharge of wastewater also led to the gradual silting up of a river that connected with the estuary that led to the sea, Kolkata then constructed major canals to transport wastewater and storm water 27 km to an estuary in the mid-20th century. Wastewater feeder canals constructed by the engineers increased the availability of wastewater to farmers in the vicinity and encouraged widespread adoption of wastewater-fed aquaculture. Some 350 holdings with a combined area of 7,300 ha were managed for wastewater-fed aquaculture at its peak of development in 1945 in the area commonly known as the East Kolkata Wetlands (EKW).

Large areas of wastewater-fed fish ponds were filled in to build Salt Lake City, a suburb of Kolkata in 1962-72 and East Kolkata and Patuli Townships in 1978-79 and further fish ponds were lost with the construction of the Eastern Metropolitan Bypass (EMB) in the 1980s. Land speculation and surreptitious land-use change in the EKW were widespread during the 1980s to 1990s as the above urban developments increased the attractiveness of the area to developers. The problem was exacerbated by the absence of a clear land-use policy for the EKW but huge pressures are today still being exerted on the peri-urban EKW because of limited land for expansion of the City of Kolkata.

Several key individuals have played a crucial role in championing the cause for the preservation of the EKW: D Ghosh a Kolkata, M Mukherjee from the Department of Fisheries, and N Kundu from the Department City engineer of Environment. D Ghosh in particular played a crucial role in demarcating a 12,000 ha Waste Recycling Region (WRR) which includes wastewater-fed rice fields and vegetable growing areas as well as fish ponds. He also was instrumental in the listing the EKW as a Ramsar Site in 2002 on the basis of wise use to produce a range of goods and services, especially a low-cost, efficient and eco-friendly system of wastewater treatment and a habitat for diverse flora and fauna including waterfowl. Wise-use of wetlands was defined by the Ramsar Convention as 'their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem'.

The benefits of the wetlands have now been fully recognized officially by the Government of India as well as the Government of West Bengal (GoWB) and the significance of the system has been highlighted globally. Practices in the EKW constitute an internationally important example of wise-use of a wetland and an alternative approach to solid waste and wastewater management for other towns and cities, both in India and worldwide. Accession to Ramsar has committed the state authorities to implement effective policy, legislation and management structures to preserve the character of the wetlands, thereby protecting them from environmentally destructive development and enhance them for future generations. The EKW (conservation and Management) Act (2006) makes provision for the 'conservation and management of the East Kolkata Wetlands' and specifies landholdings within the EKW and their character and mode of use. Furthermore, the EKW Act sets out the functions and powers of the East Kolkata Wetlands Management Authority (EKMWA). Together with government departments and nodal agencies, the EKWMA has members representing NGOs and user groups. Key functions of the Authority include preparation of action plans and subsequent implementation and monitoring.

2.2 Current status

There are 254 wastewater-fed fish farms, occupying an area of about 3,800 ha. Currently wastewater with an average daily flow of 1,100 MLD (1.1 million m^3) from the inner city of Kolkata with about 4.5 million people, is not treated by a conventional sewage treatment plant (STP). An estimated 30-50% of the wastewater from central Kolkata is treated and reused by the fish ponds of the EKW with the remainder flowing out to sea untreated (Edwards 2008a). As these ponds need to be aerobic for fish to survive and grow, they function like maturation ponds, waste stabilization ponds with a low organic matter loading rate.

Raw wastewater is the only source of water for fish culture and is conveyed in the two main 27 km canals and a complex system of secondary and tertiary canals connect with the fish ponds. Ponds are initially filled with black anaerobic wastewater in a process known as primary fertilization. The wastewater is left for 2-3 weeks after which it turns green in colour and becomes aerobic due to the development of plankton. Fish fingerlings are then stocked and natural food for the fish is maintained through secondary fertilization in which wastewater in small volumes is allowed to flow by gravity or is pumped into the ponds at doses ranging from 1-10% of the pond volume depending on the fertility of the pond water (Nandeesha 2002). Large fingerlings of 10-15g are stocked at 4-5 m^{-2}. Multiple stocking and multiple harvesting is carried out with 1 kg of seed stocked for each 5 kg of harvested fish. Supplementary feed, mainly mustard oil cake and mohua, is used by a majority of farms, especially during the monsoon season when there is insufficient wastewater available for the ponds. The ponds are emptied each year in February to remove the bottom mud and are refilled with raw wastewater 6 to 8 weeks later. The fish attain marketable size in 5-6 months. The mean annual yields for the North and South Salt Lake areas are approximately 1,400 and 1,000 kg / ha respectively although well managed farms attain yields of up to 5,000 kg / ha. The estimated total fish production for the EKW of 18,000 tonnes annually (Bunting *et al*. 2011).

Production was initially dominated by indigenous Indian major carps (IMC), specifically a polyculture of rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) and sometimes included the indigenous minor carp, bata (*Labeo bata*). Exotic fish species were introduced into the polyculture from the 1960s: common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and Mozambique tilapia (*Oreochromis mossmbicus*). More recently the Nile tilapia (*Oreochromis niloticus*) has replaced Mozambique tilapia with a trend towards culturing mainly Nile tilapia usually in polyculture with IMC but sometimes in monoculture. Walking catfish (*Clarias batrachus*) and striped catfish (*Pangasianodon hypophthalmus*) are also produced although in limited quantities. New species of higher market value are being trialed e.g. seabass (*Lates calcarifer*) and various other native species to try to enhance farm incomes.

Wastewater mainly flows into the fish ponds by gravity during 270-300 days of the year as the regulator gate at Bantala on the main sewage canals leading from the city is kept closed during the dry seasons to raise the level of wastewater in the canals so that it flows into feeder canals and then into the fish ponds. However, the regulator gate is kept open during the monsoon season to lower the water level in the main canals to prevent flooding in the city. Thus, during the monsoon season the level of the fish pond feeder canals is usually too low to permit wastewater to enter the fish ponds by gravity. Farmers complain of inadequate wastewater to feed their ponds, especially in the rainy season. Increased wastewater flow would also allow up to 1,000 ha of former fish ponds currently being used to grow rice to be converted back to more economically attractive wastewater-fed fish culture. Several hundred ha have already been reconverted to fish ponds from rice paddies over the last few years.

Some of the fish ponds are leased from the City of Kolkata, some are privately owned and a few are run as cooperatives; they provide employment for the local people at a rate of 7.5 persons/ ha. The fish are caught at dawn in traditional drag nets and sold at local auctions, from where they go to the Kolkata markets; by 7am most of the day's catch has been sold. The fish ponds supply 10-20% of the fish consumed in Greater Calcutta and are important for poorer city residents as small-sized fish are mostly marketed (Morrice *et al*., 1998). It has been suggested that restrictive terms and conditions imposed by labour unions, resulting in 'gross over-employment' and suboptimal management regimes, have made fish culture in the wetlands financially unsustainable.

2.3 Recent government and project support

Three major projects are discussed: the UK Department for International Development (DFID) funded project 'Land-water Interface Production Systems in Peri-urban Kolkata' and two Asia Development Bank (ADB) funded projects, 'Capacity building for the East Kolkata Wetlands' and 'Kolkata Environmental Improvement Project (KEIP)'.

The DFID-funded project identified the diverse issues threatening the livelihoods of poor people in Kolkata who depended on wastewater-fed aquaculture for employment and/or as a source of relatively cheap fish (Edwards, 2003). It was pointed out that even though the fish ponds were recognized as a low-cost wastewater treatment system for the city of Kolkata, the single largest threat to the system was filling in the ponds for urban and industrial development. The wastewater-fed fish ponds were also plagued with poor governance as an intersectoral planning and management body did not exist. Insecure tenure of the fish ponds had led to little desilting of the ponds for decades leading to shallow water that limited fish production. The labour unions demand excessive seining of ponds to generate employment; although it does lead to the production of relatively small and cheap fish affordable to the poor, it reduces the potential production and profitability of aquaculture in the EKW. Furthermore, technical constraints to productive fish culture were identified.

The ADB-funded capacity building project assisted the recently established East Kolkata Wetlands Management Authority (EKWMA) to develop an Environmental Management Plan (EMP) for the EKW which has been published as a manual (Bunting *et al*. 2011). The EMP comprises four sections: an Aquaculture Management Plan (AMP), a Wastewater Management Plan (WMP), a Waste Recycling Plan (WRP) and a Best Practices Plan (BPP).Each plan has a number of sections covering: management objectives; compliance to regulations; environmental and ecological objectives; social and economic objectives; educational objectives; principles of operational management; research objectives; monitoring controls and surveillance; consultation with stakeholders; post-harvest sector assessment; triggers for periodic review of the plans; institutional assessment; and legislative and regulatory assessment. Stakeholders from different user groups, interest groups and institutions, located within and outside the Wetlands were involved in the process as their participation was important to ensure that the plans contain relevant and worthwhile objectives and do not have negative consequences on the ecosystem or livelihoods. The final plans were made available to the public, posted on the internet and are accessible for consultation at the EKWMA office. Given the range of ecosystem services derived from the EKW, preliminary plans have also been developed for an interpretation centre to enhance access to the wetlands for educational and recreational purposes.

Specific guidance in the manual includes Best Practices relating to upgrading and maintaining the canal system and fishponds; implementing the WHO guidelines for safe wastewater use; and prospects for enhanced aquaculture production.

The aquaculture BMPs are as follows:

- Production of higher yields of large-sized fish in at least some ponds. This would improve economic efficiency of fish production, and lead to greater economic development with provision of more jobs for poor workers. Larger fish fetch 2-3 times higher a price in local markets than small-sized fish. This should be achieved through tripartite negotiation between fish producers, farm worker unions and government agencies
- A three-stage system of nursing, rearing and grow-out ponds. Stock large fingerlings of 100-200 g (the current size of final harvest) in stage 3 and harvest them only after their growth declines
- Natural food alone is insufficient for larger sized fish to continue to grow and increase in weight but it is best to use supplementary feed later in growth cycle so fish continue to maintain rapid growth rate when they exceed about 100 g individual weight
- Improved strains would considerably increase production, an improved strain of rohu that has been developed by a Norwegian funded project through the Central Institute of Freshwater Aquaculture, India and improved strains of Nile tilapia from Thailand
- Production of large-sized tilapia is facilitated by use of mono-sex culture which should be explored alongside the introduction of improved strains.

The overall aims of the current ADB-funded Kolkata Environmental Improvement Project (KEIP) of the Kolkata Municipal Corporation (KMC) are to provide better flood control of Kolkata and to improve environmental protection. A specific aim is to improve wastewater handling in the EKW to provide stronger wastewater to feed the fish ponds so a sub-project is being implemented to renovate the primary canal network of the EKW. KEIP is to separate currently mixed dry weather flow (DWF) and storm weather flow at the main city pumping stations. It is proposed to construct a siphon just upstream of Bantala so that the entire DWF throughout the year will be channeled into the fish ponds. The present fish pond intake at Bantala is to be abandoned so that the regulator gate can then be used solely for flood control, thereby resolving the conflict with fisheries. The main DWF channels between the city and the fisheries are also being desilted. Two existing semi-derelict siphons on the main DWF canal that feed fish ponds in the southern EKW area will also be upgraded to increase wastewater flow.

Wastewater management and environmental protection facilitated through productive use of wastewater in the EKW is increasingly acknowledged as an important attribute, helping the municipal authorities meet statutory discharge standards. The cost of wastewater treatment in the EKW was compared to that of a conventional treatment plant of equivalent capacity and associated savings on greenhouse gas emissions and it would be possible to forego construction of a multi-million dollar STP and in addition to utilise extra capacity in the EKW, whilst achieving lower carbon emissions and increased fish production (Edwards 2008). This saves an estimated total investment of US$ 125 million, excluding annual O&M cost, to treat the sewage from the inner city by conventional mechanical secondary sewage treatment.

The long-standing problem of fish pond siltation through neglect of pond maintenance has been partially addressed by permitting the West Bengal Housing Infrastructure Development Corporation to remove the accumulated material to fill land earmarked for a new city to the north of the EKW, New Town or Rajahat.

It has also been recommended that KMC consider introducing a sewage tax derived from the central city to be used to maintain the main wastewater feeder canals to the fish ponds as the EKW provides an ecological service to the city by treating its wastewater.

3. Elements of success for duplication and expansion and key actors

The example set by the wastewater-fed fish culture system in peri-urban Kolkata provides an alternative approach to waste water management for other towns and cities, both in India and worldwide. Lessons learned have already been used to install systems in three municipalities within the Kolkata metropolitan area under the Ganga Action Plan and in Kalyani, West Bengal. These systems do not use raw wastewater but have been upgraded through incorporation of pre-treatment through an anaerobic wastewater stabilization pond.

The major elements of success were:

Vociferous local supporters to maintain land-intensive wastewater-fed aquaculture in peri-urban areas under pressure for urban development policy commitment made by the GoWB in designating the EKW a Ramsar Site and passing the EKW Act (2006) which have probably 'put a damper' on or curtailed land speculation and have encouraged land owners and farm managers to seek legitimate ways to make their operations profitable and sustainable. The run-down and relatively unproductive nature of many fish farms in the early 2000s threatened the continued operation of the system and consequently the livelihoods of several thousand people. Faced with this predicament the main interest groups (producer associations, community leaders, labour unions and political parties) have entered into a constructive dialogue on the future of the system (Bunting et al. 2010).

A constitutional basis for protecting and enhancing the EKW provided an opportunity to establish a multi-agency management committee to better coordinate government action relating to the wetlands.

4. Major constraints and risks

The EKW is probably better protected than ever before because of recently constituted legislation but the threat from urban development continues due to a critical shortage of land in Metropolitan Kolkata. Continuing demand for fresh fish from the EKW has permitted producers to generate sufficient financial returns to continue operations but changing aspirations with increased economic development could lead to a decline in demand for wastewater-fed pond fish although there is no evidence yet of negative impacts on consumer acceptance or sales in Kolkata.

5. Conclusions

Wastewater reuse through aquaculture is declining even though it provides a low-cost system to treat municipal wastewater and benefits the poor through employment and income for peri-urban farmers and low-cost fish for urban consumers. It has declined drastically in China with the longest tradition and until recently the greatest extent of practice although the EKW has always been the single largest system. Most of today's peri-urban and urban aquaculture systems are inherently unstable and transitional and are probably not sustainable because of their location at the edge of mostly rapidly expanding cities. The EKW system continues to function because of a unique set of circumstances so to what extent a similar system could be developed in urban areas in other areas in India and the rest of the world remains questionable. The greatest potential for wastewater-fed aquaculture may be in arid areas where there is pressing need for water reuse.

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1.4 INTEGRATED HOMESTEAD FARMING SYSTEMS FOR IMPROVING NUTRITION STATUS OF URBAN & PERI-URBAN POPULATIONS FROM SELECTED ASIAN COUNTRIES

Lalita Bhattacharjee*

Executive Summary

Integrated homestead farming systems linked with nutrition education programmes for improving the diets and nutrition of communities have been implemented in many Asian countries. They have in common nutrition or nutrition-related objectives, be it the broad objectives of reducing the prevalence of malnutrition or improving household food security, or more specific objectives related to nutrition activities such as improving dietary diversity in household diets, infant and young child feeding as well school nutrition. Such program require appropriate institutional arrangements, mechanisms, methods and services planned from the participants along with policy support. It is crucial to understand the linkages between farming systems and nutrition and how these linkages operate, where opportunities for joint action lie, and how agricultural and health sectors can work more closely to address food security, nutrition and health. Knowledge also points to greater action in the use of biodiversity available in the local food systems for better nutrition. School-based nutrition education programmes also offer an effective way of reaching out to large sections of society, including young people, school teachers, families and community members. Lessons learned show that in order to be effective, the programs must be adopted at national level and implemented at the community level. Monitoring of programs helps ensure a results based approach to influencing behaviors and improving dietary intake to ultimately impact on nutrition.

Aim and Objectives

The aim and objectives of the case study are to review the role of food based nutrition strategies within integrated home stead farming and gardening systems to improve the dietary intake and nutritional status of populations, notably women and children. The paper provides evidence from field projects implemented in selected Asian countries, namely Bangladesh, India and Lao PDR, with a focus on food systems and their potential nutritional contributions. It also demonstrates the use and process for adopting a community based approach in implementing food based strategies as a sustainable mechanism to improve food and nutrition security of the vulnerable groups, notably women, children and school age children.

Background

Good nutrition begins with food, health and care. Many diets in developing Asian countries, namely in South Asia consist mainly of carbohydrate or grains and rice or starchy roots[2]. Such diets lack many of the essential micronutrients necessary for a child's growth and development. The prevalence of child under nutrition in Asia, notably South Asia is amongst the highest in the world. In India, the rate of child under nutrition is nearly double that of the entire Sub-Saharan Africa, with high rates of associated morbidity and mortality, and dire consequences for productivity and economic growth. It is estimated that 70% percent of the world's under nourished children live in South Asia.[3] Estimates from 2006 -2011 suggest that

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[2] FAO (2012) Selected indicators of food and agricultural development in the Asia Pacific Region, 2001-2011, FAO RAP, Bangkok

[3] ACC/SCN-IFPRI 2000.

developing Asia has the world's highest child underweight prevalence rate of 27% and in South Asia the prevalence rate stands at 43%[4]. Table 1 shows the prevalence of child malnutrition in selected Asian countries.

Table 1: Prevalence (%) of child malnutrition in selected Asian countries[5]

Country	Underweight	Stunting	Survey year	Anemia (most recent bservation)
Bangladesh	36	41.0	2011	47.0
India	43.5	47.9	2006	74.3
Nepal	29.1	40.5	2011	78.0
Pakistan	30.9	43.0	2011	50.9
Sri Lanka	21.6	19.2	2009	29.9
Lao PDR	31.6	47.6	2006	48.2
Thailand	7.0	15.7	2006	25.2
Sub –Saharan Africa	21.4	39.6	2011	
World	15.7	25.7	2011	

Micronutrient deficiencies on the other hand, are also a significant cause of malnutrition and associated ill health where iron deficiency anemia affects between over a fourth to over three fourth of children in South Asia as compared to around half in Lao PDR and around a fourth in Thailand. On the whole, the proportion of children suffering from anemia is higher in the South Asian countries as compared to Southeast countries as listed above.

Integrated horticulture/livestock/aquaculture projects and interventions are perhaps the most sustainable means to improve households' access to a variety of foods to meet diet and nutrient intakes. In many areas of South and Southeast Asia they form an integral part of traditional food production systems and strategies. Evidence from Thailand[6] and Vietnam[7] has shown malnutrition being addressed in national development policies and poverty alleviation programs. Integrated farming systems at household and community level along with multi sectorial collaboration involving agriculture, public health and education and people's participation have has shown marked decrease in child malnutrition, chronic energy deficiency in women and reduction in poverty/increase in incomes of rural and peri urban populations[8].

Strategy and Scope, Inputs and Output expected

The projects' strategies encompassed activities related to the production, acquisition and utilization of a variety of foods with an aim to diversify the diet and meet the nutrient needs of the household and family members especially women, infants and young children and adolescent girls. The nutrition education strategy set up community-based nutrition education programs to create nutritional awareness among various groups such as women and school children. Mass media educational messages and programs on the advantages of consuming a diversified diet were developed and disseminated.

[4] ADB (2013) A Zen Approach to Post 2015: Addressing the range of perspectives across Asia and the Pacific, Working Paper # 327.
[5] Various National DHS Surveys
[6] Tontisirin K, Bhattacharjee L (2008) Community based approaches to prevent and control malnutrition, Asia Pac J Clin Nutr, 17 (SI) 106 -110
[7] Burchi F, Fanzo J and Frison E (2011) The role of food and nutrition system approaches in tackling hidden hunger. Int.J Environ. Res. Public Health, 8 : 358 -373
[8] Hop L (2003) Programmes to improve production and consumption of animal source foods and malnutrition in Vietnam. Journal of Nutrition, 133:4006 S -4009S.

The scope of the paper covers integrated horticulture and nutrition development in Bangladesh, integrated home gardening along with nutrition education for nutrition improvement in Lao PDR, documentation and promotion of indigenous foods for better nutrition among the Bhils in Gujarat, India and school nutrition education with examples from urban India.

The inputs include provision of technology and training to equip the project participants growing and promoting integrated home gardens along with nutrition education for improved diets, nutritional status and income. The expected output was to create conditions for diversified food production for consumption by providing the participants with necessary knowledge, technology and skills to make nutritious food available to their community and improve household dietary diversity and nutrition.

Integrated home garden models for better nutrition including horticulture, fish ponds and backyard poultry; community-based nutrition education programmes through nutrition training and cooking demonstrations among women groups; improved dietary intake of a variety of foods/food groups by households and children; increase in the dietary protein and micronutrient intake were some of the expected outputs, with demonstration of impact on children's nutrition status in one of the projects.

Methodology, Application and Targeted Beneficiaries

The case study synthesizes the evidence from integrated farming linked nutrition projects[9] from 3 selected countries in Asia, namely Bangladesh, India and Lao PDR. The project activities were targeted to poor, landless /marginal households with children under 5 years of age including those who were malnourished (moderate and severely undernourished).

Different criteria were used in each of the projects for selection and targeting of the households, women/ women groups or students towards participation in integrated farming systems, food learning initiatives along with nutrition education. Table 2 outlines the main comparative elements in the four projects from the three selected countries as below:

Table 2: Comparative elements of the projects in the selected countries

Country	Targeted participants	Farming/Food systems/ Food learning initiative	Nutrition Education/ Nutrition Information
Integrated Horticulture and Nutrition Development, Bangladesh Peri urban locations in 15 districts	Landless households (< 0.50 acres land)	Integrated horticulture development Growing household and group gardens and planting nutritious vegetables, fruits, herbs	Community based nutrition education programs for school/ adolescent children, household women (disadvantaged and impoverished),Nutrition training for peri urban and urban school teachers of government/ public schools, elders, NGO workers, government stakeholders (sub national),

[9] Bhattacharjee L, Saha S and Nandi BK (2007) Food based nutrition strategies in Bangladesh: experiences from Integrated Horticulture and Nutrition Development Project, FAO Regional Office for Asia and the Pacific, Bangkok; Bhattacharjee L, Phithayaphone S and Nandi BK (2006) Home gardens: Key to improved nutritional well being, Report

Country	Targeted participants	Farming/Food systems/ Food learning initiative	Nutrition Education/ Nutrition Information
Integrated horticulture and Nutrition Development, Bangladesh Thirty schools in peri urban locations	Schools with minimum land area of 3 decimal for the nutrition garden and access to water ; adolescent females in 8th and 9th grades	School nutrition gardening as part of practical science learning and planting selected nutritious vegetables and fruits	Integrating nutrition in curriculum and practical modules, nutritious cooking demonstrations for adolescent female school children, school teachers , innovative games and nutrition education aids for school children
Integrated home gardens for improved nutritional well being Lao PDRMunicipal jurisdiction	All households with children under five years of age; households with a malnourished child under five years (manifested as moderate and severe underweight, wasting and stunting) Households with limited assets (production and capital assets)	Integrated home gardening (horticulture, backyard poultry, pig raising, community ponds (natural and artificial)	Government level Stakeholders (sub national), Households, communities and, mothers; nutritious cooking demonstrations for households, diets for pregnant/ lactating women, complementary foods
Indigenous Peoples Food Systems –Bhils India (Peri urban location, Gujarat State)	Tribal households School children from Grades VIII to IX from 24 schools in urban slum/ peri urban locations	Indigenous food systemsCultivation, gathering and hunting)	Documentation, identification and nutrient analysis of indigenous foods
Feeding Minds Fighting Hunger India : Four metro cities (Hyderabad, Kolkata, Mumbai, New Delhi)		Implementation of FAO Global education initiative (Feeding minds fighting hunger modules)	Nutrition education in classrooms/integration in curriculum

The projects that had home gardening and nutrition education components were implemented through the institutional arrangements at the sub national and community level within the government systems. The Feeding Minds Fighting Hunger Project was implemented through the classroom and community arrangements facilitated through the participating schools. In all the projects, the first step was close liaising with the Ministries of Agriculture and Health to raise the awareness of National Policies and Plans of Action for Nutrition and provide a nutrition orientation to farming and gardening systems as applicable, in the peri urban or community locations. The value of a collaborative program on integrated home gardens combined with nutrition education to improve nutritional well- being was emphasized in each of the projects with nutrition improvement as the ultimate goal and outcome of the projects. As a result of the liaising process each peri-urban locality was assigned a project co-coordinator who was entrusted with the responsibility of facilitating the project implementation process.

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of Pilot Project TCP/LAO/2902 (A), FAO RAP; FAO/CINE (2009) Chapter #10 in Indigenous Peoples' Food Systems; Bhattacharjee L, Menza V and Nandi BK (2007) Feeding Minds Fighting Hunger :Initiatives among school children in India, FAO.

Community participation was promoted through committees who actively mobilized the participating households in establishing and maintaining home gardens; promoting seasonal home garden vegetable cultivation practices; monthly cooking demonstrations using garden produce; group nutrition education; organizing and mobilizing women toward preparing complementary foods using micronutrient rich vegetables/fruits; regular visits to each household with a malnourished child for weight monitoring and follow up on dietary advice; discussing problems in the food system and conceiving plans for action and establishing a ' network of women' to promote best practices for improving household food security and nutrition.

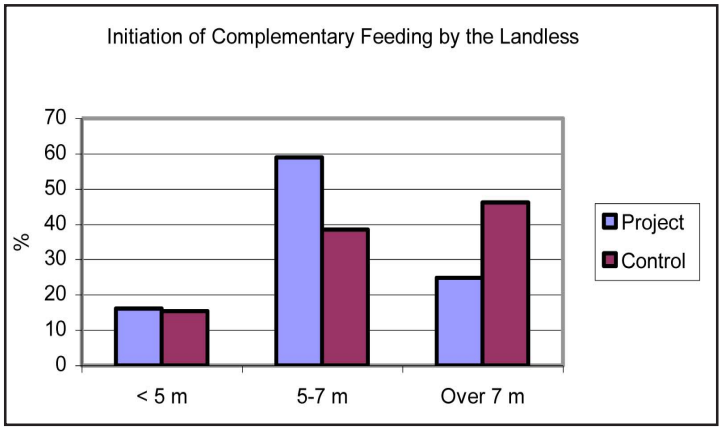
Study Results

The projects were assessed for outcomes on food and nutrient availability, dietary intake and impacts on nutrition. A summary of each of the projects has been consolidated based on a review of key findings which are presented below.

Bangladesh: Integrated Horticulture and Nutrition Development Project (IHNDP)

The project's efforts were directed towards creating an environment of growing horticulture produce (micronutrient rich vegetables, fruits, fresh spices, herbs and mushrooms) in the land available within the immediate courtyard vicinity or on roof tops. The technology provided to the participants were to grow horticulture foods mainly for consumption and for equipping the women with the necessary knowledge, technology and skills to prepare nutritious foods that can be consumed by themselves and their households thereby improving dietary quality. An attempt was made to diversify the food habits of the target groups and promote the consumption of horticultural crops as a sustainable solution to the problem of micronutrient malnutrition.

Food and dietary consumption: Due to the project interventions the consumption of leafy vegetables, yellow orange vegetables as well as vitamin C rich fruits and vegetables also increased in the project households. Over 60% of the project covered households started giving complementary foods to infants between the ages 5 to 7 months along with continuation of breast feeding as compared to only a third of non-project households who did so (Figure 1).



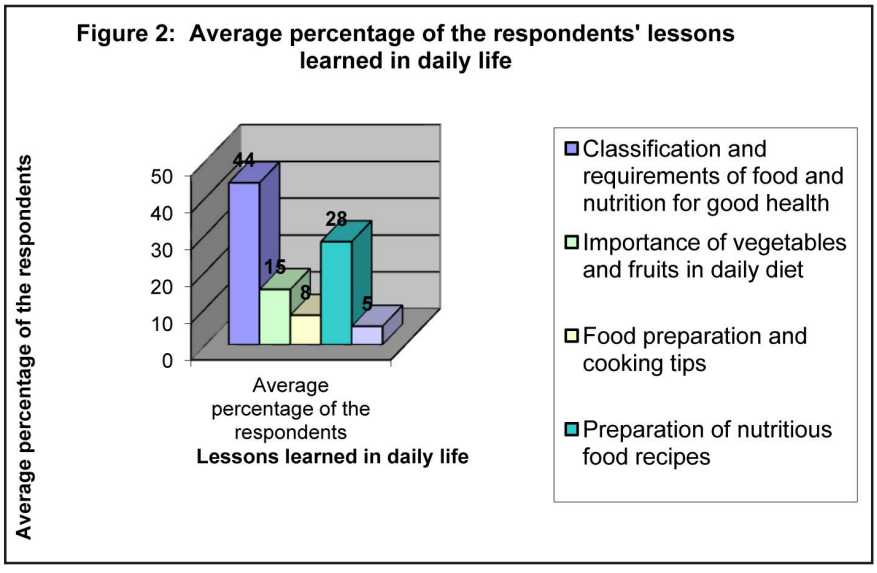
A substantially higher energy, protein and micronutrient intake was noted among the project covered households compared to non-project households. Iron intake was significantly higher in adult women, vitamin A intake was significantly higher in children, adolescent girls and adult women, while vitamin C intake was significantly higher in children and adult women and calcium intake was significantly higher in adolescent girls in the project covered households. It was seen that diets of the project covered households were more diversified than control households.

Group and community savings: Small self-help groups acted as a vehicle for technology dissemination in the project mostly with the landless, marginal women groups. Of a total of 1292 groups organized, 82 percent were female. The self-help women groups organized by the project were consolidated and reorganized

by the community at the later part of the project. The consolidation process was based on the factors such as regularity of meetings, maintaining bank account, regularity of savings and horticultural production/ processing activities at individual and group levels. The groups deposited savings regularly in their bank accounts. The savings are being utilized in many ways such as to protect them from the money lenders, paying for land lease for horticulture production and purchasing inputs. The groups organized regular meetings and discussed issues of their activities on growing horticulture foods, processing practices, marketing prospects, experiences of in-country study tours, micro-capital grant support and nutrition. Such a group approach was seen by the project to have a very positive effect on the overall service delivery process.

***School Nutrition Program*:** A one year program was launched with nutrition education and school gardening activities. Nutrition education activities included lecture cum food preparation demonstrations to build and strengthen existing nutrition knowledge through hands on food preparation activities. The school gardening activities set up a demonstration nutrition garden in the school and a peer nutrition promotion programme was also implemented**.** High school students were assigned the responsibility for sensitizing middle school students to nutrition using an 'each- one- teach- one' approach. Each high student identified a school mate not covered by the SNP and arranged to meet her at least one in 15 days to teach her the basics of nutrition and the recipes for usage in her diet. A set of recipe sheets were given to the 'student teacher'. This activity was carried out on a voluntary or extra mural basis by the students.

It was observed that 44 percent of students had learned about food groups and about food quantities to meet dietary nutrient requirements and participated actively in the discussion session. Twenty eight percent of students had a very clear understanding of the recipes, learning how to prepare them. They could explain the importance of vegetables and fruits in the daily diet, though only 5% of the students were able to explain about the importance of nutrition gardens. In most cases they were only told how to establish and maintain the garden (Figure 2)



***Horticulture production and nutrient availability*:** Vegetable garden-based production of improved vegetable varieties was an important project activity. The nutritional contribution of the vegetables produced in group and homestead gardens was assessed using summer and winter vegetable yield information in the demonstration plots at 15 horticulture development training center (HDTC) locations. The yield availability per person was calculated using an average of six persons per household. Table 3 shows average yields of winter and summer vegetables at the HDTC and household levels. The daily average household and per capita availability of vegetables from the group garden and the per capita daily micronutrient supply are also given.

Among winter vegetables, carrot has the most vitamin A as beta carotene (3 230 ìg) followed by tomato (708 ìg) per capita. Tomato is one of the most common vegetables and nutritionally valuable because of its high content of vitamins A and C. It is also a primary source of lycopene (a carotenoid) and its consumption has significant association with low risk levels of digestive tract and prostate cancers[10]. Peas and beans are not a good source of vitamin A but provide dietary protein, especially when dried. Among summer vegetables, stem amaranth (*data shak*) has maximum vitamin A (2208 ìg beta carotene), calcium (104 mg) and a little iron per capita. Indian spinach, on the other hand, is a packaged source of micronutrients including vitamin A (1704 ìg beta carotene), calcium (120 mg) and iron (6.0 mg) per capita

Table 3: Horticulture produce and micronutrient availability from group gardening

Vegetables	Average yield /season[11]				Micronutrient[12] supply /person/d			
	HBTC (kg)	Per garden (kg)	Per household/d (g)	Per person/d (g)	Vitamin-A as beta carotene (mcg)	Vitamin C (mg)	Iron (mg)	Calcium (mg)
WINTER								
Tomato	61.00	55.00	706	117	708	32	0.7	58
Pea	6.8	5.5[13]	183	30	25	3	0.45	6
Carrot	38.8	24.5[14]	533	88	3,230	3	0.88	64
SUMMER								
Indian spinach	68.00	55.00	366	61	1704	52	6.0	120
Amaranth	38.00	33.00[15]	266	44	2208	4	0.7	104

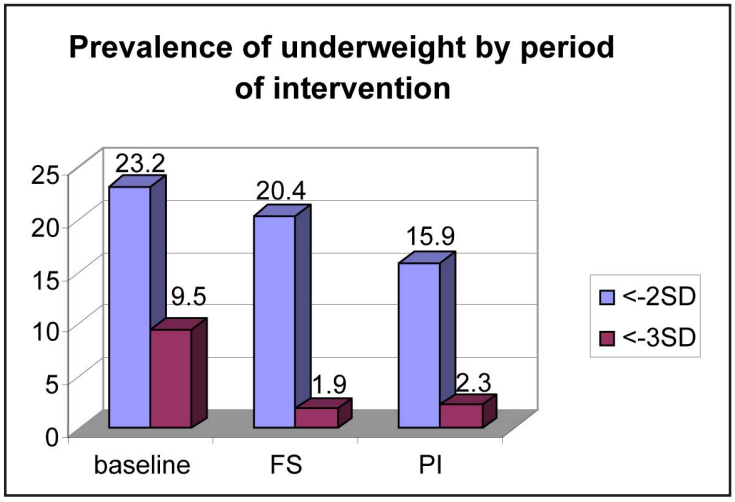
Lao PDR: Integrated Home Gardens for Improved Nutrition

A pilot project on the promotion of home gardens for improved nutritional wellbeing was implemented in four districts of Lao PDR. The project developed and implemented a creative process that evolved from participatory planning of its action plan for implementation including the community and district levels right up to the policy makers in the Department of Agriculture. Through an integrated home gardening program supported with nutrition education, model home gardens were established by each of the target households and communities in peri urban locations in the municipal regions of Lao PDR. One of the major project outputs was the development of provincial and community level capacities to implement and manage home gardening and nutrition improvement programs.

Field demonstrations were key outputs of the transfer of technology component. Household horticulture and small scale fish farming provided opportunities for nutrition and income, while raising small livestock mainly served as means of accumulating capital. At 18 months of implementation, an increase in the production of vegetables, fruits, poultry and fish was noted in the target households with an awareness created for enhancing the consumption of these home grown produce. Specifically, the consumption of green leafy vegetables and fish showed an increase.

Impacts on nutrition*:* Comparing from baseline to the post intervention period, rates of moderate and severe underweight declined from 23 % to 15.9 % and from 9.5 % to 2.3% respectively, being significant for severe malnutrition. Decline in rates of malnutrition in children under five years demonstrated evidence of project impacts on nutrition (Figure 3).

[10] Giovannucci E. Tomato products, lycopene, and prostate cancer: a review of the epidemiological literature. J Nutr. 2005. Aug;135(8):2030S-1S.
[11] 5 months , actual period of availability 2 ½ months
[12] Gopalan et al (2004) Nutritive value of Indian Foods, NIN, ICMR, New Delhi.
[13] Availability of 1 month duration only
[14] Availability of 1 ½months duration only
[15] Yield from 65 group gardens



The baseline survey found that the prevalence of underweight (WFA<-2SD from the median of the reference population" as moderate malnutrition) was 23.2% and 9.5% (WFA<-3SD from the median of the reference population" as severe malnutrition). After six months of implementation of the pilot project along with nutrition education, a semester anthropometric measurement showed that the prevalence of underweight declined to 20.4% of <-2SD and to 1.9% of <-3SD. The final anthropometric measurement was taken 9 months later and it was found that the prevalence of underweight declined to 15.9%. The rate of severe underweight declined from the baseline to post intervention period ($p = 0.02$). The lessons learned for both policy and technology have been considered for scaling up at national levels.

India: Bhil Food System and Links to Nutrition

Documentation of the Bhil food system and foods traditionally consumed by the community was undertaken. Data were collected through field visits and a rigorous food consumption survey adapted from standard tools[15] .Seasonality, procurement of food and cost of food production were also documented[16]. A total of 95 foods consumed by the Bhils were identified. The foods were classified into food groups and the numbers of foods per group and methods of obtaining traditional foods[17] are shown in Table 4.

Table 4: Bhil food list classification and methods of obtaining traditional foods

Food category	Number of items	Methods of obtaining foods	Number of items
Cereals	9	Cultivated	29
Fish and sea food	9	Domesticated	3
Fruits, nuts and seeds	18	Gathered	9
Green leafy vegetables	13	Gathered, cultivated	1
Meat and poultry	14	Wild, gathered	32
Other vegetables	10	Wild, gathered, cultivated	7
Legumes	13	Wild hunted	14
Roots and tubers	9		

Nutrient values for all foods were calculated using the Indian Food Composition Tables[18]. Food samples that did not have documented food composition values in the Tables were analyzed at the National Institute of Nutrition in Hyderabad, India. These data are presented in Table 5 along with nutrient information on key foods mentioned.

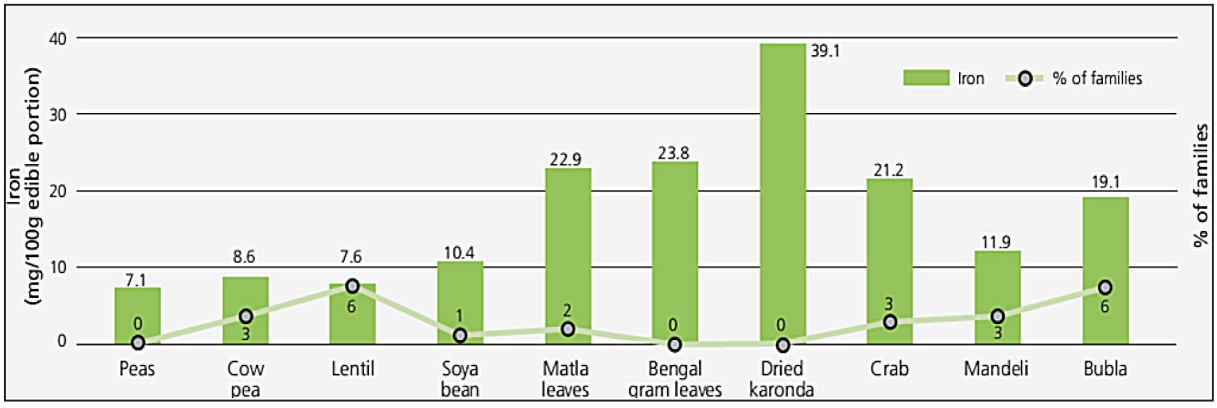
[16] Kuhnlein HV, Smitasiri S, Yesudas S, Bhattacharjee L, Dan L and Ahmed S and country collaborators (2006) Documenting Traditional Food systems of Indigenous Peoples :International Case Studies Guidelines for Procedures, IDRC, Ottawa, FAO, Rome and CINE, McGill University, Montreal, Canada.
[17] Bhattacharjee L, Priya V, Kothari G, Nandi BK and Kuhnlein HV (2006) The Bhil Food Directory.
[18] Bhattacharjee L, Kothari G, Priya V and Nandi BK (2009) The Bhil Food System :Links to food security, nutrition and health, Chapter in " Kuhnlein HV et al (2009) Indigenous Peoples' Food Systems, FAO Rome/CINE Canada
[19] Gopalan C, Rama Sastri BV and Balasubramaniam SC (2004) Nutritive Value of Indian Foods, Hyderabad, National Institute of Nutrition, Indian Council of Medical Research.

Table 5: Nutrient composition[19] of Bhil traditional foods (per 100 g edible portion)

Food	Energy (kcal)	Protein (g)	Calcium (mg)	Iron (mg)
Cereals and grains				
Pearl millet (bajra)	361	11.6	42	8.0
Sorghum (jowar)	349	10.4	25	4.1
Vegetables				
Doli mahuda seeds	559	9.0	64	7.3
Junglikhand, cooked	63	0.9	31	2.5
Junglikhand, raw	72	1.4	10	0.8
Mokha leaves	111	3.5	831	5.1
Mushroom, dry	272	20.6	94	79.4
Terana leaves	34	1.8	230	0.9
Fruits				
Indian gooseberry (amla)	58	0.5	-	-
Indian jujube (bore)	74	0.8	4	0.5

***Iron rich foods and consumption pattern*:** The ten richest foods in iron content from the traditional food list were analyzed. Figure 4 shows the percentage of families in the study group consuming them. Among the iron rich foods lentils and *bubla* were each consumed by 6 percent of families, followed by mandeli fish, cow pea and crab, which were each consumed by 3 percent of families**.** Dried karonda was the vegetable with the highest iron content, but was not eaten by any families in the study group. Green leafy vegetables such as Bengal gram leaves and *matla* were the next richest iron sources.

Figure 4: Relationship between iron rich foods and Bhil daily consumption



Lack of awareness on food combinations, micro nutrient rich foods and inappropriate recipes for complementary feeding have been noted as some of the main reasons contributing to poor nutritional status among the Bhils. It is therefore crucial to promote existing traditional food systems along with nutrition education among indigenous communities so as to create awareness of the wide diversity of food systems and improve these systems in the context of nutrition and health.

[20] Analyzed at the Food Analysis Division, NIN, India, byDr Bapu Rao.

[21] FAO, in partnership with other UN agencies including UNESCO and multilateral organizations such as the World Bank, launched "Feeding Minds, Fighting Hunger" (FMFH) global education initiative in the year 2007[21]. The aim of FMFH initiative was to transform children into key agents of change by informing and educating them about the problem of hunger, malnutrition and food insecurity, and what can be done to eradicate this.

India: Feeding Minds Fighting Hunger (FMFH) Initiative[21] among School Children

In India, the FMFH initiative was adapted in 24 urban schools in four regions of the country. The FMFH educational package served to stimulate reflection, discussion and action. The model classroom lessons on key aspects of hunger, nutrition and food security were used by teachers to encourage students explore the root causes of hunger and malnutrition. Basic concepts like importance of food, nutrients, food pyramid, importance of dietary diversity, hunger, 3 pillars of food security were explained and taught to the school children via a teaching manual and teaching aids like posters, flip charts, puppets and street plays were also prepared and organized to encourage participation. The initiative targeted children from both affluent urban families and low income urban families thereby instilling in them a spirit of partnership and empathy with the latter. A total of 1641 students were accordingly educated on various aspects of food and nutrition.

A qualitative approach was used to assess the impact of school education using children's responses to pre and post test questionnaires. The post test results showed improved knowledge. Moreover, the school children themselves took active part in the translation of the FMFH manual during an interactive workshop, ensuring that the lessons learnt were meaningful. The initiative was based on the premise that teachers can inculcate a sense of caring and commitment in children, motivating and enabling them to be active participants in the fight against hunger and malnutrition. Table 6 shows the supplementary teaching aids prepared by teachers to adapt the FMFH modules.

Table 6: Supplementary teaching aids used by teachers to adapt FMFH modules

Location	Institution	Aids used
Hyderabad (Urban)	National Institute of Nutrition	Ten posters prepared on nutrition topics identified by teachers Skit covering all concepts highlighted in the FMFH, performed by children's theatre group
New Delhi (urban)	Lady Irwin College	Posters, charts, flip book, stick puppets and flash cards; Nutrition primer for teachers
Mumbai (urban)		Workshops, essay competitions, case studies, social services (literacy) program for children and cooking competitions
Kolkata(urban)	Government school, community, NGO	Charts, games, role plays and demonstrations

Significant changes in children's knowledge and perceptions of hunger, nutrition and food security were observed at the end of the FMFH intervention in the schools where it was implemented. Some of the project teams reached out to other members and of the community through school children who were inspired to work with children from disadvantaged communities. The initiative in India demonstrated that the FMFH materials can be adapted and made part of larger multi sector initiatives to address hunger, food insecurity and malnutrition.

Elements of Success for Duplication and Expansion and Key Actors

The key strategy for success is based on the premise that in order to address issues of dietary improvement and under nutrition on an equitable and sustainable basis, the community needs to be involved in the entire process of developing and implementing the nutrition and developmental projects. The planning process

needs to be developed from measurable indicators which are identified and based on the needs of the participants and that which are essential to build ownership and responsibility for undertaking nutrition relevant actions to improve their community's nutrition.

Establishing nutrition as a priority focus needs to be positioned as central component in household farming systems and interventions. The fact that diversifying types of foods produced and consumed results in higher quality diets and contributes to healthier children and families should be a key message integrated into such programs along with nutrition behavior change communication strategies across agriculture, food and health sectors. Monitoring of outcome indicators namely household/individual/women's dietary diversity (production and consumption), food and nutrient adequacy of diets, improved maternal diets and infant and young child feeding and reduction in child under nutrition should be integrated into the monitoring and evaluation system to build and enhance effectiveness of the interventions.

As part of expansion, identifying and sharing good practices and materials across communities, sectors and related groups will help to strengthen group to group learning and help to enhance impact of the programs.

Major constraints are that several of the elements that have contributed to success and have elicited active involvement of the participants on a pilot level, need to be replicable and scaled up for implementation. In order to create an enabling environment for nutrition oriented programming there is need to adapt current international nutrition recommendations into national policies and guidelines.

Conclusions and Recommendations

The ultimate goal of food based nutrition strategies is to impact on the community situation, lives and nutrition of the population. Household farming, food planning and preparation, young child feeding, family and children's nutrition and health begin at the household and move on to the community level. Fundamental to the sustainability of such programmers is the ability of its members to make enlightened decisions and then be able to implement them.

From a policy and programmatic perspective there is need to enhance availability of nutrient rich foods, including herbs and spices through improved technologies, training and inputs for establishing integrated farming systems within peri urban and urban environments using adaptive models, as applicable.

Combine strong nutrition education programs along with farming and extension systems to enhance the consumption of a variety of foods; and strengthen capacity of agriculture interventions to respond to the requirements of complementary feeding.

Integrate nutrition outcomes into home garden programming performance and measurement systems promote behavior change and mobilize women groups and communities as an essential strategy along with capacity building for nutrition including household members namely grandmothers and fathers in order to better address equitable issues of food distribution and nutrition.

Evoke strong community participation and supportive leadership with appropriate tools and indicators which are keys to implement action for nutrition improvement

1.5. URBAN AND PERI URBAN AGRICULTURE (INCLUDING ORGANIC AGRICULTURE) FOR ENSURING SAFETY OF FOODS

A. Thimmaiah*

Introduction

The increasing trend of population moving towards urban areas is a major concern. Global population reached the seven billion mark in 2011. After the six billion mark it just took 12 years to reach seven billion. The shortest ever time to add one extra billion signals a major shift in both the pace and scale of global demographics. During early 1800 about three per cent of the world's population lived in cities. However, in 2011 there were 480 cities with populations exceeding one million as compared to just 80 in 1950. More than three billion people currently reside in urban areas and this figure is expected to rise to five billion by 2050. Global population growth is overwhelmingly concentrated in marginal urban and surrounding periphery contexts, especially in slums. This geographical shift has tremendous implications for the current and future dynamics of human development (UNDESA 1999, UN 201

With more than half the world's population now living in urban areas, there is a growing interest in urbanization processes and the role of cities in sustainable development. The current trends of urbanization are reflections of the transformations that are being seen in the national economies where farming community are moving away from agriculture to industry and service sectors. (Satterthwaite, 2007; UNFPA, 2007; World Bank, 2009).

It is expected that by 2020 the developing countries of Africa, Asia, and Latin America will be home to some 75% of all urban dwellers which would comprise of 85% of the poor in Latin America, and about 40-45% of the poor in Africa and Asia will be concentrated in towns and cities. Most cities in developing countries have great difficulties to cope with the urban population expansion which is often accompanied by increasing poverty, food insecurity, malnutrition and unemployment. Such rapid urbanization and the harsh reality of urban poverty require sound strategies to ensure adequate food supply and distribution systems to address escalating levels of urban food insecurity and food safety.Urban and Peril urban agriculture provides a complementary strategy to reduce urban poverty, food insecurity and enhance urban environmental management (FAO, 2011).

Urban and Peril urban Agriculture (UPA)

The United Nations Development Program defines Urban and Per urban agriculture as "an industry that produces, processes and markets food and fuel, largely in response to the daily demand of consumers within a town, city, or metropolis, on land and water dispersed throughout the urban and peri urban area, applying intensive production methods, using and reusing natural resources and urban wastes, to yield a diversity of crops and livestock." (Smit et. al., 1996). In other words Urban and peri urban agriculture is growing crops and raising animals within and around cities complementing rural agricultural systems in the production and supply of local food. Also it supports related activities such asthe production and delivery of inputs, processing and marketing of products and serves as an important ecological activity for income generation to supplement the revenues of urban and peri urban families and therefore constitutes an integral component of urban socio economic paradigm.

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UPA also pose food safety risks if not addressed with a scientific approach. Contamination of food may occur at any stage along the value chain; during post-harvest handling when the produce is washed with contaminated waste water from streams and unhygienic food handling. In addition, exposure of the farmers and consumers to risks associated with use of agro-chemicals and untreated sewage is a matter of concern. Some of the factors which cause food safety risks are:

i. Use of synthetic agrochemicals in crops and veterinary drugs in animals.
ii. Use of untreated waste water during production and handling of farm products
iii. Reliance on off-farm fodder, commercial feeds and manure whose source and safety is not assured.
iv. Discharge of domestic wastes and effluents into the open posing great hazard to the crops, livestock and human habitats.
v. Traceability of crop and animal products.
vi. Lack of awareness by producers, traders and consumers on best practices in the production processes and product quality.
vii. Inadequate regulatory enforcement of food/feed safety laws.

Urban and Peri urban Agriculture (UPA) and Food safety

Food safety is very important factor for the success of UPA. Safe produce begins with the good production and handling practices on the farm or production center. It is important to know the potential sources of contamination and minimize such contaminations by adopting Good Agricultural Practices (GAP). The concept of Good Agricultural Practices has evolved in recent years in the context of a rapidly changing and globalizing food economy, world trade, food crisis like, mad cow disease, melamine in baby foods, nitrate pollution of water, pesticide residues in food, soil erosion etc. The concerns and commitments of a wide range of stake holders on food production and security, food safety, quality and the environmental sustainability of agriculture have also promoted the concept of GAP. The 'four pillars' of GAP; economic viability, environmental sustainability, social acceptability and food safety and quality are being widely used in food safety standards.

According to the Food and Agriculture Organization (FAO), GAP is the application of available knowledge to address environmental, economic and social sustainability for on-production and post-production process resulting in production of safe and healthy food and non-food agricultural products. Many farmers in developed and developing countries already apply GAP through sustainable agricultural methods such as integrated pest management, integrated nutrient management and conservation agriculture. These methods are applied in a range of farming systems and scales of production units, facilitated by supportive government policies with an objective to;

- ensure safety and quality of produce in the food chain
- improving natural resources use, workers health and working conditions, and/or
- modifying supply chain governance to meet the market requirements
- creating new market opportunities for farmers and exporters in developing countries.

Now GAP is formally recognized in the international regulatory framework for reducing risks associated with the use of pesticides, taking into account public and occupational health, environmental and safety considerations. This increasing trend of acceptance of GAP by the consumers and the retailers provides incentives to the farmers by paying a premium wherein farmer would find alternatives to reduce the contamination right from the sowing of crop to harvest. GAP applies to a wide range of food/agricultural commodities that include fruits and vegetables, dairy products, medicinal and aromatic herbs, ornamentals, aquaculture etc. (Thimmaiah, 2012)

Risk Minimizing Measures in Urban and Peri urban Agriculture Adopting GAP

Good Agricultural Practices (GAP) is an important tool to reduce the risk in the entire supply chain from 'farm to fork'. The basic principles of GAP can be summarized as follows: clean soil, clean water, clean hands, and clean surfaces. These principles are required to be applied to each phase of production and processing cycle starting from site selection, pre-planting field preparations, production, harvest, and post-harvest to be effective. Such risk minimizing measures are;

a) Pre-planting Measures

i. Site Selection

Land or site for agricultural production in the urban and peril urban setting are selected on the basis of land history, previous manure applications, contamination by waste water, heavy metals, pesticide residues and suitability for farming.

ii. Manure handling and field application

Proper and thorough composting of manure, incorporating it into soil prior to planting and avoiding top dressing on plants are important steps to be followed.

iii. Manure storage and sourcing

Manure is stored in shade with sufficient aeration. It is important that during the aerobic composting process, high temperature need to be achieved to eliminate most harmful pathogens.

iv. Timely application of manure

Manure should be applied at the end of the season to the planned farming area. If manure is applied at the start of a season, then it is spread two weeks before planting

v. Selection of appropriate cmrops

A variety of crops adapted to the local area, resistant to pests and diseases, tolerant to the vagaries of climate should be selected.

b) Production Measures

i. Irrigation water quality

Irrigation water should be free from pathogens and pesticide residues. Surface water is tested quarterly in the laboratory for any contaminations. Farmers can filter or use the settling ponds to improve water quality in urban and peri-urban areas.

ii. Irrigation methods

It is always advisable to use drip irrigation to reduce the contamination because the edible parts of most crops do not come in direct contact with water. It also enhances the water use efficiency.

iii. Field sanitation

Great care to be taken to prevent the spread of human and animal pathogens. Animals especially poultry are not allowed to roam in the field especially close to the harvest time.

iv. Worker facilities and hygimene

The farm workers are provided with hygienic well maintained toilet facilities at the farming sites. Farmers should get proper training to make them understand the relationship between food safety and personal hygiene. These measures are to be monitored and enforced.

c) Harvest Measures

i. Clean harvest aids

Baskets, bins and all crop containers have to be washed and rinsed properly. They should be properly covered when not in use to avoid contamination by birds and animals.

ii. Worker hygiene and training

Good personal hygiene is very important during the harvest of the crops. Employee awareness, meaningful training and accessible rest room facilities with hand wash stations encourage good hygiene.

d) Post-harvest Measures

i. Worker hygiene

Packaging area should be clean and sanitized. The worker should be clean and use disposable gloves on packing lines.

ii. Monitor wasmh water quality

Potable water should be preferably used in all washing operations. Use of chlorinated water to wash the fresh produce is also recommended.

iii. Sanitize packing house and packing operations

Loading, staging and all food contact surfaces should be cleaned and sanitized at the end of each day. Care is taken to prevent rats and rodents, in the packing house. Packaging material should be stored in a clean area.

iv. Pre-cooling and cold storage

Harvested produce to be quickly cooled to minimize the growth of pathogens and maintain good quality. Refrigeration room should not be overloaded beyond cooling capacity.

v. Transportation of produce from farm

Cleanliness of the transportation vehicles is to be maintained. For traceability norms, it must be ensured that each package leaving the farm can be traced to field of origin and date of packing.

Assuring chemical and microbiological safety and improving quality of food supply chain is an important component of food safety. This includes understanding the links between microbial ecology and food safety; developing methods and models addressing the integrity of the food supply chains; new detection methods, traceability and its further development, technologies and tools for risk assessment, including emerging risks, management, and communication, as well as enhancing the understanding of risk perception. This will also include science based methods for risk benchmarking in the field of food safety. UPA warrants a need to develop a comprehensive management strategy and building the capacities of stakeholders to adapt to the changes in urban environment. The implementation of such a management strategy requires knowing, understanding, planning, measuring, monitoring, and record-keeping at each step of the production process. Adoption of GAPs may result in higher production, transformation and marketing costs but can assure the safety of food (Thimmaiah, 2012).

Organic Agriculture and Food safety in Urban and Peri-urban Agriculture (UPA)

By virtue of the emphasis on human values, environment, bio-diversity and animal welfare organic agriculture is distinguished from the modern agriculture. The basic principle of organic agriculture is to provide a platform that ensures high levels of food safety which are based on the preventive or precautionary approach. According to these principles, emphasis is on the preservation of natural basis for life for future generations and preventing actions that cause irreversible damages to the ecosystem. To support such sustainable view, the use of synthetically produced pesticides and other environmentally alien compounds is not permitted in organic farming. By virtue of these prohibitions the risk of pesticide contamination in food is minimized. Likewise genetically modified organisms (GMO's) are not permitted. These bans can

be considered as an alternative and more extensive desire for caution and care in our relations with nature than the assessment of risk that underlies the use of, for example, pesticides in agriculture. The regulation of organic farming is meant to ensure that this type of agriculture lives up to its basic principles. To a large extent the regulation of organic farming and processing results in higher levels of food safety in organic products.

From the perspective of food safety, however, organic food has several advantages over its conventional counter-part which uses synthetic agro-chemicals. The absence of GMOs in organic food, lower concentrations of nitrate in organically produced vegetables and animal products, ban on pesticides in organic farming improves safety by guaranteeing the absence of pesticide residues in organic foods. Finally, the bans on synthetic fertilizers and growth regulators enhance food safety by reducing the concentrations of heavy metals and the residues of growth regulators in organically grown plant products. The restricted use of veterinary medicine in organic animal production improves food safety by lowering the incidence of residues in animal products.

Of particular importance, the regulation of processing results in higher product safety in organic foods, due to the 5% limitation on non-organic constituents in an organic product and the ban on irradiation, coloring agents, sweeteners, synthetic additives, flavorings, GMOs, and trans fatty acids. With regard to the safety of agri-food-systems (i.e. supply, distribution, transparency, proximity, information, consumer influence, and the lack of negative production impacts), although basic safety principles apply to organic farming in all its forms, these need to be translated into regulations. However, the organic label provides the consumer with more information about the whole production process, thereby indicating higher safety with organic products (Hansen et al., 2002)

Organic Agriculture in Bhutan

Bhutan is a small kingdom in the Himalayas with a geographical area of 38,394 sq.kms., comprising over 70 per cent of the area under forest cover. Agriculture in Bhutan is characterized by traditional farming systems with no or minimal external inputs. However since 1980's the synthetic agro-chemicals like fertilizers and pesticides are used in agriculture in selected crops like rice, potato and maize. The use of these chemicals was restricted more to the regions which are accessible by motor able roads.

Bhutan being a mountainous region where farming to a large extent is subsistence type with fragmented landholding, the intensive farming technologies are not viable. Out of about 8 percent of the arable land only 2.93 percent is under agriculture. Organic agriculture is gaining momentum amongst the farmers as an economically feasible, resource conserving and locally adaptable method amongst the alternatives. Owing to the pristine environment there is a growing interest and encouragement from the government to move towards organic farming. Recently the Prime Minister of Bhutan, at the Rio+20 Summit on 19th June 2012, made a declaration that the country is committed to pursue an organic agriculture policy for the future.

Looking into the growing demand for safe produce and also to support the small farmers of Bhutan with organic agriculture technologies, strategies are being developed by the Royal Government of Bhutan (Duba *et al*., 2008 and NFOFB, 2007) with a foresight to achieve the following.

a. To produce safe food of high quality in sufficient quantity.
b. To work within natural systems and cycles throughout all levels from the soil to plants and animals.
c. To maintain the long term fertility and biological activity of soils.
d. To treat livestock ethically, meeting their physiological and behavioural needs.
e. To respect regional, environmental, climatic and geographic differences and (appropriate) practices those have evolved in response to them.
f. To reduce the cost of production and bring down the risks involved in farming.
g. To develop a system of traceability from field to shelf.
h. To introduce good agricultural practices (GAP), fair trade practices and quality control systems.

To support the organic agriculture activities and create enabling environment MOAF has developed the following resources;

1. National Framework on Organic Farming in Bhutan
2. A Guide to Organic Agriculture in Bhutan
3. National Organic Standards of Bhutan
4. Training Manual: Organic Production Technologies in Bhutan
5. Bhutan Organic Certification System

The practice of Organic agriculture is uniquely pro-poor, as it builds on the comparative advantages that poor farmers have, such as the relatively chemical-free land, optimal use of labour and the traditional knowledge of chemical-free production methods.

Urban and Peri urban Agriculture in (UPA) in Bhutan

Bhutan is also witnessing rural to urban migration. During 2012 about 0.8% of the population migrated to the urban areas to escape the rural poverty and finally ending up in urban poverty. Urban migration has lead to the shrinkage of labour force in rural areas affecting the agricultural production in the villages. The urban poverty could be dangerous to the society, particularly because higher rates of unemployment are observed in the youth (Pema, 2012). Looking into the increasing trend of urbanization there is a great opportunity for UPA in Bhutan to address food security, unemployment and food safety.

In Bhutan the UPA activities are at three levels;

- Household, such as backyard or homestead and container gardens,
- Community, such as gardens and farms jointly managed or by individuals
- Institutional, such as farms managed by schools and monasteries.

The Ministry of Agriculture and Forests (MoAF) is creating awareness programs across Bhutan under the 'Accelerating Vegetable Production and Marketing Plan (VPMP)' to enhance national vegetable self sufficiency and to transform vegetable farming system from subsistence to a market-oriented. The farmers are trained in forming cooperatives & farmers' groups, vegetable pricing, nutrition & home gardening and agricultural machinery, irrigations systems and protected (polyhouse) cultivation. The organic agriculture activities are promoted through National Organic program while vegetable cultivation is supported by the Vegetable program. Currently a total of 40,627 acres are under organic management of which 2069 acres are agriculture and horticulture crops with organic intent. The remaining 38,558 acres are under certified organic for wild crafted lemon grass for essential oil in community forests. Backyard or Kitchen gardens are promoted all over the country to cultivate seasonal vegetables in villages, urban and peri-urban areas.

The school children are taught agriculture in their schools through School Agriculture program (SAP) so that more educated youth are involved in farming sector. This would not only provide employment and economic opportunities but also help in combating rural-urban migration and associated social problems. Out of 553 schools in Bhutan 209 schools are the members of SAP. Through Teacher Children Parents (TCP) program vegetable seedlings are grown in the nurseries and poly houses in schools by the teachers and students. These seedlings are given to the parents of the students with a purpose of supporting vegetable cultivation and in turn contributing to UPA. Many school drop outs also take up farming as their livelihood.

Assurance System for Organic Products in Bhutan

Securing high levels of food safety and quality assurance is an important aspect of national and international regulations in organic farming world over. An innovative system called 'Bhutan Organic Certification System' (BOCS) has been developed to provide assurance to organic products. This system utilizes the trained inspectors of Bhutan Agriculture and Food Regulatory Authority (BAFRA) to inspect the farmers groups or cooperatives and certify them by adopting the established traceability systems. In addition the

organic produce will also be analysed for any synthetic agro-chemical residues to assure the produce is within the acceptable Maximum Residue Limits (MRL) for claiming organic status. The certified products will be allowed to use 'Bhutan Organic' label whereby, labeling of organic products facilitates and assures product safety. It is a zero or low-cost certification system for the farmers, where sustainable farming and protection of the ecosystem is ensured.

BOCS is a quality assurance system with focus on local market and potential for exports which is built on the foundation of sound science base. It encourages the small and marginal farmers to form groups or cooperatives and a network of such organizations helps farmers to access the local markets while assuring the organic status. Moreover, BOCS can harness the comparative advantages of the poor farmers such as relatively agro-chemical free land and production methods with abundant traditional knowledge. It will help the farmers to adopt the traceability systems and documentations of all the farm activities which in turn facilitate the inspection process by BAFRA and assure the consumers of the organic intent and in turn food safety. Further, BOCS would help the farmers for market access and developing linkages with various institutions to promote food safety and traceability (BOCS, 2013).

Organic agricultural practices can provide a wide range of solution to the daunting challenges in cities like urban biodegradable wastes which has health and environmental hazard. The biodegradable wastes can be converted into manure or compost and utilized in cultivation of crops. The food wastes from houses, restaurants and food processing units can be transformed into feed for livestock. There is a need to build capacity of stakeholders in a more holistic and integrated approach to urban agriculture research, development, and extension. Creation of a critical mass of urban agricultural professionals and institutions in GAP, Organic Agriculture and developing simple and low-cost solutions to supplement UPA is the need of hour. Appropriate mechanisms have to be developed for coordinated enforcement of product safety, traceability and standards. At the same time there is a need for advocacy and sensitization of consumers to make informed choice about food safety and reduce 'food miles' contributing to climate smart green cities.

Conclusion

Rapid urbanization especially in the developing countries increases urban poverty and threatens food security. Urban and peri-urban agriculture (UPA) provides a complementary strategy to reduce urban poverty and food insecurity and enhances the management of urban environmental. It plays an important role in enhancing urban food security and decreases energy needs and costs associated with long distance travel, refrigeration and reducing the 'food miles' with direct impact on climate change. In addition, UPA contributes to local economic development, poverty alleviation, waste management, environmental services, employment generation, social and gender inclusion of the urban poor and greening the city while ensuring sustainable environmental management and minimal health risks.

Bhutan with its unique paradigm of development has chosen to adopt organic agriculture which can be a basis for addressing food safety and quality. Sustainable organic agriculture practices are an essential tool which can tackle city's problems through innovative ways by environmental stewardship and through appropriate technologies that can transform 'pollution into solution'.

The opinions expressed herein are those of the author and do not necessarily represent the opinion of the Ministry of Agriculture and Forests, Royal Government of Bhutan.

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1.6 IMPACT OF WASTE MANAGEMENT AND UTILIZATION IN IMPROVING URBAN AND PERI-URBAN AGRICULTURE

Permpong Pumwiset*

Municipal solid waste (MSW) compost is increasingly used in agriculture as a soil conditioner but also as a fertilizer. Proponents of this practice consider it an important recycling tool since MSW would otherwise be land filled and critics are concerned with its often elevated metal concentrations. Large amounts of MSW compost are frequently used in agriculture to meet crop N requirements and for the addition of organic matter. The main concern is loading the soil with metals that can result in increased metal content of crops. Further more, in some cases, metals and excess nutrients can move through the soil profile into ground water. Municipal solid waste compost has also been reported to have high salt concentrations, which can inhibit plant growth and negatively affects oil structure. A review of relevant agricultural studies is presented as well as recommendations for improving MSW compost quality. Its safe use in agriculture can been sured with source separation (ortriage of MSW to be composted) as well as the development and implementation of comprehensive industry standards.

Organic wastes are utilized in agriculture mainly for improving the soil physical and chemical properties and for nutrient sources for growing crops. The major source of organic waste used in agriculture is animal manure, but small amounts of food processing and other industrial wastes (along with municipal wastes) are also applied to l and. In the last 35 years, and especially in the last10 years, there have been increasing environmental regulations affecting farms that have resulted in more animal manure treatment options, and thus affecting character is tics of residues that are subsequently applied to land. Farms are being assessed for nutrient balances, with the entire nutrient and manure management system evaluated for best management alternatives. Because of in adequate available land on the animal farm in some cases, organic wastes must be treated and/or transported to other farms, or utilized for horticultural or other uses.

Case Study- Sustainable Organic Solid Waste Management in Nonthaburi Background

The Municipality of Nonthaburi is adjacent to Bangkok. Because of its geographic position it can from the economic and social development of the capital city. The population had migrate to live in Nonthaburi Municipality area, its cause. The waste generation is very high about 360 Tons/day. The organic waste is what cause most problems regarding infection, odors, proliferation of bacteria, etc. Considering that the climate is a semi-humid, monsoon tropical type, with rainy season that lasts from May to September, and with temperatures. That vary from between 25-41ðC. The problem of waste fermentation is extremely high and accelerated. Furthermore, the participation in the project "Sustainable Organic Solid Waste in Nonthaburi" Nonthaburi Municipality can be planning to solve Solid Waste Management Sustainable The project of Sustainable organic Solid Waste Management in Nonthaburi has been cooperated since, March, 2001. The project foresees solving the problem of solid Waste Management because of the disposal site of Nonthaburi can't manage for sanitary land fill. Waste accumulates in these areas and the leach ate contaminates the land, water and the area creating health problems and Environment Impact. The project intends tackling this problem in an integrated manner, helping Nonthaburi municipality set up a waste disposal plan, making new plans for the waste collection system and solving the problem of organic waste with the introduction of differential collection (wet/dry) from the major producers of organic waste: market, restaurants and hotel. By building a compost station, organic waste collected will be eliminate and turn in to fertilizer for agricultural used.

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Objective

- Improve the quality of life of Nonthaburi population living near waste disposal areas.
- Reduce the quantity of organic Solid waste in the area of transitory waste deposit.
- Introduce a more efficient system of waste collection, rationalizing the haulage system- — Sensitizethemajorproducersoforganicwasteandthepopulationtotopicslinkedtotheimpactofwaste disposal and the distribution of waste container.
- Introduce an integrated solution to the problem, eliminating organic waste and those composting plant with Entsorga Technoltrans forming it into an environmentally usable resource. –Actively involve the major producers of organic waste, involving the mandoffering the biochemical degradation of organic materials to a sanitary, nuisance-free, humus-like material. Scientific composting has been described as a rapid but partial decomposition of moist, solid, organic matter by the use of aerobic micro organisms under controlled condition. Modern composting is anaerobic, thermophilic, biochemical process that with the assistance modern of mechanical equipment and controls is faster and more effective than older, relatively slow, mesophilic and anaerobic processes. The stabilization of organic matter in a modern composting process is accomplished by bacteria and other micro organisms that use large volume of oxygenandproduceconsiderablequantitiesofheatTemperaturesof50–60C, which can destroy disease producing organisms, are maintained relatively easily.
- Incentives to cooperate in a project taimedat solving a problem.

Methodology

Equipment of Composting

1. **Bio-cell**ismadefromanticorrosivesteel.ThedutyofBio-celliscomposterinthe first phase of stabilization (14days).

2. **Bio-filter** is made from anticorrosive steel, contain the hard wood and coconut fiber. The duty of Bio-filter is absorb odors from Bio-cell
3. **Curing Room**: there are many spigots for air supply under the floor. The duty of curing room is the curing phase of composting (76days)

4. **Filter Room**, inside filter room contain hard wood and coconut fiber. The duty of filter room is absorb odors from curing room.

5. Aeration system supply oxygen in Bio-cell and Curing room and suction odors to Bio-filter and Filter room.

Process of Composting

- Organic waste such vegetable scraps, fruit peelings, etc. were separated from market and
- transfer to composting plant.
- Separated no compostable such as glass, metal, plastic, rubber and hazard waste
- Mixed organic waste with coconut and grinding tree by mixing ratio 2: 1: 1
- Upload mixed material in Bio-cell, spray water cover compost in Bio-cell and aeration 14
- days. Begin spray water and aeration 10 min every hour.2 min every 8 hours.
- After 14 day, download compost from Bio – cell and transfer to curing room in row
- high 1.8 wide 2.5 m. Begin spray water 3 min every 8 hour and Aeration 45 min every hour.

Product of Composting

Nonthaburi organic fertilizerformula1

Characteristic of Nonthaburi organic fertilizer formula 1

Parameter	Sample1	Sample2	Sample3	Standard
pH	8.1	8.4	7.5	5.5-8.5
Moisture(%)	73	60	57	50
Organic Matter(%)	37.1	33.7	32.1	30
Organic Carbon(%)	21.92	19.59	20.54	20
Total-Nitrogen(%)	2.17	1.93	2.05	1.0
Total-Phosphorus(%)	1.01	2.19	1.12	0.5
Total-Potassium(%)	1.40	3.18	1.35	0.5
C/N ratio	10.10	10.15	10.02	20:1

Case Study the Bio-fertilizer Plant under the Guidelines of

The Royal Development Project

Background

"*—the slurry from septic tank sand cess pools collected by municipalities has been found to discharge into canals and rivers. If there is a place out of the town and construct the digestion tank stouse as the digesters for10 days. The slurry or waste matter will be changed and the pathogenic contained in liquid waste will*

be destroyed. For the better sake of qualities the longer period of digestion last long upto 28 days will be complete digestion for all pathogens destruction and the odor will disappear too. The dry solid material remained on the sand beds will be useful as solid fertilizer, and the effluent form the under drain of san beds is used as liquid fertilizer. Both kinds of the fertilizer have no odor. The municipalities usually have been faced with these problems. They should consider what be done…"

-The address given by H.M. the King in the occasion of H.M. Birthday Celebrations, Dec 4, 2001, Dusitdali Hall,In 2006, under the guideline of the Royal Development project, Bio-fertilizer Plant was constructed to process collected human waste residues from house hold septic tanks to an organic fertilizer.

Methodology

The human waste residue treatment of the Nonthaburi Municipality is based on an aerobic digestion process as guide-lines of the Royal Development Project. The treatment process is occurring in a bio-tank (reactor) consists of an aerobic digestion tank by the batch type addition of anaerobic digesters to the sewage sludge over a period of one day. The reactor is there after sealed. At then do faduration of 28 days, the slurry is drained rom the reactor to the sandbeds, the slurry remained on the sandbeds is left for sun drying and touse as solid fertilizer. The effluent filtered through the sand layer to be used as liquid fertilizer.

Major Component

1. Digestion tanks

There are 31 rein force concrete tanks. The digested tank is 4x5x2.5 meters to keep the slurry volume about 40 cubic meters. Each tank consists of vent tube, man hole and gate valve. The waste in the tank will discharge to the sandbed next to the tank as the final treatment of the slurry at the end of the time.

2. Sandbeds

The sand bed chamber is masonry type with the size of 4x5x1.2 meters. One sandbed is designed for the one digestion tank. The sand bed consist of under drainpipes, stoneno.2, stoneno.1, coarsesand 20,10,10 cm., respectively. The plastic wire screen sheet is laid on the top surface of the sand layer touse for solid separation after drying.

3. Effluent storage pond

The effluent storage pond is an open outdoor pond with size of 8x16x1.50 meters. It is used to collect and impound the liquid waste discharged from the sand bed which will be used as liquid fertilizer.

4. Fertilizer storage building

The building is 9x12 meters to be used for collection, mixing, packing of solid fertilizer "Nakorn-nonth Fertilizer no.2" the fertilizer is usually sold out to the farmer sand gardeners 5 tons/ month in average.

The treatment process

1. The slurry form mobile vacuum trucks is put into an anaerobic digestion tank (1tank/1 day)
2. Micro organisms present in nature will digest organic residues and other waste matters under an aerobic condition for 28 days. At the end of duration of 28 days, the digested slurry is drained from the tank to the sand bed.

Product of Composting

Nonthaburi organic fertilizerformula2

Characteristic of Nonthaburi organic fertilizer formula

Parameter	Result	Std.
pH	6.2	5.5-8.5
Moisture, % by weight	8.50	≤ 35
Total Nitrogen,% by weight	3.40	≥ 1.0
Total Phosphorus,% by weight	2.70	≥ 0.5
Total Potassium, % by weight	0.30	≥ 0.5
Organic Carbon, % by weight	30.41	_
Organic Matter, % by weight	52.43	≥ 30
C/N	9/1	≤ 20:1

1.7 VEGETABLES FARM IN SCHOOL AT SI SA KET PROVINCE

Jirapa Austin*

The paper was derived from reviewing, rapid interviewing and system analysis for the paper presentation in the Regional Workshop on Strengthening Urban and Peri Urban Agriculture (UPA) Towards Resilient Food System in Asia, Bangkok, Thailand in January 28-30, 2013. The study revealed that community garden or UPA is becoming popular in Si Sa Ket Province, originally establishing from school garden. There are all most the same cultural practices as Urban Agriculture as Rural Agriculture. However, only few or slightly differences in term of scale of farming, container, and price of the product. A case study in school garden in the province derived from several schools whereas a success example are prominent from Rajaprajanugroh 29 Si Sa Ket School and Si Sa Ket College of Agriculture and Technology. The school garden comprising of many activities e.g. organic vegetables, hygienic vegetables production for sale project, and the law of the land responsibility and teamwork as a guideline of the project. The activities of the project create discipline, regulation, marketing and household account recording skill beneficial the student. This achieve is consider a major outcome of the project creating benefit for a future smart farmer from a very beginning young generation.

Introduction

Thailand is an agricultural country. More than 50% of Thai population (63 Million people) engaged with agriculture sector. The total area of 51 million hectares, farm holding is about 21 million hectares, consisting of 5.67 million farms with an average farm size of 3.7 hectares. In 2007, Thailand was rank 7th for world exporter of agricultural product and food sector with value of $ 24,681 million or 2.52 % of world export. Thailand is also largest exporter of rice, rubber, tapioca, pine apple products, canned tuna and shrimp products. According to COMTRADE statistic in 2005, export of fresh fruit and vegetables (FFV) was accounted $ 511 million or 3% of agricultural commodity and food sector .The major FFV for export are longan, durian, asparagus, and baby corn. The Thai gross regional product per capita (GRP) showed high disparity between the Bangkok & vicinities, the highest level at Baht 329,885 per annum, and the Northeast, the lowest level at Baht 45,766 per annum. The difference was 7.2 times. The highest per capita GRP started from Bangkok & vicinities, the East, the Central, the West, the South, the North and the Northeast, respectively. Gross provincial product per capita (GPP) showed that the high per capita GPP lessen to Bangkok & vicinities, the East, the Central, and the South while the low per capita GPP was the Northeast. The largest gap in per capita GPP emerged in Rayong, the highest, and Nong Bua Lan Phu, the lowest, whose per capita GPP stood at Bath 915,195 and 33,912 per annum, respectively. It was 27.0 times difference and showed narrower gap. In 2009, the provinces with five highest per capita GPP were Rayong, Samut Sakorn, Phra Nakhon Sri Ayuthaya, Samut Prakan, and Chonburi, respectively. In contrast, Nong Bua Lum Phu, Am Nat Charoen, Si Sa Ket, Yasothorn, and Nakhon Phanom were in the five lowest per capita GPP, respectively. (There are 76 provinces in Thailand. Si Sa Ket province was 74th lowest per capita GPP)

Si Sa Ket province

Si Sa Ket province as one of Thailand's lower northeast provinces, Sisaket is located 515 kms (by train) or 600 kms (by car) away from Bangkok and 60 kms from the Ubon Ratchathani International Airport. The Province covers an area of 8,839 sq.kms. The topography of Sisaket features highlands sloping north until the Moon River, basin plains in the north, highlands close to the Phanom Dong Rak Mountain Ranges in

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the south. The province is subdivided into 22 districts (Amphoe). The districts are further subdivided into 206 sub districts (tambon) and 2411 villages (muban). Climate is dry and very hot in the summer. Windy and very cold in the winter. Influenced by northern wind from China.

Economic Factor

Forestry: Fertile tropical forests are normally located in Amphur Khukhan, Amphur Khun Han and Amphur Kantharalak.

Livestock: Pig and chicken farming are outstanding, but only as a secondary source of incomes.

Paddy rice farming: Paddy and glutinous rice farming is widely found in the province, not only for consumption, but for sale.

Fishery: The Moon River including mountain streams, natural ponds and irrigation dams are major sources of fishing.

Industry: Industrial factories found in Si Sa Ket include timber mills, jute mills, paddy rice mills, cassava mills, ice-making plants and stone-grinding mills. The family industries are silk cloth weaving, cotton weaving, weed mat weaving, loom making, wood carving, metal works, gifts making, palm leaf basket and dyeing.

Commerce: Local products and agricultural products are directly sold in markets mostly located in town and public health.

General objective of the study is to provide information and recommendation relating urban and peri urban agriculture to be inspired those policy maker public sector where specific are:

- To integrate and encourage stakeholder urban agriculture to make preparation on securing food farm, environmental greening and job creation.
- To initiatives regarding identification and formulation of projects on the development of urban agriculture in Si Sa Ket province.

Methodology Used

Several methods have been used in this report, mainly derived from reviewing, rapid interviewing and system analysis. Many tools were combined i.e. qualitative and quantitative information, statistics and survey. Secondary reviewing data were obtained from several published and unpublished literatures.

Vegetable Production in Si Sa Ket province

The production of vegetable in Si Sa Ket provincein 2010 found that there are farmer households 33,181 and harvesting area is 10,907.52 hectares. Shallot garlic and chili are the famous plants. Shallot is the highest planting area in Si Sa Ket and also in Thailand. (Table 1).

Table1 Vegetable Production in Si Sa Ket province in 2009

No.	Vegetables	Household	Harvesting area (Hectares)	Products (Tons)	Products/hectare (Kilograms)
1	Garlic	639	67.92	484.97	182.72
2	Cauliflower	32	7.52	84.10	286.24
3	Cabbage	20	3.20	38.00	304.00

No.	Vegetables	Household	Harvesting area (Hectares)	Products (Tons)	Products/hectare (Kilograms)
4	Garlic chives	6	1.12	9.65	220.48
5	Kale	262	54.48	467.30	219.52
6	Short Cucumber	307	46.36	494.08	272.80
7	Long Cucumber	1	1.12	8.40	192.00
8	Water melon	268	83.36	1,412.90	433.92
9	Yard long bean	386	74.88	663.59	226.88
10	Luffa	30	6.08	42.85	180.48
11	Choi sum	187	22.08	181.60	210.56
12	Chinese cabbage	59	5.76	71.00	318.24
13	Cilantro	81	10.32	79.85	198.08
14	Culantro	28	6.08	114.00	480.00
15	Kong-kang	208	32.72	308.35	241.28
16	Chili	18,525	4,781.40	112,314.12	601.28
17	Pumpkin	57	20.72	299.00	369.76
18	Tomato	182	13.52	178.80	338.56
19	Asparagus	269	19.04	172.55	232.00
20	Shallot	11,064	5,585.37	104,600.50	479.36
21	Multiplier onion	126	10.88	123.20	289.92
22	Leaf mustard	157	6.88	49.40	183.84
23	Sweet bamboo	7	3.20	13.00	208.00
24	Hedge bamboo	114	17.28	145.50	215.52
25	Lemon grass	109	12.64	32.10	64.96
26	Lettuce	39	3.36	24.00	182.88
27	Wax gourd	18	10.24	128.50	321.28
	Total	**33,181**	**10,907.52**	**222,541**	

Source: Adapted from Si Sa Ket Agriculture Office, Department of Agricultural Extension

Farm in School or School Garden

School gardens are a wonderful way to use the schoolyard as a classroom, reconnect students with the natural world and the true source of their food, and teach those valuable gardening and agriculture concepts and skills that integrate with several subjects.

The Benefits of a School Garden

Nature as teacher: The experience of seeing seed, soil, water and sun come together to transform into a tiny plant is a lesson in itself, and one not soon forgotten. Learning to appreciate the wonder and power of nature is the core of an environmental education. Planting a seed teaches students about the need to protect our natural resources, since clean soil and water are necessary for the plants to grow. Children learn that we need to preserve open land for food crops, trees and enjoying nature. By tending the garden and taking care of their environment, they see that they are helping nature make the magic happen.

The Law of the land responsibility and teamwork: The fundamental rule of farming is that it takes responsibility and teamwork. If you don't water your garden, your plants will die. If you don't weed the garden, the weeds get worse and you have to work harder later to get the job done. Children learn how to be responsible by taking care of something and seeing the consequences when they don't do the work. Gardens also provide a wealth of opportunities for teamwork. Students need to work together to prepare the soil, plant the seeds, water the plants and stay on top of the weeding. These opportunities to take responsibility and work with others can build students' self-esteem, and watching their garden grow is the sign of their success.

Hands-on learning Gardens provide a wealth of opportunities for kids to get their hands dirty while learning lessons in many different areas of curriculum. Students can study plant anatomy and botanical life science, and those are just the beginning. Young scientists can change variables in the garden, then collect data on plant growth, chart the research and write up their analyses and conclusions.

School gardens can take variety of forms, from the simplest containers outside a classroom to a multi-plot, in-ground garden featuring seating areas and a greenhouse.

Why Choose Organic?

Pesticides are chemicals used to control insects, diseases, and weeds that destroy or damage crops. After application, a certain amount of a pesticide is broken down by sunlight, water, and microorganisms. Usually, the breakdown products are inactive, but a few are more toxic than the original chemical. The amount of pesticide that remains on raw food is called a residue. Processing procedures, storage condition, and cooking can reduce the amount of pesticide residue in food. Recently, concern has grown about the possible effects of pesticide on food, health, and environment. Exposure to some pesticides causes immediate health problems. The scientists are developing other ways to combat pests. One of the best ways to limit exposure to pesticides is to landscape and garden without them or with minimal use of them. Home gardeners and professional farmers can practice integrated pest management (IPM), a strategy for controlling pests through a combination of biological, cultural, and chemical method. IPM techniques include using insect predators and other natural enemies of pests, bacteria that attack insects, companion planting, plants bred for insects resistance, crop rotation, physical barriers, timing harvests to avoid infestation, and applications of carefully timed and often reduced amounts of pesticides when needs.

Another option is entirely organic farming, which avoids synthetic fertilizers and pesticides altogether. But this is difficult to do using modern farming practices. Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system. Some people believe the world would be much better off with fewer or even no pesticides.

Organic Agriculture in Thailand

Thai organic agriculture is at the beginning of the take-off stage. The development so far is largely in the hand of farmers and private sector while government supports are developing but still lacking behind. Its development has capitalized on the country's strengths by focusing on organic rice and vegetable production. The majority of organic producers are family farms organized under grower group program or organic projects. The predominant organic agriculture in Thailand is crops, especially rice, vegetables and fruits.

A couple of wild products like honey exist. There is growing number of certified aquaculture productions and a few organic livestock. Several producer groups produce organic rice, most of which is the jasmine rice. Most of the rice is exported (mainly to European markets) and small quantity is sold domestically. Vegetables are the second most important organic crops. They are fresh vegetables and baby corn. Majority of fresh vegetables is sold in Thailand while baby corns are all exported. An estimate of 30,755 hectares of farmland is presently now under certified organic management. This represented around 0.15 % of the total farmlands. Since gaining the IFOAM-accreditation at the end of 2002, the Organic Agriculture Certification Thailand (ACT) is the first and the only Thai organic certification body that can offer internationally-recognized organic certification services. Established in 1995, ACT is an independent private certification body. ACT's standards include crop, wild product harvest, aquaculture, processing and handling. In 2007, ACT helped to organize a regional collaborative platform of organic certification bodies in Asia, Certification Alliance to provide one-stop inspection services to organic operators in the region. Several local certification bodies also exist offering services for specific regions or at national level but for limited scope. The Northern Organic Standards Organization (private organization) certifies organic crops in the Northern Thailand, the Organic Crop Institute (Department of Agriculture) offers certification of crops (except rice), Department of Rice offer certification for organic rice, Organic Aquaculture Farm and Product Certification Center (Department of Fisheries) offers certification for aquaculture and Department of Livestock offer certification for livestock. There are also several foreign certification body operating in Thailand, mainly from the European Union. In 2002, the National Office of Agricultural Commodity and Food Standards (ACFS) completed a national production and processing guidelines of organic crops, livestock, and shrimp production. The guideline is supposed to be used for national organic accreditation. At the moment, only ACT is accredited by the ACFS.

Organic markets reliable sources of data on organic produce are hard to find. The situation is confused by the various standards or systems of certification for organically produce and other safe produce (with no organic certification). This made it impossible to categorically differentiate between the two markets. Despite such limitation, Green Net and Earth Net Foundation estimates the total market for certified organic produces in 2009 at US$ 135.44 million, around half of which is sold domestically and the another half is exported. Currently, there are 3 channels where such products are sold, i.e. supermarket chain, specialized shops, and direct marketing (either farmer market or membership). In supermarkets, organic and/or "health" products are sold in the same way as conventional products, e.g. on the same product shelves. Only when there is product promotion or on special occasion, then organic and health products are displayed separately. Main products sold through supermarket channel are fresh fruits, vegetables, and rice. None of these supermarkets makes explicit advertisement campaign on the availability of the organic and health products. In specialized shops, organic and health foods are the main feature of the shops. Due to limited assortment of organic products, these shops have to carry many conventional health food items. Even organic products are still much more predominant but there lacks a clear identification or labeling to separate the different product quality. Consumers shopping in these shops often assume that all products there are "green and/or healthy". Direct marketing through farmer markets gain popularity in recent years and a few sell through membership scheme. The direct markets normally focus only on fresh produces.

Farm in School: Case Study from Si Sa Ket College of Agriculture and Technology

The Arava Alumni Project

The students who participated with in Arava International Center for Agriculture Training (AICAT)atArava, Israel. They've got agricultural experiences from internship. Arava region is mainly desert but 90% of its residents are successful farmers that one of the amazing for them. The Arava alumni project is planted

hygienic vegetables production, open field with sprinkler and drip irrigation systems. They are sold their products to the college's minimart, canteen and at the vegetable kiosks in front of the college.

The Benefit

- Guideline to job after their graduation
- Net income from the project more than 7,000 baht per person
- The students are the most diligent, patient and train self-behavior i.e. being on time for working

Hygienic Vegetables Production for Sale Project

This project is part of teaching vegetable production of diploma course at the college. The objective of the project that is carrying on the motto of future farmer of Thailand organizations are;

- Learning to do
- Doing to learn
- Earning to live
- Living to serve

They are learning many new things about growing vegetable such as cultivation and planting, the types of vegetables, how to make compost and extracted plant, pest and weed control, hydroponic and greenhouse growing, watering and irrigation systems etc. Each class works separately from the others. The class is worked on their own garden. A garden diary is kept for the whole class and rotating tasks. The vegetables products of the project is sold to the college's minimart, canteen and at the vegetable kiosks in front of the college.

Farm in School: Case Study from Organic Farm in Rajaprajanugroh 29 Si Sa Ket School

Rajaprajanugroh 29 Si Sa Ket School, the Welfare Education School, was located at Moo 2, Tambon Nong Krok Amper Muang, Si Sa Ket Province. There is established on July 27, 1994. Received students in Surin and Si Sa Ket Province. The school throughout Thailand take in children of the following backgrounds: 1) Children forced to enter the labor market 2) Children who are sex workers 3) Deserted Children/Orphans 4) Children in observation and protection centers 5) Street children 6)Children affected by HIV/AIDS 7) Children of the Minorities 8) Physically abused children 9)Impoverished children 10) Children affected by narcotic drugs (Source: Ed. Research and Development Bureau, OEC and Office of the Basic Education Commission, Bangkok, Thailand) The students can live in the school. This school manages education by the speech of His Majesty the King and Her Royal Highness the Princess Mother Queen for teaching poor students. It opened from Elementary to high School Education, 12 levels. There are about 833 students live in the boarding school.

Total area 41.28 hectares. Growing organic vegetables are easy activities to do in the welfare lifestyle. This activity can build good habit for students. They can learn by doing: manage their area around the houses and dormitories, make vegetable bed, harvest plants, sell product at the market and canteen, make an account by themselves and also leaning how to live and work with others in dormitories and houses. So at Si Sa Ket Welfare Education School, eligible upper level students have the opportunity to room together and plant vegetables or fruit to sell or consume. Small communities are overseen by a resident teacher but the students learn to govern themselves.

Vegetables were grown: morning glory (kong-kang), cabbage, coriander (cilantro), lettuce, radish, water melon etc. The materials for growing beautiful vegetables are animal manure, compost, black chaff, rice husk, fermented plant, biological extracts to repel insects, mulching with straw or dried leaves. They are sold vegetable products to the canteen and to the urban market "Walking Street" in downtown. Organic vegetables were grown in school garden divided in to three groups depending on their housing available i.e. in dormitory, at home garden and others. All of them do farming during holidays, before and after having class room using micro financial for freely interest. As a result, organic vegetables were supplied to school kitchen as much as 200 kg. /day. Incidentally, the activities create discipline, regulation, marketing and household account recording skill beneficial the student. Moreover, the vegetable products satisfied ACFS, "Q" standard and "Organic Thailand's Brand" of the Department of Agriculture, Ministry of Agriculture and Cooperative, Thailand.

Conclusion

Community garden (UPA) is becoming popular in Si Sa Ket Province, originally establishing from school garden. There are all most the same cultural practices as Urban Agriculture as Rural Agriculture. However, only few or slightly differences in term of scale of farming, container, and price of the product. A case study in school garden in the province derived from several schools where a success example are from Rajaprajanugroh 29 Si Sa Ket School and Sisaket College of Agriculture and Technology. The school garden comprising of many activities e.g. organic vegetables, hygienic vegetables production for sale project, and the law of the land responsibility and teamwork as a guideline of the project. The activities of the project create discipline, regulation, marketing and household account recording skill beneficial the student.

Organic Thailand's Brand

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1.8 THE WOODFUELS INTEGRATED SUPPLY/DEMAND OVERVIEW MAPPING (WISDOM) METHODOLOGY

Roger Steinhardt*

1. Executive Summary

The "Woodfuel Integrated Supply/Demand Overview Mapping" (WISDOM) is a spatial-explicit method for highlighting and determining priority areas of intervention and supporting wood energy / bioenergy planning and policy formulation and is supported through the FAO Wood Energy Program. WISDOM supports strategic planning and policy formulation, through the spatial integration and analysis of existing demand- and supply-related information and indicators, and by modeling access patterns to supply sources.

2. Title, aims and objectives of programme/project.

The objective was to review of the nexus between rapid urbanization processes, poverty and woodfuel consumption trends in the urban and peri-urban areas of developing countries. Development of analytical methods and planning tools aiming at a sound and objective definition of urban/rural interaction in order to support urban wood energy planning and policy formulation.

3. Background

The Woodfuels Integrated Supply/Demand Overview Mapping (WISDOM) methodology was conceived as a partnership between the Wood Energy Programme of the FAO Forest Products Service (FOIP) and the Ecosystem Research Center (CIECO) of the Institute of Ecology of the National University of Mexico (UNAM).

4. Strategy and Scope, Inputs and Output expected.

WISDOM supports strategic planning and policy formulation, through the spatial integration and analysis of existing demand- and supply-related information and indicators, and by modeling access patterns to supply sources. It provides relative/qualitative values such as risk zoning or criticality ranking, highlighting, at the highest possible spatial detail, the areas deserving urgent attention and, if needed, additional data collection. In other words, WISDOM serves as an assessing and strategic planning tool to identify priority places for action WISDOM is based on: a) the use of geo-referenced socio-demographic and natural resource data bases integrated within a geographical information system framework; b) a minimum spatial unit of analysis at sub-national level, c) a modular, open, and adaptable framework, that integrates information of relevance to wood energy from multiple sources; and d) a comprehensive coverage of woodfuel and biofuel resources and demand from different energy users. Special attention is paid to an accurate coverage of the existing patterns of "traditional biomass energy use", such as fuelwood and charcoal use in households and small industries.

5. Methodology used

The WISDOM methodology is to map woodfuel surplus and deficit areas in terms of local supply/demand patterns and to define and map urban woodsheds. The new Woodshed Module is used to analyze the location of hypothetical biomass plants or the supply zone of existing ones. Through the study the aim was to develop

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the first conceptual, methodological and technical definition of "urban woodshed" as the potential sustainable woodfuel supply zones of cities.

The methodology may be divided into two sequential phases/contexts of analysis:

- WISDOM Base. This phase includes the analysis over the entire territory of the study area.
- Woodshed analysis. This second phase of the analysis uses the result of the WISDOM Base to delineate the sustainable supply zone of selected consumption sites. Depending on the scale and objectives of analysis, the selected sites could be urban centers, rural villages or existing/planned biomass plants.

The application of the standard WISDOM analysis producing supply and demand balance mapping at the local level involves five main steps.

1. Definition of the minimum administrative spatial unit of analysis.
2. Development of the demand module.
3. Development of the supply module.
4. Development of the integration module.
5. Selection of the priority areas or woodfuel "hot spots" under different scenarios.

The analysis for the delineation of woodsheds, i.e. supply zones of specific consumption sites requires additional analytical steps that may be summarized as follows.

6. Mapping of potential "commercial" woodfuel supplies suitable for urban, peri-urban and rural markets.
7. Definition of woodshed, or potential sustainable supply zones, based on woodfuel production potentials and physical accessibility parameters.

6. Application and targeted beneficiaries

The woodshed analysis is implemented over selected cities in East Africa (Dar-es-Salaam, Arusha-Moshi, Kampala and Khartoum) and Southeast Asia (Phnom Penh, Battambang, Vientiane and Luang Prabang). The studies reveal how deeply the supply zones extend into rural areas and forests, with woodfuels often travelling several hundred kilometers to reach urban consumers, and highlight the essential contribution of wall-to-wall analysis in the definition of the zones of influence of individual cities.

7. Study Results

This study examined the environmental and socio-economic changes induced by rapid urban growth and proposes conceptual and methodological tools to support urban wood energy planning and the establishment of sustainable wood energy systems. From a "WISDOM" perspective, the main result is the conceptual, methodological and technical definition of "urban woodshed".

To support operational wood energy planning within priority areas defined at the strategic level, the study presents the features and parameters to be collected for accurate wood fuel flow analysis and discusses best practices in urban and peri-urban land management for the integration of wood fuel production in multifunctional urban forestry.

8. Elements of success for duplication and expansion and key actors.

WISDOM can be used to analyse woodfuel demand, including: updating/upgrading of the Demand Modules of WISDOM and completing value chain and socio-economic analysis of the Wood Energy sector. In terms

of expansion of the program an example was an activity was carried out in the framework of the FAO Programme "Sudan Institutional Capacity Programme: Food Security Information for Action" (SIFSIA) FAO OSRO/SUD/620/MUL. The study provided a comprehensive diagnostic of the difficult wood energy situation of Sudan, revealing a negative supply/demand balance even under the most optimistic scenario. The results show also that 20% of the rural population of the Country, i.e. some 4.4 million people, live simultaneous conditions of marked poverty and woodfuel deficit. The study supported the evaluation of main policy options, considering different LPG penetration regimes and woodfuel import regimes, which were discussed in a policy brief.

There is also an on-going WISDOM study in Rwanda. The update and upgrade of WISDOM Rwanda is currently in progress. Scope of the analysis is to support the formulation of the fuelwood and charcoal supply master plan for Kigali. The activity is carried out in the framework of the Programme d'Appui au Développement du Secteur Forestier PAREF -B2 (Belgian cooperation), for the Department of Forests and Natural Conservation (DFNC), Rwandan Natural Resources Authority (RNRA), Ministry of Natural Resources.

Another example is the **c**ompleted WISDOM analysis in N'Djamena Woodshed in Chad - The study was carried out in the framework of the FAO Project "Appui à la formulation d'une stratégie nationale et d'un plan d' actions de foresterie urbaine et périurbaine à N'Djaména, République du Tchad" TCP/CHD/3203D. The analysis permitted the delineation of N'Djamena area of influence including urban, peri-urban and woodfuel supply zone. The analysis supported, from the wood energy perspective, the formulation of a national urban and peri-urban strategy and action plan and the preparation of an urban and peri-urban forestry programme for N'Djamena.

9. Major constraints

Some major constraints include limited institutional and technical capacity as well as the financial constraint for many countries to undertake this analysis at a national scale. It is difficult at times to obtain reliable information, including the estimation of the current consumption of woodfuels in the commercial and public sectors and of the consumption of construction material.

10. Conclusions and Recommendations

The comprehensive and spatial-explicit vision of supply and demand is an essential pre-requisite to wood energy planning and strategy formulation at local and national levels and synergies among institutions for an integrated multi-sectoral approach are absolutely vital. In the case of Rwanda WISDOM Rwanda provided a first comprehensive and spatially explicit vision for Rwanda, thanks to the application of the WISDOM methodology and to the knowledge shared by institutions and to some new data.

It is a strategic planning tool to be maintained, deepened and, most important, used by forestry and energy and rural development planners concerned with wood energy. In this respect, the analytical conclusions, thematic maps and tables developed should be considered as the first step in the analysis of this sector and not its conclusion. The integrated analysis of woodfuel deficit and poverty, for instance, or the nexus between woodfuel deficit, use of residues and soil fertility are only introductory examples of the analyses that can be made. In fact, the main result of the activity is the WISDOM geodatabase, more than the single table and map that have been produced in the process, and the possibility to "refresh" the system with new reliable parameters as they become available.

On a more general perspective, the WISDOM analysis produces, or is expected to produce the following benefits:

- Holistic vision - For the first time the wood energy issue can be visualized and analyzed over an entire country maintaining at the same time a local perspective.
- Priority areas definition - The local perspective and national consistency of analysis and parameters permits the identification of priority areas of intervention and/or further analysis.
- Valorization of existing data/knowledge - The need to feed the WISDOM modules with the best available information on supply and consumption aspects implied the review and use of every piece of information, study, survey etc. ever done over these subjects in the country, thus attributing factual value to such knowledge and offering a comprehensive context of analysis to information otherwise fragmented.
- Critical data gaps definition - A thorough review of the information available allowed the identification of data gaps that are really critical for a good understanding and for the formulation of sound policies.
- Optimize available resources - The identification of priority areas of intervention, in geographic as well as thematic terms, allows circumscribing and focusing future actions (resource management, additional data collection, etc.) and thus enhancing the efficiency and reducing the costs of such actions.
- Promote cooperation and synergies - The inter-sectoral and interdisciplinary character of WISDOM implies the exchange of information among agencies and it favors the discussion about the multifaceted wood energy "sector" over a common shared ground built with the contribution of each party. It is hoped that the use and maintenance of the WISDOM geo-database will further strengthen these liaisons and inter-agency collaboration in the future.
- Enhance visibility and political recognition - The integration of various aspects and the cartographic representation of result makes WISDOM easy-to-visualize and to some extents it makes a complex issue simple and, to some extent, attractive.

2 REVIEWS AND PROSPECTS

2.1 ENHANCING MULTI-STAKEHOLDER COLLABORATION AND INVESTMENT IN URBAN AND PERI-URBAN AGRICULTURE

P.G. Chengappa*

Agriculture is commonly considered as the quintessential rural activity, and urban agriculture is often perceived as archaic, temporary, and inappropriate. Some consider it marginal at best, perhaps a constructive recreational activity or an aesthetic function that helps to beautify the ugly city. In fact, urban agriculture is a significant economic activity, central to the lives of tens of millions of people throughout the world. It is a rapidly growing industry that is increasingly essential to the economic and nutritional security of urban residents and has far-reaching economic, environmental, and health implications throughout world in recent years. The number of activities to promote urban agriculture at international, national and local level has grown, but urban farmers in many cities in the world still struggle to get their main survival strategy recognised by city or town authorities. The demand of policy makers and local practitioners for inspiring examples of successful policies and actions in cities is therefore growing. Urban agriculture contributes to a wide variety of urban issues and is increasingly being accepted and used as a tool in sustainable urban and peri-urban region development. Currently, the challenge is to integrate UPA into city or town planning and facilitation of its multiple benefits for urban inhabitants through multi-functional stakeholders' collaboration.

Urban agriculture is growing of plants and raising of animals for food and other uses within and around cities or towns. It also includes related activities such as delivery of inputs, value addition and marketing of products. It comprises of a variety of production systems ranging from subsistence production for household consumption to fully commercialised agriculture. Generally, it is characterised by closeness to markets, limited and high competition for land, use of urban resources (organic solid wastes and wastewater), low degree of farmer organisation, high value and perishable products, high degree of specialisation, to name a few (Gowda, 2012; Zeew, 2004). By supplying perishable products such as vegetables, fresh milk, poultry products so on.., urban agriculture supplements to some extent urban food demand for achieving a sustainable national food systems.

UN-HABITAT (2006) suggests that the rate of population growth will lead to an increase in urban slum areas, with high levels of unemployment, food insecurity and malnutrition. It is expected that by 2020, 85 percent of the poor in Latin America and 40–45 percent of the poor in Africa and Asia will be concentrated in towns and cities. According to the Food and Agriculture Organisation (FAO) estimates, by 2050, global food demand will increase by 70 per cent to feed the estimated global population of 9.3 billion. If present trends continue, the vast majority of these people will be living in irregular settlements without access to decent food, shelter, water and sanitation (Mougeot, 2005). Similar to this, India will have 590 million urban population (Fig. 1) which is 63 per cent higher compared to 2011. The rate of increase of urban population is much higher than the growth rate of rural population (Fig. 2). This is going to put tremendous pressure on urban food chain and create chaos in the urban area, implying an urgent need for an alternative

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way to combat food shortages. Urban agriculture, although not a panacea for food insecurity, has the potential to provide millions with some secured access to food.

The striking feature of urban agriculture which distinguishes it from rural agriculture is that, it is integrated into the economic and ecological system of urban context. It includes the use of urban residents as labourers, use of typical urban resources (like organic waste as compost and domestic waste water), direct links with urban consumers, direct impacts on urban ecology (positive and negative), being part of the urban food system, competing for land with other urban functions, being influenced by urban policies and plans, etc. It is often thought that urban agriculture is a remnant of rural habits that has come with the migrants to the cities and that will dwindle over time which in reality is not correct. The key differences are listed out below in Table 1;

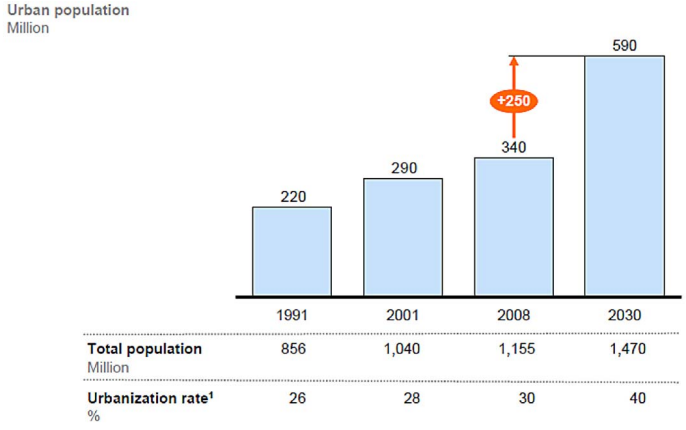

Figure 1: Urban population in India and projection for 2030
(*Source: MGI, 2010)*

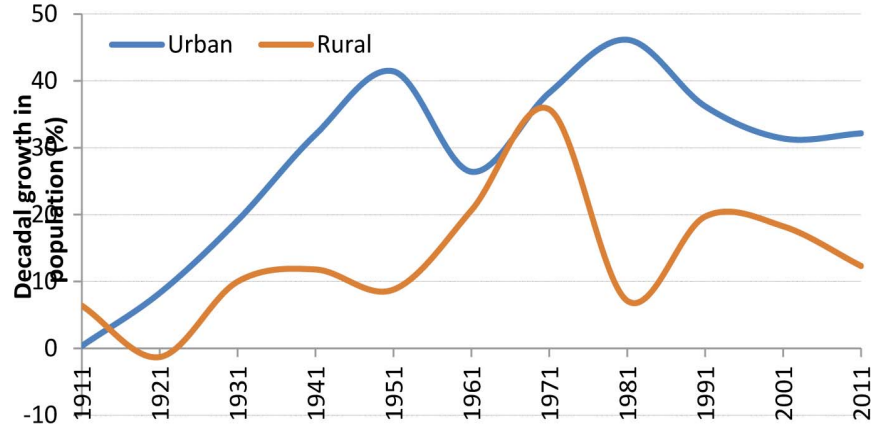

Figure 2: Decadal growth of urban and rural population in India (1911 to 2011)

Source: RBI, 2010 and Census, 2011 analysis by authors

Table 1: Key differences between rural and urban agriculture

Indicator	Rural agriculture	Urban agriculture
Livelihood	Farming is a primary livelihood and engaged on full-time basis	Farming is often a secondary livelihood, engaged on a part-time basis
Farming knowledge	Strong traditional farming knowledge	Weak traditional farming knowledge (that does not apply well under urban conditions)

Indicator	Rural agriculture	Urban agriculture
Products	Mainly staple food crops, cattle, sheep as well	Perishable products especially green vegetables, dairy products, poultry and pigs, mushrooms, ornamental plants, herbs, fish etc.
Cropping calendar	Seasonal periods	More of year-round growing of crops (multiple crop cycles, irrigated, under cover, etc.)
Research and extension service	More likely (although in many countries declining)	Hardly available (but individuals may gain direct access to libraries, research organizations, market information, etc.)
Availability of credit services	More likely (although may be for larger farmers)	Hardly available (due to small and informal farming units)
Market	Distant markets, through involvement of middlemen, low degree of local processing	Closeness to markets, direct marketing, high degree of local processing
Land security	Relatively high	Insecure, often informal use of public land, competitive land uses

Source: (Zeeuw, 2004) with modifications

However, one should think in terms of a rural-urban continuum, rather than sharp distinction between urban and rural agriculture. The intensity of the interactions between agriculture and ecology in the urban system differs from location to location and its effects vary from place to place.

Dimensions of Urban and Peri -Urban Agriculture

Urban Agriculture has many dimensions unlike rural agriculture among them, some of major dimensions are discussed in this chapter.

Viable enterprises: Urban agriculture includes production activities as well as related processing and marketing activities, inputs of production, services delivery (e.g. animal health services) by specialised micro-enterprises or NGOs, etc. The interactions between these activities are also important (chains, clusters). In urban agriculture, production and marketing (and also processing) tend to be more interrelated in terms of time and space than the rural agriculture; there is greater geographic proximity and quicker resource flow. Economies of agglomeration seem to prevail over those of scale. As many studies indicated, in urban and peri-urban areas, food production may include different types of crops (root crops, vegetables, mushrooms, grains, fruits) or animals (poultry, rabbits, goats, sheep, cattle, pigs, guinea pigs, fish, etc.) or combinations of these. Besides, on-food products such as aromatic and medicinal herbs, ornamental plants, tree products (seed, wood, fuel, etc.) and tree seedlings also figure Production units in urban agriculture in general tend to be more specialised than rural enterprises.

Social, Economic and Environmental considerations: UPA is a dynamic concept that comprises a variety of livelihood systems under varying socioeconomic conditions and political regimes. In several economies, particularly developing ones, it is one of the largest productive urban industries. In low-income cities, it is a prime generator of jobs. It has many facets with contributions to social, economic and ecological objectives of sustainable urban development. UPA can develop city as *Healthier City* (ecologically) by urban greening, recreational services, productive use of urban wastes, and reduction of urban ecological footprint, improved

urban micro-climate, landscape and biodiversity management. *Inclusive City* (socially) by subsistence oriented urban agriculture with food and nutrition security, poverty alleviation, social inclusion, community building and social safety network. *Wealthier City* (economically) by market oriented urban agriculture with focus on income and employment generation, enterprise and market development. In this paper, we have attempted to address some of the key issues like access to land, production and marketing services, use of solid waste and use of domestic waste water in urban agriculture through public-private partnerships.

International Policies for Urban and Peri-urban Agriculture

UPA is increasing in cities in developed countries as well as in developing countries and the number of cities revising existing policies or formulating new policies and action programmes on UPA are growing rapidly (Veenhuizen, 2006). However, many urban farmers around the world operate without formal recognition of their main livelihood activity and lack the structural support of proper municipal policies and legislation. Appropriate policies and regulations are required to enhance the potential of agriculture in cities and mitigate its potential risks and some of the policies are summarised in the table 2.

Table 2: Recent developments in urban and peri-urban agriculture

Country	Developments
Sri Lanka, 2007-10	Integrated urban food production in its National Campaign to Motivate Domestic Food Production
Sierra Leone, 2005	Included urban and peri-urban agriculture in its "Operation Feed the Nation"
Ghana, 2009	Included in the national food and agriculture sector development policy
Brazil, 2010	Developed an urban agriculture programme as part of its: "Hunger Zero" policy
Kenya, 2010	Adapted National Urban and Peri-Urban Agriculture and Livestock Policy
Democratic Republic of the Congo, 2011	Support to the development of urban and peri-urban horticulture through National Service for Urban and Peri-Urban Horticulture
Namibia, 2009	Integrated initiative on urban and peri-urban horticulture development
Canada, 2009	Integrated urban food production in its Peoples Food Policy

Source: FAO, 2011

The challenge for UPA is to become a part of sustainable urban development program and to be valued as a social, economic and environmental benefit rather than a liability. Many studies have indicated contribution of UPA to the urban economy and some of them are listed in table 3 below.

Table 3: Contribution of UPA to urban economy

City	Contribution
Hyderabad, India	Of the 1.8 million litres per day of milk consumed in Hyderabad 100,000 litres is supplied by urban dairies
Havana, Cuba 2000	UPA provides >160,000 tons of grains, vegetables and tubers, 7.5 million eggs and 4 million cut-flowers (60%)
Singapore	Prior to avian flu, 80% of poultry and 25% of vegetables consumed were produced in the city

City	Contribution
Dhakar, Senegal	90 % of the vegetables consumed are produced in the city
Hanoi, Vietnam	UPA accounts for 80% of fresh vegetables, 50% of pork, poultry and fish, 40% of eggs
Shanghai, China	Nearly, 60% of vegetables, 100% of milk, 90% of eggs, and 50% of pork and poultry meat are provided by urban peri-urban growers

Source: Amerasinghe et al., 2010

Policies and schemes for promotion of UPA in India

Urban and peri-urban agriculture in India is just witnessing the beginning with few initiatives in some of the cities, such as, composting and vermiculture (prominent in cities such as Kolkata and Chennai), dairying/ animal husbandry (Bangalore), urban agro-forestry (Hyderabad), horticulture production activities (Delhi) and terrace farming in Mumbai. In Hyderabad, it was found that households that produce vegetables saved 20 per cent of their total food expenditures by retaining part of the produce for their household consumption (Kapoor, 2012). As India progresses towards a rapid phase of urbanisation there is a need to focus on concept of sustainable cities with environmentally and economically sound urban agriculture systems. In this backdrop, the union government of India has launched a special scheme called *Vegetable Initiative for Urban Clusters* during 2011-12 with an outlay of Rs. 3000 million under the aegis of the Rashtriya Krishi Vikas Yojana. The scheme envisages development of vegetable clusters for ensuring supply of good quality vegetables to one city or town in every state having a population of one million and above. The scheme covers all aspects relating to vegetable production from supply of planting material to marketing up to the retail level along with support for conducting base line survey, formation of farmer groups, their linkage to aggregators/markets besides training and capacity building of vegetable growers in the identified clusters (Jadhav, 2011). In India, urban and peri-urban agriculture has been formally institutionalized by the government through developing and implementing such urban agriculture schemes in recent years by encouraging investment. However, it is necessary to integrate UPA as a part of urban planning by allocating funds and investments in UPA for its sustainability.

Issues in UPA and plausible solutions through multi-stakeholder collaboration

UPA is carried out under extremely difficult conditions with limited access to land, credit and lack of production support services (agricultural extension, veterinary services, and technologies). So far UPA is neither included under any of agricultural policies nor urban planning. UPA has a potential to meet major share of soaring urban food demand and also contribute for urban ecological service through enhancing urban green cover and opening a sink for urban waste reuse. A key challenge is developing policy, technologies and investment mechanisms for harmonious urban development by incorporating UPA in urban landscape. This requires integrated approach involving multiple stakeholders comprising of government institutions, local authorities, developmental department and the civil society (Diouf, 2006). In this section, issues and plausible solutions on access to land for UPA, production and marketing services in UPA and urban waste (sewage and solid waste) utilization in UPA are discussed.

Access to land and security of tenure: UPA is carried out inside the cities (intra-urban) or in the urban fringes (peri-urban) under customary or informal land tenure arrangement. On private lands farmers may practice farming on their own or lease it out and sometimes may be informally used. Informal use of land for cultivation is prevalent in public (along roads, streams and railway lines) and community lands (parks, schoolyard and grounds of hospitals).

In recent years, rapid growth of urbanization has led to change in land use away from UPA in favour of more remunerative urban oriented utilities like domestic, commercial and industrial purpose. Demand for land for non-agricultural use increases the land value and further this limits its availability for agriculture. In highly competitive land markets, the access to land for agriculture at affordable prices is near impossible. The land tenure arrangement in case of leased land lacks legal recognition so tenant farmers are under constant threat of losing tenure. The situation is not different for cultivators working on vacant public land which is unauthorized in the eye of law though it employs productive use of urban natural resource. This inhibits the cultivators from investing on improving the productivity of the land. In case of non-farming households, lack of access to land in the city is the major reason given for not farming. In developing world, real estate business is booming and land is an asset of investment for appreciated returns. The illegal of accumulation by land mafia limits the access of land to cultivators. Unsecured land tenure is the greatest constraint for the sustainable UPA development (FAO, 2011).

It is recommended that at least 30 percent of the urban space should be kept "green" in order to contribute to the absorption of Carbon Dioxide (CO_2), the release of Oxygen (O_2), the cooling of the air temperature, and to enhance the rainwater infiltration rate (FAO, 2011). With proper urban planning and enforcement, UPA can be accommodated in this green cover of urban landscape. In addition to production functions, urban agriculture offers a wide range of ecological functions (e.g., biodiversity, nutrient cycling, and micro-climate control) and cultural functions (e.g., recreation, cultural heritage, and visual quality) that benefit the society as a whole (Lovell and Johnston, 2009) . These multifunctional benefits of UPA should be capitalized by integrating it in to urban planning. Suitable institutional provisions should be made to blend UPA into urban land use and secure land for urban agriculture. However, multiple claims for the same plot i.e. between private and public sectors pose a great challenge for its appropriation.

In India, cities have grown organically over a period of time and there is hardly any land left for UPA in core area. In peripheral areas, UPA can be accommodated though land is still scarce. City planning in recent decades strictly mandated green urban space in which a room for UPA can be created. In the former context, scarcity of land is high; here UPA can be promoted through family gardens around individual households, micro garden system on patios, terraces and roof. These gardens can be popularized among women folk as their cultivations require less physical effort as compared to conventional growing systems. Urban local bodies can initiate training programmes and access to infrastructure and supplies for micro gardening involving NGO's and developmental departments. In the urban fringes and peripherals UPA on private land can be promoted through accepting UPA as a legitimate form of urban land use and, legal recognition of tenancy or leasing without harming interest of land owners .Besides, innovative approaches - land banking or pooling for UPA should be promoted among urban farmers. In public land, a part of land reserved for urban green cover could be zoned and demarcated for urban agriculture. Further, these plots can be allotted to cultivators for crop production by urban local bodies. Legal provisions must be created for usufruct rights to cultivators per season or year without harming environment from inappropriate agricultural practices. Self-compliance among the farmers can be encouraged by organising and exploring peer pressure.

Production and Marketing Services in UPA: Specialized and intensified commercial scale UPA is taken up as a source of income, through sale of surpluses (Hoornweg and Munro-Faure 2008; Zeeuw, 2010). Urbanization at an unprecedented rate both in terms of population and income have been generating demand for perishable agricultural commodities in which UPA has niche over rural agriculture due to market proximity, lower transport cost and lower supply chain loss (Rao and Joshi 2009; FAO, 2011). In addition, it allows for energy savings at various levels of the food chain; packaging, transport, storage and distribution with a positive effect on the final retail price (FAO, 2011). Market-oriented, small-scale urban agriculture

is often more profitable than small-scale agricultural production in rural areas and generates incomes above formal minimum wage level (Veenhuizen and Danso, 2007). Besides many advantages, it lacks recognition by national and city authorities hence are excluded off from many government subsidy programmes, extension support services and credit facilities as compared to their rural counterparts.

Necessary infrastructure, investment and agriculture information to encourage production, marketing, environmental and health risks involved in urban agriculture is completely absent as little attention is provided by agriculture research and extension organisations. This situation is again aggravated by informally or un-organised nature of farming with limited capacity to improve production system, marketing activity and less capital formation (Zeeuw, 2010; Amerasinghe *et.al*, 2011). To overcome these consequences of relating to production, marketing and capital formation, there is a need for strong institutional support for developing urban specific tool kit of package of practices involving all stake-holders including private research institutes, financing institutions, NGO's and contract firms for backhand support to encourage hygienic agricultural practices for UPA, and also popularise among cultivators.

Resource Centres on Urban Agriculture and Food Security (RUAF) has implemented an innovative programme "Strengthening Urban Farmers' Organizations and their Marketing Capabilities: From Seed to Table". This programme was funded by IDRC and implemented in 18 cities of 8 countries around the world. In India, the program was implemented in Magadi taluka of Ramanagara district, Karnataka by the International Water Management Institute (IWMI), DHAN Foundation (DF) and University of Agricultural Sciences, Bangalore (UAS, B). To strengthen and sustain the urban producers, a town based Multi-stake Holders Forum (MSF) was constituted involving City Council comprising of developmental departments (Agriculture, Horticulture, Watershed, Social Forestry, Animal Husbandry etc.), DHAN Foundation (NGO), UAS,B (Research Institute) and Urban Producers' Association (community organization formed for the purpose). This forum is implementing the city strategic agenda of promotion of urban agriculture and the greenery in the town area. In its mission, emphasis has been laid on agricultural production, marketing and social inclusiveness with gender mainstreaming. An Urban Producers' Field School (UPFS) was established that trained participants on good agricultural practices and organic methods of crop production, collective marketing, mutual help and group savings. The need for credit was addressed through forming self help groups and linked to micro-financing institutions. On rotation basis all members of the group have availed credit facility. This was the key point for the success of this programme as urban producers were not able to avail loans from the nationalized banks due to their small size of land holding. The producers' association has undertaken capital formation activities such as establishing a poly tunnel nursery unit to supply seedlings to farmers, custom hiring of sprayers and power tiller and other machineries and equipments. The association operates an input retail shop where quality inputs are procured in bulk and sell the same to the members as well as non members at a fair price. Association is still finding it difficult to establish market linkages to sell the produce of its members to assemblers, wholesalers and retailers. This partnership model is a good beginning in creating awareness on urban agriculture and developing required skills of urban producers through MSF though marketing of produce still remains a challenge *(Source: Amerasinghe et al., 2011 and author's field experience)*

Urban Waste Water and its Utilization in UPA: Wastewater generated at urban centres is a complex urban natural resources and used as an additional source of water for irrigation in urban and peri- urban agriculture. Wastewater use in agriculture has many advantages as it forms a reliable source of water supply for crop production, nutrient rich waste water reduces the need for artificial fertilizers, increases crop yields and returns, provides income generating opportunities from other enterprises aquaculture, livestock etc..,.

Wastewater reuse in agriculture is an economical way of sanitary disposal of municipal wastewater, provided it is treated to overcome its ill effects. Wastewater generated in cities loaded with pathogens has potential for causing infectious diseases to consumers and health risk to farmers. Wastewater is also rich in salts so crop yield may be negatively affected over long run. Prolonged application of wastewater contaminated with heavy metals, dissolved solids and nutrients leads to build up of salinity, breakdown of soil structure and overall reduction in productive capacity of soil resulting in lower crop yields. Indiscriminate use of waste water in agriculture causes excess supply of nutrients and heavy metal percolation and degradation of groundwater. Property values in the vicinity of wastewater irrigated land have negative impacts due to risk of prolonged exposure to polluted environment. Ultimately, wastewater utilizations have negative impacts on socio-ecological systems if not treated before use. Though costs involved in waste water treatment to zero risk level are high the benefits to society on the whole from reuse of recycled waste water are even higher.

Utilization of wastewater for agriculture is a common practice in most of developing counties with high population density. It is widely practiced in the water scares urban and peri-urban environment for agriculture (Bahri, 2009). Urban areas in India flush 53,898 million litres of wastewater per day and projections show that by 2050, about 48.2 BCM (132 billion litres per day) of wastewaters would be generated that can meet 4.5% of the total irrigation water demand (Bhardwaj, 2005). Another estimate shows sewage water generated in India at present has potential to irrigate about 1 to 1.5 M. ha (Sengupta, 2008) of land area annually and contribute about one million tonnes of nutrients in turn creating 130 million man-days of employment (Minhas and Samra, 2004).

At present, treatment capacity of 19,827 MLD is installed which accounts for around 36 per cent of sewage generated in the country (Kaur, *et al.,* 2010). More than 80 per cent is discharged into natural water bodies (Winrock International India, 2007). Apart from domestic sewage, about 13468 MLD of wastewater is generated by industries of which only 60% is treated. Absence of treatment technology with direct economic return is a major retrieving factor for local authorities for not taking up complete treatment of waste water in India. (Mekala, *et al.,* 2008). The highly subsidised nature of urban water supply, where polluting consumers are not charged for sewerage treatment further aggravates the problem. The estimate by the CPCB (Central Pollution Control Board) on cost for establishing treatment system for the entire domestic wastewater is around Rs. 7,560 crores (CPCB, 2005). Water Act, 1974 also emphasizes utilization of treated sewage in irrigation. In India construction, operation and maintenance of sewerage infrastructure including treatment facility is the responsibility of state governments/urban local bodies. Provision has been made to take support through central schemes (National River Conservation Plan, National Lake Conservation Plan, Jawaharlal Nehru National Urban Renewal Mission, and Urban Infrastructure Scheme for Small and Medium Towns) for sewer infrastructure creation. State Pollution Control Boards have been vested with statutory powers to take action against any defaulting agency.

It is high time city planning in India develops efficient urban water resource management strategies that includes waste water recycling and utilization in UPA. Indian experience shows so far publicly owned and managed water agencies have not been successful in achieving sustainable water resource management. Often, they lack investment and access to latest technology for sewage treatment and mobilize cost -gains for recycling of water. Private can push in huge investment required whereas; governments must adopt equitable, efficient and affordable privatization models. Urban local bodies must take initiative to develop multi-stake holders' collaboration involving polluting urban residents, sewage treating firms and recycled water utilizing urban cultivators and industries

Alandur Sewerage Project (ASP) was initiated by Alandur Municipality (AM) located in Tamil Nadu in the year 1996 through the Public Private Partnership route to construct an underground sewerage system and waste water treatment facility. Project was awarded to IVRCL Infrastructures and Projects Ltd in technical collaboration with Va Tech Wabag Technologies Ltd. The former carried out the civil works for the project and latter designed the process, procured, installed and commissioned the equipments. A Special Project vehicle (SPV) called 'First Sewerage Treatment Plant Pvt Ltd' (First STP); a concessionaire company was created to sign contracts with following mechanism.

1. *Infrastructure creation* in which underground sewerage system and sewerage treatment plant (STP) was constructed by the First STP on the basis of BOQ (Bill of Quantities) and BOT (Build, Operate and Transfer).

2. *Operation and maintenance:* the private agency was entrusted with responsibility of maintenance of sewerage system and STP facility for a period of five years and 14 years respectively. Municipality has undertaken collection of tariff and provision of new connections.

The capital cost of sewage network was Rs. 34.6 crores and is completely borne by AM through loans. The citizens of Alandur contributed 23 per cent to the project in the form of connection charges. Private agency was paid on a fixed fee basis by AM for operate and maintain the underground sewerage system for a period of five years of its inception. The STP plant was financed by the BOT operator at capital cost of about Rs. 6.68 crores. The land requirement for construction of the sewerage treatment plant and pumping station was provided by AM from its own sources at a cost of approximately Rs. 0.25 crores. The private agency have been given provision to recover the investment on the basis of a per unit rate payment from the municipality for treatment of sewage delivered. As indemnity, a minimum payment level per annum regardless of the volume of sewage actually delivered was assured by municipality as BOT-annuity to cover the company's minimum fixed operating cost and capital investment. Ultimately, public paid sewerage fee to AM which covers both debt repayment and O&M costs of the Sewage system and BOT-Annuity payment for STP. **Impact:** Every household received direct connection of underground sewerage system and modern sewerage treatment plant designed to international standards for the city as the whole. This has eliminated the risk of mosquitoes and related diseases and eradication of ground water contamination. Further, there is scope for distributing treated water to UPA and thereby municipality can increase its tariff collection *(Source: NIUA, 2011)*.

Solid Waste and its Utilization in UPA

Municipal Solid Waste (MSW) is defined as any waste generated by household, commercial and/or institutional activities that is not hazardous in nature. Total MSW generated by urban India is estimated at 188,500 TPD or 68.8 million tonnes per year by 2011. A major fraction of urban MSW in India is organic matter (51%), followed by recyclables (17.5 %) and inert waste (31%) (Annepu R., K., 2012). For every increase of income by Rs 1000 the solid waste generation increases by one kilogram per month and on the whole MSW generation is increasing at rate of 5% (Kaushal *et al*., 2012). In India, the municipal agencies spend 5-25% of their budget on Solid Waste Management (SWM) (ENVIS, 2010). Expenditure on SWM is about $10 – 30 (INR 500 – 1,500) per tonne, around 60-70 per cent of this amount is spent on collection and 20-30 per cent on transportation (Annepu, 2012). In most Indian cities, the SWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal but excludes treatment. If MSW is not properly handled it is estimated that by 2047 around 1400 sq.km land is required for solid waste disposal. However, in India around 60%- 90% of MSW in cities and towns are directly disposed of on land in an unsatisfactory manner giving rise to serious environmental degradation.

According to MSW Rules, 2000, waste processing and disposal facility must be set up and operated by municipal authority and submit an annual report regarding status of waste management. The State governments and union territory administrations have the overall responsibility for enforcement of the provisions of these rules. The Central Pollution Control Board (CPCB), State Pollution Control Boards, and the other committees are required to monitor the compliance of the standards as per recommendations once every 6 months.

Agricultural utilization of MSW through composting is the most cost effective MSW management option over traditional means such as land filling or incineration as it enables recycling of potential plants nutrients (Bundela *et al*., 2010). The compostable organic fraction that forms bulk of MSW comprises of food waste, vegetable market wastes and yard waste. Composting of organic component is an alternative to get rid of MSW which yields a marketable by-product which is additional revenue for municipal authorities. At the same time, composting makes a positive contribution to agriculture by supplying of nutrient rich manure. Compost can be used as an organic amendment to improve the physical, chemical and biological properties of soil. Compost application helps to increase the ability of the soil to hold and release essential nutrients (Khajuria *et al*., 2010).

Urban and peri-urban agriculture is part of the urban ecological system and can play an important role in the urban environmental management system through absorbing urban waste, preventing expansion of waste dumping and turning illegal waste dumping sites into productive open spaces. The compost prepared from organic waste decreases the need of chemical fertilizers and contributes for sustainability of soil fertility. India has a composting potential of 9.6 million tons by 2011, but actual composting is around 10-12%, due to lack of organised segregation of waste at the source. Compost produced using un-segregated MSW is likely to be contaminated with plastics and heavy metals (Hg, Cd, Pb), thus it is unfit for agricultural utilization. If all MSW generated in India in the next decade were to be composted as mixed waste and used for agriculture, it would introduce 73,000 tons of heavy metals into agricultural soils (Annepu, 2012). Thus, there is ample scope for enhancing PPP in compost preparation MSW to recover recyclable waste material, reduction of waste environmental hazard and support UPA with vital organic compost for sustainable soil fertility management in urban environment.

Waste segregation is a challenge but a necessary task for compost preparation. This can be done at source of collection or segregation in later stages. Of two methods, former is cost effective and efficient but requires greater participation of public and commitment of the personnel employed in urban solid waste management. Further, separate infrastructure must be created for transportation, storage and collection, treatment and disposal. The city municipal administration entrusted with solid waste management should explore opportunities for multi-stakeholder initiative in establishment of compost plants and popularise municipal compost among farmers practicing UPA.

Ahmedabad is the seventh largest metropolis in India located in the north of the state of Gujarat. The city generates around 2600 metric tonne/day of Municipal Solid Waste (MSW). About, 56% of which is biodegradable, 24% recyclable and 20% is non-biodegradable (non-recyclable) waste. In the year 1997, Ahmedabad Municipal Corporation (AMC) awarded a contract to Excel Industries to generate organic manure from MSW, with an intention to reduce the quantity of waste going to landfill site and also help agricultural production through generation of organic manure.Excel Industries has entered in to 15 year contract with AMC in 1997 to process 500 tonne per day of MSW into organic Compost. AMC has agreed to lease out 10 hectare of land on token lease rent of Rs.1 per mt2 per annum. Company which is utilizing waste from municipal at almost free of cost shall pay 2.5% royalty on

sale of compost for entire lease period. The compost produced by the company is marketed under the brand name called CELRICH: "Bio Organic Soil Enricher." Initially, company was unable to process 500 tonnes per day as agreed because of mixed nature of waste. Adding to this, the cost of production of compost was around Rs. 4200 per metric tonne whereas, it was unable secure even Rs.2250 per metric tonne for its products. Excel demanded Rs.220 per tonne as a cost for segregation of MSW but was not obliged by AMC as it was not a part of the agreement and successful marketing of product is the responsibility of the company. If the company were to close the plant, AMC had to bear additional cost of Rs.150 for further transportation and disposal. In an attempt to find a way out for the problem, AMC started sourcing green waste generated from gardens, vegetable, fish and meat markets to the compost plant. Also, green wastes in residential properties were collected in the morning hours by organising door-to-door collection. A wise move by AMC and commitment by Excel industries has helped to survive the plant. This has further led to promote derivation of organic manure from MSW thereby reducing quantity of waste going to landfill site. In recent years this model has inspired many companies to come up with an environment-friendly proposal to use the city's solid waste to generate power or produce compost. This model can be replicated to enhance the UPA by providing nutrient rich manure and avoiding pollution due to use of chemical fertilizers *(Source: MoF, 2010)*.

Way Forward

There is vast scope for urban and peri-urban agriculture, as demonstrated by many studies conducted throughout the world. UPA provides a good contribution to the economy and food security of the nation. In India, the issues of urban and peri-urban agriculture can successfully addressed through multi-stakeholders collaborations. Along with this, capital formation in UPA can be encouraged through collaboration of financing institutions and farmers associations with proper mechanism. However, urban solid waste and urban domestic waste water can be utilized in the UPA with proper treatments. This can enhance the urban development in two ways: by utilizing urban waste effectively and maintaining greenery. Hence, Government needs to promote both urban and peri-urban agriculture through proper policies. It will help to maintain ecology and sustain the urban development as well as to meet the demand of the urban consumers in long run.

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2.2 DEVELOPMENT INITIATIVES IN FOOD PRODUCTION, UTILIZATION AND MECHANISM OF MANAGEMENT IN DEVELOPING URBAN AND PERI-URBAN AGRICULTURE IN ASIA

N. Nagaraj*

Executive Summary

UPA is distinctly emerging as a catchy agricultural sector worldwide for enhancing food, nutrition, health and economic security reducing negative environmental impacts. In the process, the long term impact of rise in land prices associated with reduced size of holding for agriculture and short term impact of rise in agricultural wages are being experienced. Institutional innovations such as formation of Urban Producers Organizations for capacity building in marketing, access to credit through SHGs/micro-financing institutions, Farmers' field schools have immense potential to contribute productivity (as observed to be 16 % to 54 % in Magadi, the peri urban of Bangalore megacity).

Results relating to food production in UPA indicated that hired labor formed the highest percentage of cost of cultivation due to economic scarcity of labour. Farmers cultivating finger millet + field bean realized relatively higher net margin (Rs.5368) compared to other field crops. In the case of vegetable crops, farmers cultivating carrot realized the highest net returns (Rs.28489) compared with other vegetable crops. Thus, farmers in UPA have comparative advantage in growing vegetables due to market proximity. Food production from peri urban farmers cannot be adequate to meet the consumption needs of cereals and pulses. The key constraints affecting UPA are increasing economic scarcity of labor, economic scarcity of groundwater, unreliable power supply for pumping water, lack of proper market linkages followed by price fluctuations, market inefficiencies due to delayed payments and relatively poor logistical services. Good practices to promote UPA inter alia, are soil and water conservation, collective marketing of produce and market linkages reducing transaction cost, Urban Producers Field School, biogas for sustainable energy management, ornamental fishery and value addition in millets for additional income and women empowerment and home gardens.

Significance of Urban and Peri urban Agriculture

UPA and rural agriculture are part of a continuum and the two interact and complement each other. However, India's agricultural policies have largely focused on rural areas, aiming to achieve self-sufficiency in food production reducing poverty. The role of urban and peri urban agriculture as means of improving food security and enhancing the livelihoods of poor producers, is increasingly described in the literature (Bakker *et al*., 2000). UPA is crucial in terms of food supply and revenue generation, overcoming malnutrition, employment creation, livelihood support and poverty reduction, protecting environment, wastewater use in urban and peri urban agriculture and for greening cities (Cofie 2009).

Objective

This study aims to distil the experiences and lessons learned from the developmental initiatives in food production, utilization and mechanism of management based on case studies in UPA andcritical constraints, and good practices/interventions to promote urban agriculture.

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Review

In the synthesis of urban and peri-urban agricultural research it is observed that expanding cities affect the areas surrounding city by altering the natural resource base, converting land to new uses, changing labor patterns, challenging the environment, concentrating urban waste pollution and diminishing natural resource based livelihoods (Sabine Gündel, 2006). The major challenge of this journey through the rural to urban transition is for poor.

Table 1: Challenges for the poor in Rural and Urban Areas

Challenge	Rural area	Urban Area
Livelihood opportunities	To reduce income risk and diversify income sources, non-farm income often sought through periodic Significant dependence on migration. self-provisioning	Labor market often dualistic. Incomes mainly from semi-permanent wage labor, informal sector, petty trading and increasingly through crime. Greater dependence on cash
Food security	Adverse climatic conditions may cause local food shortages and hunger.	Adequacy of food depends on cash availability.
Physical and Social Infrastructure	Facilities often remote and disconnected. Services and O & M often of poor quality	Formal and high quality services expensive and restricted. Regulation makes low cost alternatives scarce
Housing and land	Few problems with shelter per se, but land tenure may be insecure due to increasing pressure to sell land for residential and industrial uses	Choice often limited and environmental risks high. May be forced onto illegal sites.
Environmental management	Adverse climatic conditions impact on livelihoods	Density and poor urban vulnerability worsen effects of environmental disasters and disease risks.

Source: 1.David Satterthwaite, "Location and deprivation: beyond spatial concepts of poverty". Mimeo, London, IIED, March 2000.2. Allison Evans, "Working paper to address spatial considerations in PRSP processes", mimeo, World Bank, Dec. 2000.

Significance for Livelihood

In the project on Natural Resources Systems Program, in South India reveals the importance of agriculture as a sole occupation with increasing proximity to the city due to pressure on land availability and the presence of alternative employment opportunities. As urbanization changes land use, farming is gradually becoming a minor occupation, especially for those whose access to land is constrained by development or where farm prices reduce incomes to unsustainably low levels. The group most notably dependent on agriculture are often poor female agricultural laborers (e.g. in the Hubli-Dharwad study of NRSP).

"In Hyderabad, about 600 million liters per day of wastewater enters Musi River which is used for irrigating para grass, leafy vegetables and paddy along the 'Musi River Corridor'. Around 2108 ha para grass in and around Hyderabad and 10,000 ha of paddy along the 'Musi River Corridor' is irrigated with wastewater. In addition vegetable production was also undertaken on a small area under wastewater irrigation mainly by women farmers. However, fodder and vegetable production contributed significantly to livelihoods and food security of resource poor urban and peri-urban women and men. It was found that households that produce

vegetables saved 20% of their total food expenditures by retaining part of the produce for household consumption (Daniel 2008).

Contribution to Poverty Alleviation

The NRSP project concludes that despite the trend away from farming as the main source of livelihoods, the continued importance of agriculture, particularly to women, was evident in Hubli-Dharwad. It was clear that the poorest farmers were food crop farmers with a small area of land. The only option for the resource poor is to continue in farming.

Table 2: Renewable Natural Resources Research Strategy (RNRRS) projects with "Technology" focus

Project Name	Title	Technology
CPHPLPP	The use of oilseed cake from small-scale processing operations for inclusion in rations for peri-urban poultry and small ruminant production Improving peri-urban horticultural productivity in sub-Saharan Africa Improving the livelihoods of peri-urban vegetable growers through market promotion of fresh and processed indigenous vegetables	Cost-effective feeding systems for poultry and goats Nursery program and crop rotation technology tested Identification of suitable vegetable varieties
AHP	Integrated pest management of mixed forage dairying in Kenya Sustainable approaches for management of root-knot nematodes on vegetables in Kenya	Improved pest management strategies Bio pesticides tested and scaling-up potential identified
LPP	Improved urban livestock production for effective and safe management of organic and other urban wastes in Kisumu City, Kenya	Identification of technologies for animal waste disposal and re-use, e.g. for safe fuel
R7524	The use of oilseed cake from small-scale processing operations for inclusion in rations for peri-urban poultry and small ruminant production	Cost-effective feeding systems for poultry and goats
NRSP	Kumasi Natural Resource Management Improved utilization of urban waste by near-urban farmers in the Hubli-Dharwar city region	Technologies for soil fertility management and improved farming practices established Techniques for improved utilization of urban waste

Economics of Peri-Urban Agriculture: Case of Magadi, Bangalore:

Peri-urban agriculture has brought out two impacts on farmers and the rural economy. The first is the long-term impact of rise in land prices associated with reduced size of holding for agriculture, and the second, the short-term impact of rise in agricultural wages (Ramalingegowda et al, 2012). In peri-urban and rural agriculture, the contribution from wage income exceeds 50%. Nevertheless, the per capita incomes of farmers in these scenarios are 50% lower than the per capita income of an average Indian. The data for this study were drawn from pretested schedule administered on a random sample of 50 farmers located in FHUI (Farms with high urban influence) area, 50 farmers located in FLUI (Farms with low urban influence) area which are both located in Magadi town. The FHUI farmers are all from Hombalammanapete, while the FLUI farmers are from Tirumale, Someswara colony, Kalya gate and other parts of the Magadi town. As a control, the population of 21 farmers located in Jenukallu village which is located at a distance of 20 kms from Magadi town which has no accessible road (i.e. No motorable road) to represent rural agriculture are chosen to represent farmers with no urban influence (FNUI). All the three study areas are located in Magadi taluk.

The per capita net income of FHUI farmers was Rs.7017, of FLUI farmers was Rs.17452, and of FNUI farmers was Rs.8112. Thus, FLUI farmers derived the highest per capita income, due to their higher relative and absolute magnitude of off farm income (Rs.58596 forming 71 %) as compared with FHUI and FLUI farmers. The per capita monthly health expenditure was higher for FHUI (Rs.137) farmers as compared with FLUI (Rs.98) and FNUI (Rs.8) which shows the relative vulnerability of peri urban farmers (Table 3).

The access to water and access to urban / peri urban farming are the necessary conditions for realizing higher per capita incomes, but not sufficient conditions. The FNUI enjoy higher per capita incomes than FHUI because they offer their labor and earn high wages than what agriculture can offer. In FHUI and FLUI, farmers suffered from health problems while in FNUI no major ailments were reported.

Table 3: Socio economic features in peri urban agriculture of Bangalore mega city

Category	FHUI (n=50)	FLUI (n=50)	FNUI (N=21)
Family size (Range of members)	5.44 (2 to 15)	4.72 (2 to 18)	4.24 (2 to 14)
Net cropped area per farm (Acres)	0.29	1.97	0.85
Gross cropped area per farm (Acres)	0.48	2.12	0.85
Net returns per farm from agriculture (Rs)	11,978 (31%)	10,452 (13%)	3,194 (9%)
Net returns per farm from livestock (Rs)	3629 (10%)	13348 (16%)	3457 (10%)
Net family income from off farm (Rs)	20588 (54%)	58596 (71%)	27743 (81%)
Net family income from all sources per (Rs)	38175 (100%)	82576 (100%)	34395 (100%)
Per capita income (Rs)	7017	17452	8112
Annual (monthly) health expenditure (Rs)	8964 (137)	5552 (98)	384 (8)
List of major illness suffered	BP, Sugar, stroke, heart, eye problems	Sugar, BP, heart, stroke	No major ailments
Disability adjusted life years	5.6(0.5 to 12)	6(1 to 14)	0
Literacy (%)	67	72	28
Net income from agriculture & livestock per farm family (Rs)	17607	25768	6652

Source: Primary data from sample farmers

Note: Figures in parentheses give range. The denominator chosen to compute figures per family refers to the actual number of families possessing or holding the respective feature.

This study recommendations include 1) Promotion of groundwater irrigation (demand side) as well as watershed development programs (supply side) focusing on Integrated Farming Systems across all types of farms 2) Collective marketing of high value low volume agriculture produce (such as perishable fruits and vegetables including flowers) and market linkages for increasing the producer share in consumer rupee and reducing the post-harvest losses 3) Improved metal road network to reduce the transport cost and improved market logistics within peri urban areas to widen the market access to different classes of consumers

Case Studies

Peri-urban agriculture in Magadi, near Bengaluru under RAUF:

In the inner city areas urban horticulture initiatives are visible in the form of backyard/front yard as well as terrace gardens. These small spaces are effectively used for growing vegetables and recycling wastes. The program initiated by Resource Centers on Urban Agriculture and Food Security (RUAF) in India (Magadi, Karnataka) was coordinated by International Water Management Institute (IWMI) and implemented by DHAN Foundation with the support of University of Agricultural Sciences, Bangalore in Magadi Town.

The Municipal Council and developmental departments like Agriculture, Horticulture and Animal Husbandry and University of Agricultural Sciences was involved in capacity building of officials of developmental departments and as well as farmers. The program "Strengthening Urban Producers Organizations and their Marketing Capabilities: From Seed to Table" was started in 2009 with the financial support from IDRC. As part of this program urban producers association was formed and enhanced collective action to undertake collective procurement of inputs and marketing reducing transaction cost. The need of credit was addressed through forming self-help groups and linked to micro-financing institutions. On rotation basis, all members of the group have availed credit facility. It was the key point for the success of this program as urban producers were not eligible to avail loans from the nationalized banks due to their small size of land holding. These farmers were engaged in the production of high value short duration vegetables. The theme of field school was adapted with little modification in its operations to suit the urban setting. This field school was called "Urban Producers Field School (UPFS)". Along with formation of this field school various sessions were planned based on the results of the field survey. In this field school local resource persons and progressive farmers were invited to build the capacity of the urban producers on good agricultural practices and methods of organic farming. The association had 97 members which was little bigger in size to conduct the classes leading to formation of small groups of 10 members to facilitate concept of learning by doing.

Majority of the sessions included management of water, weeds and pest and diseases through organic methods. This model enabled to increase production by 12% in the first cycle. Followed by this, demonstration of off season carrot production began with improved techniques to avoid splitting and rotting of tubers in rainy season. This demonstration was also successful and 30 percent of the producers adopted cultivation of carrots in the offseason with improved cultivation practices for the first year and expanded to 54 percent in the second year of the project. Productivity increased by 56 per cent compared to baseline survey with application of improved cultivation methods and good quality seeds. This model has succeeded to enhance the capacity of urban producers with improved cultivation methods. Now producers themselves are trying with the new methods of managing pest and disease menace. It was a successful model in enhancing crop yield and sustaining urban producer's livelihood. This model can be replicated for capacity building of urban producers.

In the study on peri urban agriculture and its impact on household food security, Raju and Nagaraj (2010) indicated that the share of hired labor charges accounted around 30% in the cultivation of crops due to higher dependency of peri urban farmers on hired labors. Farmers growing finger millet, finger millet + field bean and red gram realized gross returns of Rs.10324, Rs.13594 and Rs.13920 with a net margin of Rs.2556, Rs.5368 and Rs.5156 respectively. The benefit cost ratio indicated that farmers growing finger millet+field bean realized 1.7 followed by red gram (1.6) and finger millet sole crop (1.3).

Table 4: Economics of field crops in peri urban farms (per acre)

Particulars	**Finger millet**	**Finger millet +Field bean**	**Red gram**
Main product yield (qtl/ac)	9.3	10.1+0.76	3.4
By product yield (tonnes/ac)	3	2.8	—
Price per quintal (Main product)	920	942.5+3151.1	4094.1
Price per tonne (By product)	600	600	—
Gross returns	10325	13594	13920
Total cost of cultivation	7768	8225.2	8763.8
Net returns	2557	5369	5156
Returns to cost ratio	1.3	1.7	1.6

The cost of cultivation per acre of radish, carrot, knolkhol, beans and green leafy vegetables was Rs.13609, Rs.18017, Rs.20863, Rs.19953 and Rs.12592 respectively (Table 5). The labor component formed 1/3rd of the recurring expenditure. The chemical fertilizers and organic manure costs formed the 3rd largest share of expenditure. The net returns from carrot (Rs.28489) and knolkhol (Rs.28053) were the highest compared to other vegetables which was twice that of beans and green leafy vegetables and thrice that of radish. Benefit cost ratio was high for carrot (2.6) followed by knolkhol (2.3), green leafy vegetables (1.8) and beans (1.6) and the least was for radish (1.4).

Table 5: Economics of vegetables in peri urban agriculture (per acre)

Particulars	Radish	Carrot	Knolkhol	Beans	GLV
Yield (qtl)	15.6	26.0	36.9	23.4	24.3
Price per quintal	1248	1788	1325	1390	928
Gross returns	19463	46507	48917	32536	22551
Total cost of cultivation	13610	18018	20864	19954	12592
Net returns	5853	28489	28054	12582	9959
Returns to cost ratio	1.4	2.6	2.3	1.6	1.8

Note: GLV= Green Leafy Vegetables.

Marketed surplus: Peri urban farmers produced 5.2qtls of cereals and 0.2qtls of pulses with marketed surplus of59% of cereals and 50%of pulses produced (Table 6).

Table 6: Marketed surplus in peri urban agriculture (quintals per farm)

Food crops	Production	Retained	Marketed surplus (Quintals)	Marketed surplus (% of production)
Cereals	5.2	2.1	3.1	59.2
Pulses	0.2	0.1	0.1	50.0

Gap in production and consumption: Peri urban farmers produced 5.2qtlsof cereals and 0.2qtls of pulses but their consumption was 6.8qtls and 0.6qtls of cereals and pulses respectively, leading to a deficit of 1.6qtlsfor cereals and 0.4qtlsfor pulses (Table 7). The deficit indicates that production of food was not sufficient to meet the consumption needs. The deficit in the food requirement was met by income realized from the other enterprises. The per capita expenditure on food crops accounted for Rs.1, 662 and Rs.636 on cereals and pulses respectively. This implies that the household food security in peri urban agriculture is yet to be achieved.

Table 7: Negative gap in food crops in peri urban agriculture (Qtl/farm per year)

Food crops	Production	Consumption	Deficit
Cereals	5.2	6.8	1.6
Pulses	0.2	0.6	0.4

The University of Agricultural Sciences, Bangalore, India in cooperation with Iowa State University conducted an innovative program for agricultural technology transfer to the peri-ruban village communities viz., Venkatahalli and Heggadehalli near Bangalore, with the goal of providing new approaches for sustainable development (Nagaraj and Chengappa2009) sponsored by USAID-HED. Participatory methods for involving community in different conservation and economic development activities with financial

assistance available on a cost-share basis for some practices at varying incentive levels were adopted. The thrust areas included soil and water management, sustainable farming systems, value addition, biogas development and market linkage. Need based training cum demonstrations were conducted in the thrust areas.

Value addition of finger millet for improved nutrition and income

Finger millet malt preparation as an income and employment generating activity was introduced in peri urban villages of venkatahalli and Heggadehalli. The program was implemented involving Self Help Groups members of both the villages who have been trained by the Nutrition Department of the University of Agricultural Sciences, Bangalore through USAID-ALO project. Motivation through trainings, demonstrations and market linkage has made possible for them to start processing of finger millet into malt. On an average, the cost of finger millet malt powder preparation accrues to Rs.75 per kg with a market value of Rs.100 per kg receiving a net profit of Rs.25 by Self Help Group members. Thus, processing of finger millet enabled them not only additional income but also improved nutrition. The most important aspects of Finger millet is that it is very rich in calcium and many other nutrients.

Water use efficiency through micro irrigation: The usage of drip irrigation by the farmers reduced water usage by 25-42 %, costs by 15-32% and increased net returns over conventional flow method of irrigation.

Efficient use of farm bio waste through bio digester: Dairy as the major source of subsidiary income supported peri urban agriculture. Farmers owned 2 to 5 milching cows along with a pair of bullocks for ploughing and transportation purposes. Earlier cow dung used to be dumped in open pits for manuring. Majority of the farmers were using firewood, agricultural residues, dung cake and kerosene for cooking before intervention of the project. Due to dairy activity, the daily cow dung availability in the study villages was estimated to be 7tonnes per day, which has potential to produce 350m^3 of gas per day. With the introduction of Gobar gas2.5 tonnes of cow dung was used (36% of dung availability) indicating scope for further expansion. The gobar gas plant generated 2m^3 biogas adequate to support fuel needs of 7 persons. Farmers using LPG incurred an expenditure of Rs.9 per meter cube of gas while the same would cost just Rs.1.78 in Biogas digesters (saving of 80%). Around 60% of the farmers applied the slurry to their crops.

Complementary enterprises for women empowerment: Ornamental fish rearing

Venkatanahalli a peri-urban village with 125 households had 5 self-help groups comprising80 members actively involved in dairy, goat rearing, sheep rearing, preparation of value added products of crops, petty businesses, making leaf plates, availing micro credit from SHGs.

Considering the existing market opportunities in Bangalore mega city (located at 40 kms from the village), ornamental fish production and rearing was promoted where 5 members of women self-help groups participated.

The capacity building of farmwomen by teaching, exposure visits and interaction with market players and supporting them infrastructurally(with 4 circular cement rings ,each of 500-600 liters capacity, live food production tank -150 liters capacity covering net, brood holding cage, plastic tubs, hand nets, plankton net). Ornamental fishery being the first time activity, farmer was provided with selected livebearers – mollies, guppies, platys and swordtail (parents stock 50 no's) for production and fry (babies)of 200-300 numbers each for rearing and acquiring hand on experience. The farmers were trained to produce fish feed (pellets, flakes, egg custard), and live food (Infusoria, Rotifers, Daphnia, Mosquito larvae, Earthworms, and Fruit flies) using locally available resources. Farmers were successful in rearing fries, obtaining survival of 85

to 100% in a 40 day cycle. With 20% of the stock (with good color variant) chosen for future brood stock and the rest sold to buyer at farm gate price of Rs.2.5/ fish farmwoman realized gross returns of Rs.475-550 from ornamental fishery apart from brood stock valued Rs.70-180. This generated supplemental income from the unused resource with a cost to return ratio of 1: 2.66.

Relay cropping: Introduction of short duration coriander, greens and radish as relay cropping with eggplant not only enhanced income but also enable farmers to double crop their land, eliminate time management bottleneck, and protect the environment by reducing soil erosion and efficient use of nutrients.

Enhancing livelihood capacities of small and marginal peri urban farmers in Gampaha, Sri Lanka

The main objective was to strengthen farmer organizations, help innovate food production systems and enhance marketing capacities to benefit on-going development activities. An urban producer association 'Seemasahitha Gampaha Haritha Krushi Nishpadana Smagama' was formed with about 81% being women. These urban producers participated in exposure visits to enhance their skills and capacities on different aspects related production, marketing, finance and landscaping. Chillies were selected aiming for high-end markets. A three cluster level marketing outlets were established to sell the produce. Accordingly each member produces a minimum of 25 kg vegetables per month and pays SLR 2.00 for association common fund and marketing outlets pay SLR 25.00 per day as rent to association. Compost making was also demonstrated and some have undertaken the commercial level production reducing the purchase level from 20000kg to 2000kg.

Nourishing inspiration in the Sri Lanka model garden: Urban home gardens can be located on the ground, on balconies or on concrete roofs; productivity depends on factors such as the number of family members, the time devoted to the garden and the regional climate. In Sri Lanka, as in other countries, the percentage of families using a home garden increases where there is higher rainfall. The majority of urban home-gardening families in Sri Lanka grow crops to meet their domestic needs, but in semi-urban areas and villages, some products (typically fruit, such as mangoes, avocadoes and rambutan) are deliberately grown for market or sold when in excess. Productivity is affected not only by time and climate, but also by access to space, to water in times of drought and to fertilizers (whether purchased or homemade); gardener's ability to benefit from lessons learned is also an important factor. In order to help families in Sri Lanka, a model home garden was created at the Horticulture Research and Development Institute (HoRDI) in Gannoruwa. According to HoRDI, the model garden was created to help people increase their knowledge of gardening techniques.

The 900 m model garden features many of the vegetables, fruits, spices, herbs and tubers which are grown in Sri Lanka. During 2006, over 63000 people from all over the country viewed HoRDI's model home garden, including large numbers of school children.

Management Mechanisms

Currently peri urban agriculture in India lacks policy focus due to the absence of specific policies to facilitate farmers to cope with the pressures of PUA. An important pressure is that of demand for agricultural land for urban use. While farmers still wish to retain their land. Land grabbers tempt farmers to part with their land for throw away prices and enjoy abnormal profits in the process of land sale, despite the largest number of institutions governing land use. It is therefore crucial to have another organization exclusively for protecting farmers' right to retain a part of their land for their use. Karnataka has a policy of providing 60% of benefit from land sale to farmers, and 40% for buyer. However, due to information asymmetry and

lack of market information regarding land prices, farmers lose more than what they gain in the long run. With an ever expanding land market, there is no organization, where farmers can get information on the land prices. While for instance commodity markets and market boards have developed, 'land market', which is perhaps the biggest market in terms of 'turn over', has absolutely no space, where farmers, buyers, sellers of land can obtain the likely price for lands located in different places in PUA.

Second, due to emerging demand for organics in PUA, there is no focus on organic farming in PUA. This should be facilitated since there is price premium for organic produce in UA.

Third, PUA farmers need to be supported by market linkages to linking their produce with the consumers of different sizes directly, thereby increasing the farmers' share in the consumer price. This requires the role of NGOs and market entrepreneurs who can link the producers and consumers at the least transaction cost. While finding market linkage is time consuming and is subjective, logistical support to transfer the produce to the nearby market will enable farmers to reap market benefits, since transportation at the right time in suitable packs, sizes and crates is crucial for farmers.

Fourth, farmers in PUA receive far less benefit from the developmental programs of the Government, due to the rigmarole procedures and transaction costs which delays the reach of benefits to the needy. Good governance is crucial for programs facilitating production of vegetables, especially greens, green leafy vegetables which are crucial for nutrition and health.

Lessons Learnt

i) Drip irrigation: Farmers are convinced of the benefits of drip irrigation. However, the investment required is substantial. Though there is high subsidy provided by the Government, there is poor governance. Lack of capital and credit availability, small holdings, and limited crop choice constrain drip irrigation.

ii) Biogas: Farmers' response is overwhelming for biogas development and use because as it provides a sustainable source of energy at far cheaper cost compared to fossil fuel sources, thus, reducing s drudgery for women in cooking

iii) Heap compostingandvermicomposting: Response was modest because of low knowledge base relating to nutrient status and impact on productivity.

vi) Marketing: Group marketing of carrots reduced the transaction cost in Magadi village

ix) The farmer field school: The filed school has been a great place for training and extension to ensure the dissemination of good agriculture practices, product safety and environment preservation.

x) Kitchen/Home garden system was practiced featuring some crops for domestic purpose and also horticultural crops for marketing in Sri Lanka.

Good Practices

Some of the good practices identified from the studies include: a) training on production practices b) collective marketing of produce and market linkages to increase income and reduce post-harvest losses to farmers c) value addition to finger millet d) Urban Producers Field School, e) Relay cropping in vegetables f) Micro irrigation techniques g) Bio-gas h) Ornamental fish rearing i) Home gardening

Constraints

Production constraints: The Garret ranking for constraints analysis indicated that non-availability of labor for agricultural operations was ranked the highest with the mean score of 62.1. The wage paid to men and

women labor was relatively high at Rs.200 per day along with meal and other services and for women labor wage was Rs.150 per day with meal. Thus, High labor wages was ranked as the second important constraint faced by the peri urban farmers with a mean score of 59.9. Peri urban farmers are dominated by marginal and small holdings struggling to meet food and income. Farmers' ranked non-availability of agricultural land as the third key production constraint. Non availability of irrigation water, increasing cost of inputs and pest and disease menace were ranked fourth, fifth and the sixth.

Marketing constraints: As local market was inadequate in terms of infrastructure and other services/ facilities, proper marketing facility to market their produce was ranked first among other attributes as the most crucial, with mean score of 60. Price fluctuation of perishable produce was ranked second with mean score of 54. Lack of transportation facilities was ranked the least with the score of 33.

Limited land: Land, the key resource, constituted the single largest component of the rural assets and determined social and economic status of farmers. As land values are appreciating, interest in farming has been dampening. Profitability from the agriculture is shrinking due to adverse terms of trade. Lack of access to improved technologies, improved storage facilities and infrastructure at farm level and post-harvest processing are other constraints.

Conclusions and Recommendations:

The policies directly aiming at the developmental initiatives for UPA agriculture are yet to emerge in India. For UPA, ceteris paribus, land, water, access to credit, technology, labor, the cultivation of food crops is not as remunerative as the cultivation of vegetables, flowers and other commercial crops due to effective demand from the proximal megacity markets. In addition, livestock, a key complementary activity is shrinking in UPA s due to scarcity of fodder and space. The good practices to promote UPA include training on good agricultural practices and collective marketing of produce and market linkages to reduce transaction cost through Urban Producers Field School, biogas for sustainable energy management, ornamental fishery and value addition in millets contributing additional income, better nutrition and health.

The key constraints affecting UPA are increasing economic scarcity of labor, economic scarcity of groundwater, unreliable power supply for pumping water, lack of proper market linkages followed by price fluctuations, market inefficiencies due to delayed payments and relatively poor logistical services. Weak input delivery, poor post-harvest processing for value addition, poor storage and infrastructure, exacerbate the predicament of low productivity.

Mechanization of activities, organic farming, rainwater harvesting, use of ICT, sorting, grading and branding the produce, technical support and capacity building, improving input delivery like access to quality seed/ plant material, credit and investment, vertical integration, and market linkage are crucial for UPA. Investing in raising quality seedlings through low cost high tech horticulture structures, viable water management strategies, organic farming, institutions and policies and climate change adaptation solutions are crucial.

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3 DISCUSSIONS

3.1 CASE STUDIES

A total of eight case studies were presented enumerating the experiences and different types/models/practices of UPA interventions towards resilient food systems in practice/implemented/being implemented. The participants deliberated on various issues and some of the important questions/ answers and suggestions having significant bearing on the implementation of UPA are given below;

i. Application of Horticulture in Improving Urban and Periurban Agriculture towards Enhancing Food Production in Bangkok City.

Question: Are there models/practices specifically developed for UPA and any scientific studies conducted for identification of crops and varieties, structures required and economic feasibility studies with benefit cost ratio?

Answer: These models are implemented based on the knowledge and experience and are implemented on pilot scale which is working well in the present conditions. This concept has the patronage of the Royal King for his philosophy of Sufficient Economy Theory that emphasizes moderation in performance, reasonableness and creating immunity for ones self and the community which has made this vegetable farming sustainable and profitable. These could be repeated in other countries on pilot scale for their suitability. Validation and new studies may be taken up exclusively for UPA interventions at a later stage.

Question: Is there a separate department looking after UPA activities in Thailand?

Answer: Presently no. However, the DOA has established "The Garden" in honour of Her Royal Highness Princess Sirindhorn to facilitate people in Bangkok and peri urban areas with a training center located in Kasetsat University, Chatuchack, Bangkok. In Bangkok city, roof-top and vertical urban farming is successfully running for the past 10 years as the best example of urban horticulture at Lak Si District Provincial Hall serving as a training center open for public. Under the administrative control of Lak Si district they are producing mainly vegetables and some small fruit crops.

Question: What is the funding source for UPA activities?

Answer: Presently these are implemented on pilot scale funding from institutions like FAO. There is ample scope to invite funding from the government as well as from the private sector under the PPP model. A lot of awareness has been created in Thailand regarding UPA viz., nutritional gardens, edible landscape gardens, rooftop gardens, pot culture etc. which are gaining popularity.

Question: Could UPA become a commercial venture?

Answer: Urban horticulture, as per our experience cannot be a commercial venture unless market intervention in terms of UPA movement takes place on a larger platform. Presently urban horticulture in any format is subsistence in nature. Whereas, peri-urban horticulture is definitely a profitable

commercial venture as it has a definite market orientation as seen from peri-urban vegetable plantation at Bang Duea Sub district, Mueang Pathumthani.

Question: What is the scope of organic production under UPA?

Answer: Majority of the urban horticulture, particularly vegetable cultivation is under organic production. Under peri-urban commercial cultivation of vegetables, organic production is at a lower ebb as **no scientific validation of organic practices** on larger areas has been done by us.

Suggestion:

- Creation of greener areas for the urban cities for recreation and leisure for the urban populace would be a welcome step for promotion of UPA. A new concept like UPA Tourism involving crop demonstrations and food parks may be promoted with private –public participation.

ii. Contribution of Small Livestock in Developing Resilient Food Systems for Urban and Peri-urban Agriculture in Thailand.

Question: Urbanisation is horizontal. The satellite and majority of other areas have been encroached / occupied and this trend is likely to continue. Urban cities/towns are the hubs for consumption of milk, egg, chicken, meat etc. and demand for these products would be ever increasing in the times to come. Under such circumstances land for livestock production even in the peri-urban areas would be seriously challenged. What would be the probable solution?

Answer: This is the time for government policy interventions. Urban/peri-urban ceiling has to be recognized by the governments. Also, there is a need to create urban land bank. Perhaps, a policy/law enacted in Republic of Korea may serve as an example. The other solution is to shift livestock farming to rural areas and develop a strong supply chain and value chain for milk, egg, chicken, meat, etc. Possibly small livestock production or the commercial production for domestic/exports can be encouraged under UPA.

iii. Towards Sustainable Wastewater-fed Fish Culture in Kolkata, India.

Suggestions:

- Waste water fish culture faces the risk of food safety. This should be addressed scientifically.
- Fish is an important commodity in the market for urban and peri-urban consumers. The low lying areas of rice cultivation may be converted for fish farming integrated with duck farming.
- Inland fisheries particularly, the tanks/ponds in the urban and peri-urban areas may be utilized for commercial production and fish parks may be created for the urbanites inviting participation from rural/coastal fish producers.
- Aquatic vegetable production like Wild rice *(Zizaniaaquatica*; *Zizanialatifolia*; *Zizaniapalustris*; *Zizaniatexana), w*atercress (*Nasturtium microphyllum* (Boenn.) Rchb.*Nasturtium officinale* W.T. Aiton,), Water pepper (*Persicariahydropiper),* Water Spinach **(***Ipomoea aquatic), Wasabi* **(***Wasabia japonica),* Chinese water chestnut (*Eleocharisdulcis),* Taro (*Colocasia esculenta),* Lotus (*Nelumbonucifera Gaertn), Cattail*, Bulrush (*Schoenoplectuscalifornicus)* etc.holds better promise which may be popularised.
- Setting up of production units of quality feed for fish culture would be a subsidiary activity in urban and periurban areas.

iv. Tree Planting in Urban and Peri-urban Areas

Suggestions:

- Tree planting particularly fruit trees viz., mango, tamarind, jack fruit, Singapore cherry, Garcinia, amla, social forestry trees viz., pongamia, neem and plantation and nuts like coconut, oil palm, etc. could be used for planting along the roads, community gardens in the urban areas and thereby develop green cover for the cities.

v. Integrated Homestead Farming Systems for Improving Nutrition Status of Urban &Peri-urban Populations – Case study/ Experiences from Selected Asian countries.

Question: In urban areas, street food and food vendors are being considered more economic and day by day these are increasing. How far are these safe and healthy and have any studies been conducted on these aspects.

Answer: Public health and hygiene are a burning issues in relation to street food and food vendors. In developed countries many studies have been conducted on this sector. In the developing countries street foods are growing at a faster pace. The local governments have to look into issues of public health and hygiene and accordingly fix standards and enact laws for them. Street food has emerged as a very potential business as it is more affordable even to the poorest.

Question: Are school nutritional programmes successful?

Answer: Yes, these are successful but they need policy support from the governments and moral obligations on the part of the schools and the parents.

Suggestions:

- In countries like India, as a part of nutritional security, the government, has introduced a Mid-Day Meal scheme for school children. Similarly, there are schemes to ensure nutritional security for pregnant women under child and women welfare departments. Vegetables and fruit should form a part of the diet in such schemes.
- The concept of nutritional garden is a strong tool to create awareness about nutritional security at the school levels as well as at the homestead levels. Like curriculum on 'Physical Education', a curriculum on 'Gardening/ Kitchen Garden/ Nutritional garden' may be introduced in schools for the children.

vi. Urban and Peri-urban Agriculture (including organic agriculture) for Ensuring the Safety of Foods.

Question: How much of the crops in Bhutan are under organic cultivation?

Answer: 80% of agriculture in Bhutan is rural while 26% of land in cities is under agriculture. Since UPA is a new concept in Bhutan and organic cultivation is traditionally being followed, organic cultural practise is being preferred in the urban areas. Since organic culture is patronised by the Royal King of Bhutan most of the UPA interventions would be with organic practices only.

Question: Whether GAP for the crops grown under UPA has been standardised?

Answer: Clean soil, clean water, clean hands, and clean surfaces are the essence of GAP. Same principles are being followed in UPA. As such, exclusive packages of GAP for crops under UPA have not been developed.

Question: What is the market size of organic products in Bhutan?

Answer: Traditionally agriculture in Bhutan is organic. There has been lot of awareness about food safety and quality and naturally consumers prefer organically produced products. Bhutan has a very strong innovative system called 'Bhutan Organic Certification System' (BOCS), which has been developed to provide assurance for organic products. This system utilizes the trained inspectors of Bhutan Agriculture and Food Regulatory Authority (BAFRA) to inspect the farmers groups and certify them by adopting the established traceability systems. Further, BOCS would help the farmers for market access and developing linkages with various institutions to promote food safety and traceability (BOCS, 2013). Lemon grass and red rice are certified organic for exports.

vii. Impact of Waste Management and Utilization in Improving Urban and Peri-urban Agriculture.

Suggestions:

- Urban and peri-urban agriculture can play an important role in the urban environmental management system through absorbing urban waste, preventing expansion of waste dumping and turning illegal waste dumping sites into productive open spaces. The compost prepared from organic waste decreases the need of chemical fertilizers and contributes to sustainability of soil fertility. The wastewater generated at urban centres is a complex urban natural resource and can be utilized as an additional source of water for irrigation in urban and peri- urban agriculture.

It is high time that urban planning should include municipal solid waste management and efficient urban water resource management strategies in UPA possibly under PPP mode.

viii. Vegetables Farm in School at Si Sa Ket Province

*Question***:** Are these agricultural schools?

Answer: Rajaprajanugroh 29 Si Sa Ket School is a welfare school whereas Si Sa Ket College of Agriculture and Technology is an agricultural school.

Question: What is the knowledge base of the teachers?

Answer: The teachers in the Si Sa Ket College and Rajaprajanugroh 29 Si Sa Ket School are qualified teachers in agricultural disciplines.

Suggestion:

- The success of nutritional garden in schools depends more on the teachers and the parents. Refresher courses for the teachers and awareness and training courses for the parents on UPA and its practices may be taken up by the schools.
- Special provisions and rewards may be initiated for taking up home gardens by urbanites and community gardens by the private organisations as a social responsibility.

3.2 REVIEWS AND PROSPECTS

3.2.1 Enhancing Multi-stakeholder Collaboration and Investment in Urban and Peri urban Agriculture.

Question: Generating cash surplus, economic stability with food and nutritional security would be the main issue for the sustainability of UPA. How is UPA equipped with tools to address this.

Answer: Various types, practices and UPA models are being implemented at various places. An institutional arrangement for carrying out the economic feasibility studies of these has to be done. It is also essential to initiate research work on these aspects by the agricultural/horticultural universities and research institutes as a part of their ongoing research programs. If neededе funding arrangements may be made from some international organizations to take up such studies.

Question: Land value and economy plays important role in implementing UPA. There is a need to create an urban land bank. What measures could be taken for this purpose?

Answer: This is a policy issue to be tackled by the government. However, recommendations from forums like this would definitely influence the policy makers and politicians in favour of UPA.

3.2.2 Development Initiatives in Food Production, Utilization and Mechanism of Management in Developing Urban and Peri-urban Agriculture in Asia.

Question: There would be inequality between urban and rural economic growth. How could this be addressed*?*

Answer: There is less understanding about the concept and various aspects of UPA. In no way is the urban agriculture going to put pressure on the economic growth of rural agriculture. In fact, these would supplement and complement economic growth of each other.

Suggestions:

- The migrants to urban cities are the most vulnerable and their voice needs to be heard for which there is a need to develop a mechanism. The migration to urban cities is going to increase unless the government provides economic security to the rural poor.
- Emphasis needs to be given to peri-urban agriculture for which more infrastructure facilities need to be created in peri-urban areas.

4 BEST PRACTICES

BEST PRACTICES

Urban and Peri-urban Agriculture (UPA) is growing crops and raising live stocks within and around the urban areas: cities/towns/metropolis, complementing the rural agricultural system in the production and supply of food to the locals, including related activities like supply chain and value chain management, enhancing the exchange capacities of urban and peri-urban poor by providing employment and entrepreneurship opportunities- an integral component of sustainable socio economic development, a smart ecological activity to maintain healthy environment and harmony in the community towards resilient food system notwithstanding the food safety aspects. With this understanding the United Nations Development Program defines Urban and Peri-urban Agriculture as 'an industry that produces, processes and markets food and fuel, largely in response to the daily demand of consumers within a town, city, or metropolis, on land and water dispersed throughout the urban and peri-urban area, applying intensive production methods, using and reusing natural resources and urban wastes, to yield a diversity of crops and livestock' (Smith et.al., 1996). Urban agriculture / peri-urban agriculture is not a new production system, which has been in practice since the dawn of civilization. But UPA as a new concept on most scientific production principles is definitely a new concept, to be perceived and understood as a resilient food system in the growing trend of urbanization and food and livelihood security of the urban and peri-urban population.

Presently, the concept of UPA has taken a new direction to provide a definite road map for the food production for the urban and peri-urban masses. New models, processes and protocols, activities, action plans and practices have been developed for production of food to meet the growing demands of healthy and safe food for the urbanites. Economic viability and profitability, social/community acceptability, environmental sustainability, food quality and safety are the torch bearers of sustainability of any UPA production system. Many UPA production systems and practices in vogue are: open field crop production, home gardens, school gardens, hospital gardens, prison kitchen gardens, community gardens, vacant public gardens, landscape gardens, vertical gardens, roof top gardens, under plastic cover, green houses, hydroponics, organo-ponics, aquaculture, small animal rearing (livestock production), small processing units, supply chain and value chain management systems, urban waste water and organic waste/solid waste treatment plants in varying scales, input levels and degree of market orientation like subsistence, mixed subsistence, small market oriented, small commercial oriented, large commercial oriented etc.

What makes the 'Best Practice' is that which provides the best choice of the crop/livestock, production system/technique, availability of space, media for production, minimizing risks of water and soil contamination, proximity to traffic and dense human population, minimizing risks of public health and community sentiments, proximity to consumer markets, perishability of the produce, availability of support inputs and services, etc. and at the same time is economically viable and profitable.

A good number of country papers and case studies on UPA were presented along with various models and practices being followed/implemented in various countries and suitability of these were discussed during the Regional Workshop on Strengthening Urban and Peri-urban Agriculture towards Resilient Food Systems in Asia and best practices across various urban and peri-urban situations and agro-climatic and crop growing situations were identified as below;

1. Commodity based Best Practices

1.1 Horticultural crops

The most preferred crops are vegetables

1.1.1 Vegetable Crops

Cole crops: cabbage, cauliflower, broccoli, Brussels sports, kale, knol khol, baby pak choi, lettuce, arugula.

Root vegetables: radish, turnip, beet root.

Solanaceous vegetables: green chilli (hot pepper), tomato, eggplant, sweet pepper.

Melons and cucumbers: musk melon, long melon, water melon, and cucumber.

Leafy vegetables: spinach, basella, fenugreek, spinach beet.

1.1.2 Fruit Crops: papaya (dwarf varieties), guava, banana, lime, orange, dragon fruit, passion fruit, etc.

1.1.3 Mushroom: all types of domesticated edible mushrooms.

1.1.4 Fruit Crops under Social Forestry: mango, tamarind, jack fruit, Singapore cherry, Garcinia, amla, etc.,

1.2 Plantations and Nnts: coconut, oil palm

1.3 Social forestry plants: pongamia, neem

1.4 Agricultural Crops: pulses like perennial red gram, field beans, sweet corn.

1.5 Livestock:

1.5.1. Meat and dairy goat, lamb

1.5.2. Broiler - chicken, duck

1.6 Aquaculture: Inland fisheries, waste water fed fish culture, aquatic vegetable production.

The above crops and livestock are produced from urban and peri-urban agriculture under various models/ production techniques as detailed below.

2. Production based UPA Best Practices

2. 1. Pot Culture: Cabbage, cauliflower, broccoli, brussels sprouts, kale, knol khol, baby pak choi, lettuce, arugula, radish, turnip, beet root, green chilli (hot pepper), tomato, eggplant and fruit plants like lime, Chinese orange, straw berry are the preferred crops.

2. 2. Edible Landscape Gardens: Cabbage, cauliflower, broccoli, Brussels sports, kale, knoll khol, baby pak choi, lettuce, arugula, radish, turnip, beet root, green chilli (hot pepper), tomato, eggplant, and fruit plants like mango, guava, papaya, passion fruit and flower like morning glory are the preferred crops.

2. 3. Roof Top Gardens: Vegetable crops like cabbage, cauliflower, broccoli, Brussels sports, kale, knol khol, baby pak choi, lettuce, arugula, radish, turnip, beet root, green chilli (hot pepper), tomato, eggplant and fruit plants like papaya (dwarf varieties), guava, banana, lime, orange, dragon fruit, passion fruit are the most preferred crops.

2. 4. Home Gardens/Subsistence Farming: Pot culture, roof top garden and traditional raised bed cultivation methods are the best suited ones. Green chilli (hot pepper), tomato, eggplant, sweet pepper, spinach, basella, fenugreek, spinach beat, perennial red gram, field beans, sweet corn, papaya (dwarf varieties), banana, lime, guava, passion fruit.

2. 5. Peri-urban Vegetable Cultivation under Cover (net house production and poly house production): Sweet pepper like colour capsicum, cantaloupes, muskmelon, watermelon, English cucumber, cherry tomato, lime and lemons. These are also small market oriented, small commercial oriented, large commercial oriented production systems.

2. 6. School Gardens: Pot culture, roof top garden and traditional raised bed cultivation methods are the best suited ones for the schools. Green chilli (hot pepper), tomato, eggplant, sweet pepper, French bean, spinach, basella, fenugreek, spinach beet are the preferred crops. In some cases where the schools have sufficient land as large space, some of the fruits like mango, guava, pomegranate, amla, coconut are also grown by the children. In some countries nutrition garden is being taught as a part of the curricula in which the importance of nutritional values particularly of the fruits and vegetables, production of vegetable seedlings are taught to school children.

2. 7. Hospital Gardens: Edible land scape gardens, roof top gardens and raised bed open cultivation on the principles of back yard home gardens are the most suited models. Green chilli (hot pepper), tomato, eggplant, sweet pepper, French bean, spinach, basella, fenugreek, spinach beet, few gourds like ridge gourd, bitter gourd, ash gourd and cucumber are the most suited vegetable crops.

2. 8. Prison Kitchen Gardens: This is basically introduced in the prisons based on the principles of backyard home gardens for self-consumption and as a part of rehabilitation of the prisoners. The most suitable crops are; green chilli (hot pepper), tomato, eggplant, sweet pepper, French bean, spinach, basella, fenugreek, spinach beat.

2. 9. Community Gardens: This has got ample potentials to implement UPA models like roof top gardens, pot culture, edible landscape gardens and traditional open field cultivation. The preferred crops could be vegetables. Apart from this the issue of empowering civic societies to implement UPA would be addressed properly.

2. 10. Vacant Public Places: Vacant public places have great potential for taking up various models of UPA practices with people's participation and this can be implanted in the PPP mode, inviting funding from private bodies.

2. 11. Institutional Gardens: Roof top gardens, edible landscape gardens and production under protected environment are suitable practices and most of the vegetable crops would be the preferred crops. In addition, it offers ample opportunities as small market oriented, small commercial oriented, and large commercial oriented UPA practice with organo-ponic production of exotic vegetable crops.

2. 12. Organoponics: Organoponics are a system of urban organic gardens. They often consist of low-level concrete walls filled with organic matter and soil, with lines of drip irrigation laid on the surface of the growing media. Organoponics are a labor-intensive and could be taken up by institutional setups and civic communities.

2. 13. Aquaculture: Wastewater-fed fish culture, Inland fisheries in ponds and lakes of the urban localities, organic waste–fed fish culture in the periurban ponds/lakes and production of aquatic

vegetables like wild rice (Zizania aquatica; Zizania latifolia; Zizania palustris; Zizania texana), watercress (Nasturtium microphyllum (Boenn.) Rchb. Nasturtium officinale W.T. Aiton,), water pepper (Persicaria hydropiper), water spinach (Ipomoea aquatic), Wasabi (Wasabia japonica), Chinese water chestnut (Eleocharis dulcis), taro (Colocasia esculenta), Lotus (Nelumbo nucifera Gaertn), Cattail, Bulrush (Schoenoplectus californicus) etc. are some the preferred ones.

2. 14. Small Animal Rearing (livestock production): Land and odour are the limiting factors. The most preferred practices are; rearing meat and dairy goats/sheep in the peripheries of the urban areas and broiler production in the peri-urban areas.

2. 15. Birds rearing: the home-and enlarged-poultry units and duck rearing are coming up fast in urban and peri-urban areas.

3. Theme based UPA Best Practices

3.1 Waste Management and Utilization in Urban and Peri-urban Agriculture: All the organic waste and other solid waste including waste water generated in the urban areas can be converted into fertilizer using appropriate conversion technology, e.g. anaerobic digestion, which can be used for the crops in UPA.

3.2 Urban and Peri-urban Forestry/Social Forestry/Forests and Trees for Healthy City: Tree planting particularity fruit trees, social forestry trees, plantation and nuts are the most ideal plants which could be used to plant along the roads, community gardens in the urban areas and develop green cover for the cities by planting them in the peri-urban areas.

3.3 Organic Agriculture for UPA: Organic agriculture is picking up very fast in the urban areas because of the increased awareness of consumption of safe food. All the crops grown under various models /practices of UPA can adopt the principles of organic production of crops that generate better revenue because of niche market.

The above identified practices are found to be suitable under UPA conditions. Studies are under way in various countries and in the coming years definite recommendations with benefit cost ratio studies would emerge.

The summary of the best practices mentioned above contributed by the participants from participating countries and the resource persons have been compiled for ease of the readers. The details of the above practices can be found in the respective volumes and chapters of the Proceedings.

5 FIELD VISITS

FIELD VISITS

The field trip programme was organised on the last day namely 30 January 2013. This was facilitated by Ms. Wilailak Sommut and very informative, educative and interesting. The details of the field visit are given below;

1. Visit to waste management, water treatment and utilization plant, Nonthaburi Municipality, Nonthaburi Province, Thailand

The Bio fertilizer plant under the guidance of the Royal Development Project is situated at the Services and Environmental Quality Development Center (SED), 69/13 Moo 9, Tambon, Bangkvasor, Muang District, Nonthaburi Province, Thailand. Mr. Permpong Pumwiset, Chief of the Project extended a warm welcome to the visiting delegation to the project site and made a detailed presentation of the activities and achievements of the project. Mr. Kisada Chumim, Director of the project addressed the visiting delegation.

The major activities of the project are Treatment and management of human waste residues collected from various corners of the city, separation of the waste into organic waste, solid waste, and infectious and hazardous waste and utilization of these, conversion of these into bio-fertilizers and utilization of the bio-fertilizer for agricultural crops particularly for horticultural crops in the urban and periurban areas. This is based on anaerobic digestion process as the guideline of the Royal Development Project. The process consists of an aerobic digestion in bioreactor tanks by batch type addition of anaerobic digesters to the sewage sludge over a period of one day. The slurry from mobile vacuum tanks is put into an anaerobic digestive tank (1 tank/day). There are 31 reinforced anaerobic digestive tanks in the project site. Each tank is of 4.0 X 5.0 X 2.5 mts size to keep the slurry volume about 40 cubic metres. Each tank consists of vent tube, manhole and gate valve. The waste in the tank is discharged to the sand beds next tank as the final treatment of the slurry at the end of 28 days of anaerobic digestion. The bio rector is sealed thereafter for 28 days. Micro-organisms present in the biosphere will digest the organic residues and other waste materials under anaerobic condition for 28 days. At the end of 28 days of digestion, the slurry is drained out from the reactor to sand beds, left for sun drying and to be used as solid fertilizer. The sand bed chamber is a masonry type with 4.0X5.0X1.2 mts size. One sand bed consisted of under drain pipes. Stone No 2, stone No 1, coarse sand 20, 10, 20 cms respectively. A plastic wire screen sheet is laid on the top surface of the sand layer for solid separation after drying. The effluent is filtered through the sand layer and used as liquid fertilizer.

The major components on the site of the project were;

1. Anaerobic digestion tank (bio-reactor)
2. Sand beds
3. Effluent storage pond
4. Fertilizer storage plant.

The compost final forms

The fertilizer storage building on the site is a 9X12 mts size structure used for collection, mixing and packing of the said fertilizer "Nakoran Nonth Fertilizer-2". This fertilizer is sold to the farmers and gardeners on an average of 5 tones/ month.The effluent storage pond is an open outdoor pond of 8.0X16.0X1.5 mts size. This is used to collect and impound the liquid waste discharged from the sand bed and used as liquid fertilizer by farmers and gardeners. The project personnel claimed that the solid fertilizer formula -2 was free from pathogens of digestive system disorders, improves soil conditions and has no bad odour.

This project is one of the best examples of Sanitary Disposal Method to bring prosperous public health works to solve the environmental problems.

2. Visit to Roof Top Agriculture at Laksi District Office, Thailand

Views of office premises of Laksi Distict Office Building

The project site was the landscape office premises and the roof top of the Laksi District Office Building, Laksi District, Thailand. The visiting delegates were received by the staff of Laksi District Office

under the leadership of Mr. Narong Jongjamfa, Director of Laksi District Office followed by a video presentation of the Roof top agriculture (gardening) in the same building. It was an exciting experience for the visiting delegates. The beautiful landscape of the building starting from the compound wall and entrance to the building, which were decorated with beautiful flowers of pansy and petunia and well grown healthy vegetables grown in hanging pots were a welcome experience to the delegates.

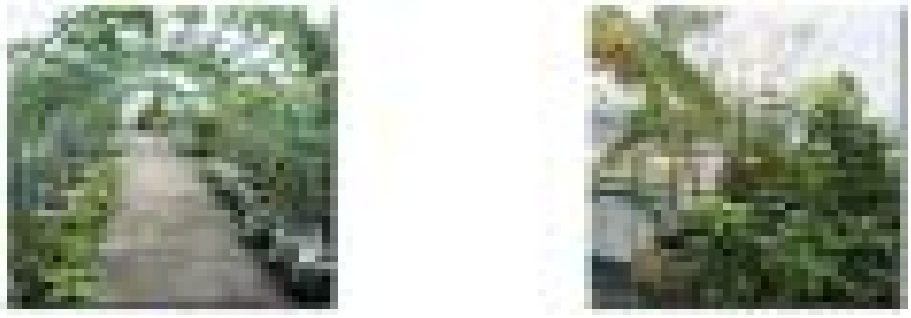
The entrance wall to the conference hall fully covered with hanging pots of beautifully grown vegetables gave a smiling and pleasant feeling while entering the conference hall where a video presentation of the project was made.

The corridor, the center of entrance path, the corners of the climbing staircase to the various floors with message on growing vegetables and fruits were all landscaped beautifully and aesthetically with various types of vegetables grown in pots. This path further led to the roof top garden on the 9th floor of the building.

Views of Roof Top Garden at the Laksi District Office Premises

This Roof Top Garden on the 9th floor has a total area of 440 sq. meters which has been architected and built by the staff of Planting and Park Cleaning Section of Laksi District Office and managed by Ms. Tensri Tosa-ad, the technician assisted by 6 skilled staff. The major activities of this include growing vegetables, fruits, and flowers in pots of sizes suitable to the respective crop. The entire space of the Roof top was filled with a variety of vegetable crops like cabbage, broccoli, lettuce, radish, basil leaves, morning glory, tomato, chilli and gourds; and fruits like banana, Chinese orange, lime,

passion fruit, pomegranate, papaya, dragon fruit and noni. All these crops were organically grown. Vermin-compost was the major growing media used. Bio-extracts were indigenously prepared by the staff itself which was used as fertilizer.



Views of Roof Top Garden at the Laksi District Office Premises

The materials used for preparation of the bio-extracts were waste from the vegetables, fruits and fish bone. For plant protection, an insect repellent liquid bio-extract which is bitter, volatile, hot and astringent was used and is prepared by the staff there itself using indigenous methods. A soil surface dwelling compost preferring earth worm species was used for vermin composting. The vegetables grown in the roof top garden and at various places of the landscape of the building is being sold to the staff of the Laksi District Office and also to the general public over the counter. It was informed by the staff that during the recent flood in the district which had destroyed all the vegetable crops in the area and when the entire building was surrounded by water due to flood, the roof top garden and various other places of the landscape of the building could provide sufficient quantity of vegetables to the staff for three days. This project is the center of attraction in Laksi district for the tourist, students and the general public and is one of the best standing examples of urban agriculture in a true sense. This has inspired many and through the experience of roof top gardening to the ground gardening, this concept has been replicated at nine more places in the city. This has also become a learning center for the school children, agricultural/horticultural students, and garden hobbyists and general public.

On 22 October 2007, FAO had awarded Roof Top Agriculture Garden of Laksi District with World Food Day medal certifying that the district produces plenty of safe and quality food for the people. Laksi district office was also awarded 'First Local Thai Innovation Award' by the Prime Minister, Mr. Abhisit Vejjapiva on 07 September 2010 in the field of National Resources and Environment Conservation.

Certainly this project is the best standing successful example of Urban Agriculture – a new hope to contribute towards food and nutritional security of the urban masses- a concept which can be duplicated in all urban and peri urban typographies round the world in these days of increased urbanization.

3. Visit to Waste–fed Fish Culture

The delegates visited the project site of fish culture fed on vegetables and fruits waste from the fresh markets and restaurants. The project site, spread over four hectors of area with seven tanks for commercial fish culture, belonged to Ms. Pitsami, Suan Prik, Thai Municipality, Pathumthai, Thailand.

This is an interesting and successful rural women enterprise project. The lady has taken 4.00 ha of seven natural tanks for commercial fish culture on lease basis from the municipality. Carp and Catfish

are the main types of fish cultured here. A separate small tank is maintained for growing fingerlings that are subsequently released in the main tanks for culturing. The main source of feeding for these is vegetable and fruit waste collected from fresh markets and organic food waste from restaurants from Bangkok city. This waste is fed to the fish in the tanks by carrying the waste in boats and immersing it in tanks for the fish as main food. The lady is assisted by two permanent workers. The fish collection / harvest is done once a year and marketed in retail. The ever smiling lady Ms Pitsmai proudly explained that it was a satisfying and profitable enterprise for her, which she has been doing for the past several years. This project is a good example of typography of UPA involving fish culture to provide food and nutritional security to urban populace along with waste management of organic waste of urban cities.

4. Visit to Peri urban Vegetable Plantation

Peri-urban Vegetable Cultivars

Post lunch, the delegates visited the peri urban vegetable plantation at Bangdena Sub district, Soi Wat Nong Pong, Mucang Pathumthani, Thailand. The visiting delegates could see and experience the real concept and understand the meaning of peri urban horticulture implemented at this place. About 100 ha low lying black heavy soil land was grown with variety of vegetable crops. Raised beds of about 50-100X4 metres dimension had been made in continuous rows along the length of the land with 2.0 metres distance between the raised beds. This space was fully surrounded by water flowing from a river channelized to these raised beds. The 2.0 metres distance between the two raised beds was like a canal having continuous flow of water through it with sufficient depth for the movement of a boat.

All the culturing operations starting from preparation of raised beds, planting of vegetable seedlings, inter culturing operations, plant protection operations, harvesting, etc. are done using boat for the

movement of men and materials. The entire area on both the sides of the road was filled with vegetable plantations on such raised beds. It was a scenic beauty to witness various vegetable crops grown in this area. Various vegetable crops like cabbage, broccoli, lettuce, radish, kale, basil leaf, morning glory, tomato, chilli, gourds (like bitter gourds, ash gourd and bottle gourd), etc. were seen growing in this entire area of 100 hectares. This entire area of 100 hectares belonged to about 16 farm families as informed by the farmers. The delegates interacted with Ms. Yuppadee Prawmpraing a vegetable grower owning about 3.35 ha of land in this area. This lady grows various vegetables like kale, lettuce, basil leaf, morning glory, cabbage and chilli. The lady informed that she has been doing this type of farming since past 8 years and is fully satisfied with the profits being made in vegetable growing. She also informed that she supplies these vegetables to the city through whole sale markets at Si Mum Mucang and Talad Thai and also through retail markets and street markets at Muesng Pathumthani. Another interesting point she mentioned was that the 2.00 metres low lying land between the raised beds where water flows continuously is also used for fish culture which is an additional income for the family. She also informed that she and the fellow farmers of this area are grateful to the Royal King for his philosophy of Sufficient Economy Theory which has made this vegetable farming sustainable and profitable. This peri urban horticulture area meets the demands of urban area of Bangkok and surrounding places.

5. Visit to Street Market

Meuang Pathumthani Municipality street market is a popular street market to which the workshop delegates visited. The Chief of the Municipality extended a warm welcome and along with his staff took the participants around to show various retail shops given to farmers free of cost for selling their farm produce.

Different kinds of vegetables displayed in the Street Market

Various types of vegetables commonly available in the malls and super markets were displayed in these stalls. This even though it is the most disorganized supply chain, it was found to be a well organized value chain market here. Participants were informed that every Sunday this is a very potential market which would be flooded with variety of customers. Many customers come in search of rare fruit and vegetables and fresh farm produce, and many customers come for marketing as leisure activity and enjoy street marketing. Other than farm produce dry products, fish, mushrooms, traditional and ethnic products etc. are also sold in this street market. Street markets are the upcoming and most potential markets around the world competing with organized markets.

The field visit ended with thanks to the organizers and particularly to the facilitator Ms. Wilailak Sommut.

Different kinds of vegetables displayed in the Street Market