

# Milieu Features of Food Insecurity and Potential Facets of Rural Aquaculture-Centered Asian Integrated Farming Systems

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## Abstract

The food security is now far more complex issue than it was a generation ago, and a fast-unfolding food shortage is engulfing the entire world, driving food prices to mind-bogglingly highs. Indeed, due to rapid population increase and diet-globalization as well as recent mounting grain-demands dilemmas - *Calorie-for-Calorie* and *Food-to-Fuel*, not a single country in the world, regardless rich or poor, so as to be totally food self-sufficient. Even the individual's nutritional security now depends much on global food distributions and market prices; and in Asia, along with rapid population growth, rising natural calamities, low productivity, and diminishing per capita resources becoming severe threats to the rural poor dwellers. After some concise overviews on such facets with notable reference to Bangladesh, this article mainly targeted to focus on obligatory-need of integrations of the agricultural sub-sectors, basically for the improvements of rural livelihoods. Prior to that, some brief focuses would be on food and nutritional status in Asian countries with a succinct dietary-learning query on Japan. The farm-resources interdependencies, an old practice in Asia, characterized by various cycles and recycles, offers new hopes; and some innovative integrated farming systems are emerging as *de rigueur* to enhance the production of animal (*poultry, eggs, milk, fish, etc.*) and plant (*vegetables, fruits, etc.*) foods from the same unit of land. The recent surge of interests in aquaculture-centered farming *integrations* are due to growing concern to maximize productivity through optimum resources-utilization in a world undergoing rapid population growth, severe malnutrition, low productivity, and diminishing per capita resources. Indeed, small-scale such integrated farming practices could play diverse roles towards the improvement of rural livelihoods, if designed and promoted for the disguised family labors including women as homestead and/or near-by pond-dike production programs. The prime purposes here are to

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provide a *précis* on concepts, goals, and potential roles of Asian aquaculture-based small-scale integrated farming models, related impacts, and then some field level experiences. The article also recaps the status of Asian livestock and aquaculture as well as rationalized the requisites of a '*blue revolution*' towards rapid promotion of aquaculture-based farming integrations.

**Keywords:** Population, Resources-degradation, Smallholdings, Food-security, Globalization, Malnutrition, Employment, Integrated-farming, Aquaculture, Livestock, Bangladesh, Japan, and Asia.

## I. INTRODUCTION: The Scopes and Setting of the paper

When assessing the adequacy of basic resources, such as land or water over time, population is the universal denominator - *as population expands, per capita availability shrinks*. World population has exceeded 6 billions spotch in 1999, which is more than double the figure of 1960, and projected to be between 7.3–10.7 billion by 2050 (UNFPA 2000); and most likely, in early-2008, be 6.7 billion. Meanwhile, over 83 per cent people live in the contemporary least developed countries (LDCs), where populations are growing at 1.5 per cent annually — 6 times as faster than average of industrialized or developed countries (DCs). Such huge population will need to be matched by the production of more food that every person can afford; and each year the world's farmers need to nosh at least an additional 70 million people,<sup>1)</sup> good or bad climate. Globally, around 3 billion people are food insecure, who live on 2 dollars or less a day and who spend up to 70 per cent or more of their income on food, as even a modest rise in basic-food prices can quickly become life-threatening (Brown 2008a). Among them over a billion are hardcore poor, who live on simply 1 dollar or less, in the Asian LDCs - *as there were total livings on the entire planet only a century ago*. For them, it is the next meal that is the overriding concern.

The principal of chronic poverty is, basically a low level of nutrition, ultimately due to inadequate food availability. The transition of ending stock ratio of world grains is drastic, and due to recent global boost-up of basic foods prices (*see* FT 2008), many LDCs are probably a step behind famine and social outbreaks. Due to rapid diet-globalization and mounting demand-dilemmas of grains, such as "*calorie for calorie*"<sup>2)</sup> and bio-fuel for vehicles, not a single country, regardless rich or poor, so as to be totally food self-sufficient.

The food security is now far more complex issue in now-LDCs than it was a generation ago, and a fast-unfolding food shortage is engulfing the entire world, driving food prices to record highs. The excessive human demands have been collapsing environments and increasing natural calamities,<sup>3)</sup> above all severely affecting people's livelihoods. Besides rapid decreases of arable land, even up to one-half of the world's population lives in water-scarce environments (Huang *et al.* 2002); and fishes

and other aquatic animals are among the world's most threatened species.<sup>4)</sup> Opening more arable land, using more fresh water in the name of agricultural intensifications, and dependent only on natural fishes are no longer desirable options.

There is no short-cut solution to ensure livelihoods security of the poor rural dwellers rather need comprehensive ways to tackle, as their poverty and/or food security are now multi-dimensional phenomenon. Besides further promotion of existing major poverty alleviation strategies, after necessary modifications, the food production strategies in LDCs need to be redesigned with balanced-diets and changing market-dynamics under globalization. At the micro-level, to achieve stable households, food security persist to be a primary development of most LDCs with highest priority in rural areas.<sup>5)</sup> Among many options, so far, for the food and nutritional security of the vast rural dwellers in Asian LDCs, socio-economically and environmentally most viable way would be to recycle all wastes and residues obligated as means to maximize rural farming productivity, both subsistence and commercial types, at lower costs.

Traditionally in Asia, *as a densely-settled continent plus for its diverged socio-cultural and agro-ecological characteristics*, resources interdependencies in farming are ubiquitous, and numerous *Integrated Farming System* (IFS) have been practicing for long.<sup>6)</sup> The recent surge of interest in aquaculture-based IFS is due to the growing concern to maximize productivity and through optimum utilization of resources in a world undergoing rapid population growth, severe malnutrition, low productivity, and diminishing per capita resources. Poor people traditionally had been much dependent on natural aquatic products for their nutritional supply and within last two-three decades fish culture became popular practices. Small-scale rural aquaculture has diverse roles towards the livelihoods improvement – potentially it can contribute to improving household food security and supplementing family income of the resource-poor rural dwellers (*see* Karim 2006, Halwart 2005, Muir 2003, New 2003, Edwards 2002, Yap 1999, etc.). The hypothesis here is that the role of fishponds in IFS has potential towards improving rural livelihoods, basically food and nutritional security. Some small-scale IFS models are now considered by many as viable economically, ecologically and socially. If we look on potential insights of aquaculture, a *Blue Revolution* in Asia, like previous Green Revolution (GR), would be obligatory. The prime aim here is to explore the context and characterize the aquaculture-based small-scale IFS in Asian LDCs to easy access of low-cost protein sources for health and nutritional security of the poor, above all their livelihoods improvements. The article is based on author's long observations on human security situations in Asia under a UN regional development project, and basically aquaculture-based IFS portions are derived from time to time several field-visits (2001–2006) as well as hand-in-experiences in aquaculture-based IFS in most South and Southeast Asian countries. Numerous secondary documents and databases also used after necessary reviews.

After above introductory overviews, the next *Section* outlines the milieu features of increasing food insecurity and undernourishment in LDCs, whereas *Section-III* focuses the food and nutritional

insecurity and dietary perspectives in Asian countries with a comparative succinct learning-query on Japan; and then the resources degradation and land fragmentations in densely-settled areas with example of Bangladesh. The *Section IV* concentrates on concepts, goals, and traditional resources interdependencies in Asian farming along with brief highlights on status and potential insights of Asian livestock and aquaculture as well as needs for an obligatory '*Blue Revolution*' towards rapid promotion of aquaculture-based IFSs. The *Section V* provides brief reflections on aquaculture-centered basic models of IFS, especially prime focus areas would be on potential aspects and related experiences of small-scale aquaculture-based IFSs. Finally, *Section VI* is for overall discussions and concluding remarks.

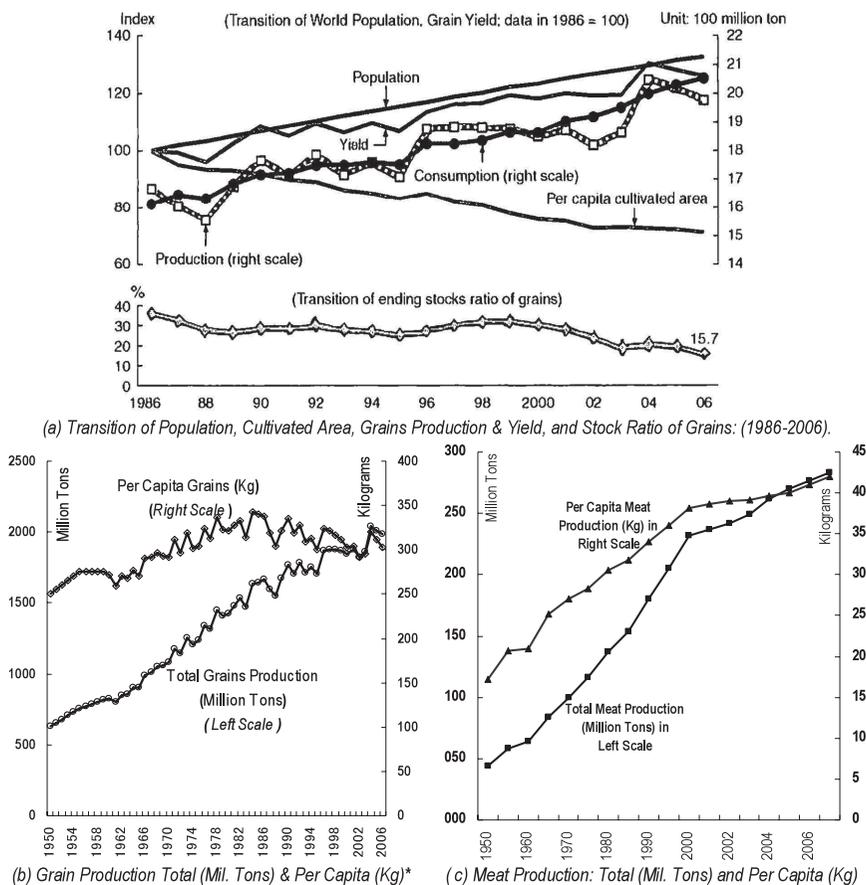
## II. MILIEU FEATURES OF FOOD INSECURITY AND MALNUTRITION IN THIRD WORLD COUNTRIES

### Transitions of Global Population and Food Production-Consumption

***Population Growth and Grain Production:*** The near famine food-crisis of the mid-1960s preceded the bold "GR" gamble on a technological package of a semi-dwarf wheat and dwarf rice varieties, irrigation, and complementary inputs, enabled higher growth of grains production for decades. Indeed, along with rapid population growth and the drastic decreasing trends of arable land, the overall food production and productivity have been raised remarkably, albeit the cereal stock ratio gradually reduced to 15.7 per cent in 2006 (Figure 1:a), which indeed lowest ratio in 3 decades (EDI 2007b). The per capita grains production yet above 300kg, as before (Figure 1:b), though the grain carryover stocks in May 2008 have fallen to the level of just 55 days of world consumption, the lowest on record (Brown 2008b).

Growth in world grain demand, traditionally driven by population growth and rising incomes, basically the desire of people in LDCs to move up the food chain and consume more grain-intensive livestock products, and also would further being driven by the fast growing other demands, such as grain-based fuel ethanol for cars (Brown 2008a). So far, in recent times, roughly 60 per cent of the world grain harvest is consumed as food, 36 per cent as farm animals feed and around 3 per cent as bio-fuel (EPI 2007b).

While the use of grains for food and feed grows by roughly 1 per cent yearly that used for fuel is growing by over 20 per cent a year; and the total bio-fuel production tripled between 2000 and 2007. Much concentration on grains use for ethanol in USA (*see* Figure 2) becomes a severe threat to the third world countries - *as traditionally USA is the number one political food-aids provider and also most dominant export player in world's grains and corn trades*; and during 2007, the grain-based ethanol supplied less than 4 per cent of US gasoline consumption but used as much as 20 per cent of the harvested-grains.

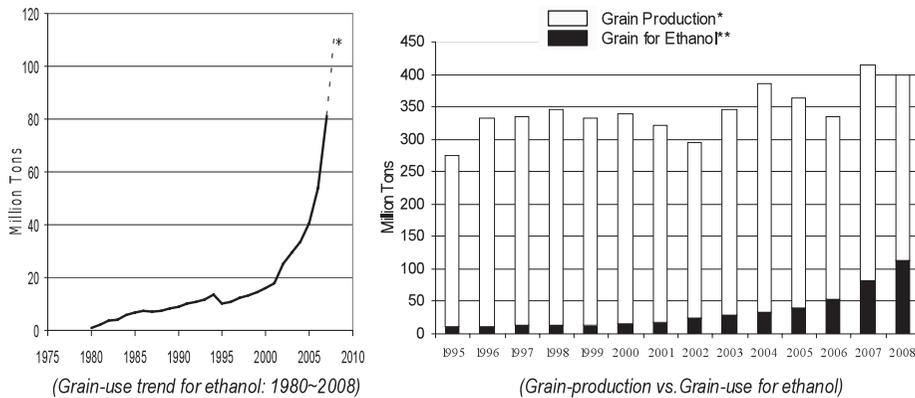


**Figure 1: Population, Resources, and Food Production - Trends and Transitions**

Notes: Based on—(a) MAFF (2007), whereas (b) & (c) FAO and USDA databases. \* The per-capita grain production (PGP) increased from 250kg in 1950 to 312kg in 1972; and since after with exceptions of 3 years — 1973 (296kg), 2002 (292kg), and 2003 (295kg), the PGP always exceeded 300kg with a peak of 343kg in 1985.

**Global Meat Production and Status of Aquaculture:** One of the most predictable trends in the global economy, the world meat production climbed from 44 million tons in 1950 to 233 million tons in 2000, more than the five-fold increase; and the meat intake per person worldwide increased from 17 kg to 38 kg; and the meat growth was roughly double that of population (see Brown 2001); and the total and per capita global meat production trends are provided through Figure 1 (c). World meats production grew to 265 million tons in 2005 of which 92 per cent sourced are beef (22.7%), poultry (30.6%), and pork (38.7%), and remaining portion are from sheep, goat, etc (see WWI 2006).

Demand for meats — *beef, pork, poultry, mutton, and so on*, typically rises with income, perhaps driven by the taste for meats with little exceptions of the crises related to recent modern farming products, e.g. diseases from food-borne pathogens, such as E. coli, to mad-cow or *BSE*<sup>7)</sup> disease in vitro-beef products and bird-flu virus in poultry industries.<sup>8)</sup> As of estimate, global meat outputs in



**Figure 2: US Grain Production and Use for Ethanol: Trends and Proportions**

Notes: \*Estimate for 2008 (projected by *Earth Policy Institute*), and \*\* Ethanol supplied less than 4% of gasoline consumption in 2007...but used 20% of the U.S. grain harvest.

Source: *EPI, USDA, RFA*.

2007 raised by 2.3 per cent to almost 283 million tons, an increase of over 6 million tons from the previous year, probably within the context of a recovery in consumer confidence in meat products. Global modern farming meats production increased rapidly in recent years with a clear domination in LDCs, even if per capita consumption is yet near one-third that of the industrialized countries.<sup>9)</sup>

**Table 1: Growth of World Animal Protein Production, by Sources: 1990–2000**

Protein Sources	Annual Rate of Growth (%)	Remarks
Aquaculture *	11.4	Notes: * For the periods of 1990–98. Based on <i>FAO: Yearbook of Fishery Statistics: Capture Production and Aquaculture Production (Rome: various years)</i> . Source: <i>Brown (2001: Chapter 7, Feeding Everyone Well)</i> .
Poultry	4.9	
Pork	2.5	
Beef	0.5	
Oceanic fish catch *	0.1	

During 1990s, among major animal protein sources, so far, the overall aquaculture-based protein production shows highest growth rate compare to beef, pork and poultry (Table 1). The trends of global fish harvests increased remarkably with narrowing gap between dominant wild harvests and fish on farms raised.<sup>10)</sup> There was a decrease in the contribution of capture fisheries to human consumption, but this was offset by an increase in the aquaculture contribution with rapid growth in recent years (Table 2).

*Calorie for Calorie* or industrial animal production, not surprisingly, the economics of the varying rates<sup>11)</sup> in conversion is accelerating growth in outputs among the more efficient converters; and related costs would be a concerning issue in shaping the future production trends of *beef, pork, poultry, and fish*. In the new situation, the world’s existing feedlots are being maintained, but there is little

**Table 2:** Recent World Fisheries and Aquaculture Production and Utilization  
(Production in Million Tons, except Per Capita Food Fish in Kg and Population in Billions)

Production & Utilization	2000	2001	2002	2003	2004	2005*
Inland Production (Total)	30.0	31.4	32.7	34.4	36.4	38.5
<i>Capture</i>	8.8	8.9	8.8	9.0	9.2	9.6
<i>Aquaculture</i>	21.2	22.5	23.9	25.4	27.2	28.9
Marine (Total)	101.1	99.6	101.0	98.8	104.1	103.1
<i>Capture</i>	86.8	84.2	84.5	81.5	85.8	84.2
<i>Aquaculture</i>	14.3	15.4	16.5	17.3	18.3	18.9
Total World Fisheries	131.1	131.0	133.7	133.2	140.5	141.6
<i>Total Capture</i>	95.6	93.1	93.3	90.5	95.0	93.8
<i>Total Aquaculture</i>	35.5	37.9	40.4	42.7	45.5	47.8
Human Consumption	96.9	99.7	100.2	102.7	105.6	107.2
Non-food Uses	34.2	31.3	33.5	30.5	34.8	34.4
Per Capita Food Fish (kg)	16.0	16.2	16.1	16.3	16.6	16.6
World Population (billions)	6.1	6.1	6.2	6.3	6.4	6.5

Notes: Production excluding aquatic plants. \* Preliminary estimate.

Source: FAO Aquaculture, Statistical Year Book 2006.

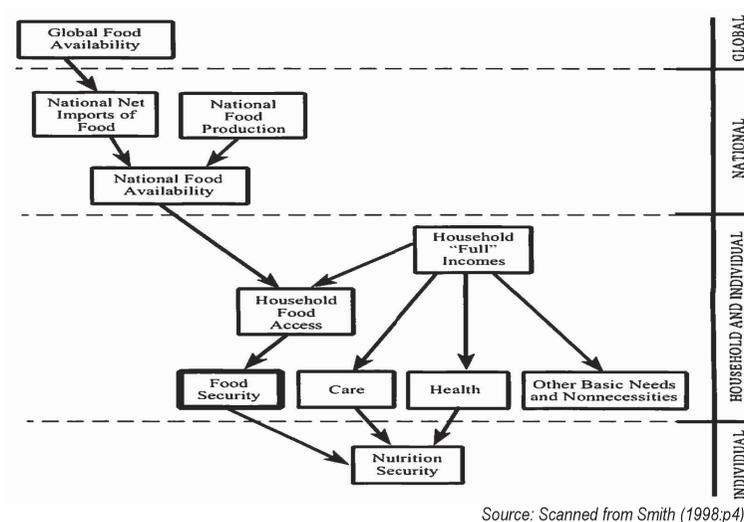
new investment in feedlots simply because of the higher cost of fed beef (vitro) products. The less growth rate of beef during 1990s, probably had linked to sudden fears of *BSE* disease and also related trade-impacts on global beef markets.<sup>12)</sup> Whereas the reasons of rapid growing poultry meats is due to comparatively lower production costs - *less feeds and less space need, and home-based management, even by the female members* as well as various restrictions on other meats.<sup>13)</sup> Even if, now a days, there are growing bird-flu fears among many peoples as well as import-dependent grain-feed becoming costly, the poultry industry probably would continues to grow in coming years.<sup>14)</sup>

Fishers in LDCs catch 3 out of 4 wild fish by weight and also eat most of the world's fish, though due to high population density they eat much less per capita, roughly half compared with developed world's consumption at 29 kg (Larsen 2005). However, aquaculture would be most emerging industry in future, mainly in Asia, as traditionally fishes and other aquatic products are dominant protein source in Asian-diets; and fishes alone supply 30 per cent of the protein in Asia versus just 6 per cent of protein worldwide.

### People's Nutritional Security, Hunger Outlooks and Undernourishment in LDCs

Food security has defined as access by all people at all times to enough food for an active, healthy life (WB: 1986). Traditionally, food and nutritional security refers to overall livelihoods improvement, depends much regular income flows through job generation, both wage and self-managed, and provisions for basic amenities. In recent two decades, the food and nutritional security became toughest issue worldwide, especially among international communities and United Nations (UN)

systems. There is not a single country in the contemporary world, regardless rich or poor, so as to be completely self-sufficient, and thus every individual's food and nutrition security now strongly linked with global food production and distribution, above all availability in reasonable prices. So far, to ensure food and nutritional security for the individuals, a comprehensive policy planning is deemed essential (*see* Figure 3).



**Figure 3: Conceptual Framework for People's Nutritional Security**

Beside many initiatives, those have been undertaken for poverty alleviation and rural livelihoods improvement during last few decades, the food insecurity and the number of hungry people in world's low-income territories rose rapidly. For instance, the global poor peoples increased from 804 million to 849 million between 2005 and 2006 in 70 countries those had considered for the evaluations (*see* Meade *et al.* 2007), which means that now more people are vulnerable to food insecurity. The average nutrition gap, the indicator of food availability, was 13.5 million tons (grain equivalent) in 2006 and is expected to increase to 14 million tons by 2016. The average nutrition gap was much smaller than the distribution gap, which takes into account unequal purchasing power within countries. So far, the high increasing trends in prices of the basic foods, many third-world countries probably now only few-steps behind the famine situations.

So far, most of world's contemporary policy strategies, both international and nationals are not in favor of hungry peoples. Even if, the WFS and MDG set a goal to reduce half of global hunger by 2015, the number of undernourished people in LDCs did not change well enough since 1990–92. In third world countries, the undernourished peoples have reduced just 3 per cent (from 20% to 17%); and the undernourishment is worse in Asian LDCs, specifically South Asian countries in general is most lag-behind (*see* Table 3). In case of poverty level - *as of World Bank's prescribed standard: US\$1 per day*

**Table 3:** Prevalence of Undernourishment and Progress toward WFS and MDG Goals

Particulars	Poverty (People <US\$1 in PPP/day) (%)		Total Under- nourished People (in Millions)		Proportion of Undernourished to Total (%)		Prevalence of Undernourished Ratio: <i>Current*</i> / <i>Baseline</i>	
	1991	2003	1990-92	2001-03	1990-92	2001-03	WFS Baseline 1990-92 <sup>*1</sup>	MDG Baseline 1990 <sup>*2</sup>
Region / Country	1991	2003	1990-92	2001-03	1990-92	2001-03	Target:0.5 (2015)	Target:0.5 (2015)
Asia Pacific	-	-	569.7	524.0	20	16	0.9	0.8
South Asia	-	-	290.4	298.5	26	22	1.0	0.8
<i>Bangladesh</i>	36	36	39.2	43.1	35	30	1.1	0.9
<i>India</i>	42	35	214.8	212.0	25	20	1.0	0.8
<i>Pakistan</i>	48	33	27.8	35.2	24	23	1.3	1.0
<i>Sri Lanka</i>	4	8	4.8	4.1	28	22	0.8	0.8
S.E. Asia	-	-	80.0	65.3	18	12	0.8	0.7
<i>Cambodia</i>	<i>n/a</i>	34	4.4	4.6	43	33	1.1	0.8
<i>Indonesia</i>	17	8	16.4	13.8	9	6	0.8	0.7
<i>Malaysia</i>	2	2	0.5	0.6	3	3	1.3	1.0
<i>Myanmar</i>	<i>n/a</i>	<i>n/a</i>	4.0	2.7	10	5	0.7	0.6
<i>Philippines</i>	20	15	16.2	15.2	26	19	0.9	0.7
<i>Thailand</i>	18	2	16.8	13.4	30	21	0.8	0.7
<i>Vietnam</i>	15	2	20.6	13.8	31	17	0.7	0.6
East Asia	-	-	198.7	159.5	16	12	0.8	0.7
<i>China</i>	33	17	193.6	150.0	16	12	0.8	0.7
Third World	-	-	569.7	524.0	20	17	0.9	0.8

Notes: PPP: Purchasing Power Parity, \*Current refers to 2003. WFS: World Food Summit, MDG: Millennium Development Goal. SE - Southeast. <sup>\*1</sup>WFS goal of 1996: halve, between 1990-92 and 2015, the number of undernourished people.

<sup>\*2</sup>MDG goal 1 & target 2: halve, between 1990 and 2015, the number of undernourished people.

Source: Compiled from FAO (2006).

in PPP-scale (or hardcore poor), no significant achievement is yet reported in South Asia, specifically poverty in percentage has remained stagnant in Bangladesh.

The recent IFPRI research has shown that 160 million people live in ultra poverty on less than 50 cents a day (Ahmed *et al.* 2007). Besides whatever initiated until now, much more honest measures are deemed necessary, otherwise those who are the poorest and hungriest today will still be poor and hungry in 2015, the target year of the WFS and MDGs. Indeed, the rapid changes in global economy, especially mounting demands of grains for non-food needs, the poor people are most vulnerable now than the recent past; and if such trends continue, many more would join to the hunger lists across the globe.

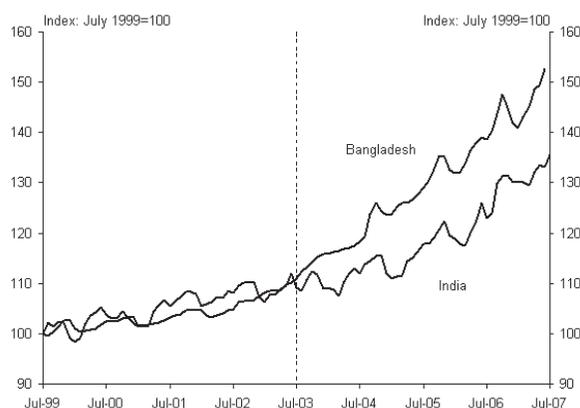
Current dilemma is - whether it may be possible to produce enough nutritious food at reasonable prices that will be accessible to the poor? How then the rapidly growing numbers of labour-force can productively be employed in agriculture, a sector which is often considered to be already over-

populated to the point marginal productivity are low or zero? It will be more problematic for densely-settled territories such as Bangladesh, India and Indonesia, where much of rural inhabitants have been continuing to be landless or near landless.

### Food Insecurity in LDCs: *Silent Features and Future Concerns*

The globalization of world economy has brought many changes, both good and bad, in food distribution, dietary systems and food habits, and people's livelihoods. Much concentration of grains for animal feeds and non-food or bio-fuel use, the annual growth in world grain consumption demand since 2005 has risen roughly from 20 million tons to 50 million tons. Under such circumstances, world cereal, energy prices, and food insecurity are becoming increasingly linked; basically the situations are becoming more complicated in traditional food-deficit countries. Among the losers from higher food prices are big importers, such as Japan and Saudi Arabia will have to spend more to buy their food. Perhaps they can afford it; however, in food-deficit LDCs situations would be either *silent hunger and/or spread of malnourished peoples as well as risks of food-riot, social unrest, and political instability, etc.*

***Mounting Food Prices and Silent Hunger in LDCs:*** Indeed, the impacts of cereal prices increase on food-insecure and poor households are already quite drastic in many places. Increased bio-fuel demands has contributed to higher world food and feed prices (Coyle 2007). Since 2000, the prices of wheat and petroleum have tripled, while the prices of corn and rice have almost doubled (see Braun 2007) but reportedly very drastic since mid-2007.<sup>15)</sup> Many densely-settled LDCs have been facing *Silent Hunger* since last 3-4 years; and in most recent months, many areas across the globe, food riots



**Figure 4: Food Prices in Bangladesh and India (July 1999 – July 2007\*)**

Notes: Based on FAO database. \* In Bangladesh, since after, peoples have been facing severe food insecure situations as food prices drastically further increased 40~70%, varied food to food, due to two floods in 2007 and a devastated cyclone in late-2007 as well as long political deadlocked situations (see Hossain 2008).

are becoming commonplace (*see* Brown 2008b).

There are large numbers of people who lose more from higher food bills than they gain from higher farm incomes - exactly how many varies widely from place to place. More worryingly, some of the poorest places in Asia, such as Bangladesh and India also face higher food bills, as shown in Figure 4. The higher cereal prices are not only leading to the deterioration of their diets in terms of quantity and quality, but also significantly eroding their overall purchasing power. With grain stocks at all-time low, many LDCs are only one poor harvest away from total chaos in food market.

**Table 4: Global Grains Exporters and Export Restrictions in 2008**

Top Grain Exporters	Quantity (Mil. Tons)	Top Corn Exporters	Quantity (Mil. Tons)
United States	106.1	United States	62.0
Argentina	28.1	Argentina	15.0
Canada	18.6	Brazil	9.0
E.U.	14.3	Paraguay	1.6
Russia	13.1	Ukraine	1.2
Australia	10.6	China	1.0
Thailand	9.3	South Africa	0.8
Kazakhstan	9.0	India	0.5
Brazil	8.7	Canada	0.4
Vietnam	5.0	E.U.	0.3
Top Wheat Exporters	Quantity (Mil. Tons)	Top Rice Exporters	Quantity (Mil. Tons)
United States	32.5	Thailand	9.0
Canada	14.5	Vietnam	5.0
Russia	12.0	United States	3.5
Argentina	11.0	India	3.4
E.U.	9.0	Pakistan	2.9
Australia	8.0	China	1.3
Kazakhstan	8.0	Egypt	1.1
Ukraine	5.2	Uruguay	0.8
China	2.5	Argentina	0.5
Turkey	1.5	Cambodia	0.5

Notes: Circles indicate export restrictions in place, as of May 2008. Mobilized from EPI links (EPI, USDA, FT database).

Around the world, a politics of food scarcity is emerging further. Most fundamentally, it involves the restriction of grain exports by countries that want to check the rise in their domestic food prices (Table 4). These export restrictions in early 2008 simply further drive food prices higher in the world market, basically drastic but unusual impact is on international rice market (*see* Figure 5), even if rice is mainly staple food in Asian countries with reported huge production access in Asia as well as rice is unlikely be used as livestock feeds since the unit cost of producing rice is much higher than other grains (*e.g.* maize).

The food security is strongly linked with the global food prices; and for every 1 per cent increase in the food price, food consumption expenditure in LDCs decreases by 0.75 per cent (Regmi *et al.* 2001). The poor across the globe, mainly in Asian LDCs, now spend a higher share of their income than 2007 on food than do wealthier sections of populations due to further drastic increase of rice price in early-2008; and even the moderate poor in many Asian LDCs becomes most vulnerable groups quickly as they bound to spend 70 to 80 per cent or even more of their total expenditures on basic foods alone. Above all, the major changes under globalization neither favoring the third world nor even their vast poor.



**Figure 5: Rice Prices in International Trade (Aug./1985–April/2008)**

Notes: Medium Quality Rice (*or Grade B*) and based on USDA ERS database (*Monthly-based*).

***New Challenges in LDCs and Priority Policy Strategies for Asia:*** *Calorie for calorie*, we need more grain if people eat it transformed into meat than if eat it as bread. The innate hunger for animal protein, which manifests itself in every society, has lifted the world demand for meat in each year, especially during last four decades at expense of the world grains. Overall meats production increased rapidly in LDCs, albeit, virtually less or no benefits to the vast rural depressed.<sup>16)</sup>

It is not difficult to guess “*who loses and who gains*” from the rapid economic globalizations.<sup>17)</sup> For instance, as the price of one crop shoots up, farmers plant it to take advantage, switching land from other uses. So a rise in wheat prices has knock-on effects on other crops, such as maize and rice. In principle the farmers in LDCs should gain from higher farm incomes, however, in practice it is near impossible, specifically in densely-settled Asia.<sup>18)</sup> Obviously, farmers, basically larger ones benefit – if governments allow them to keep the gain, which is true for larger farmers in countries like USA. Again, due to rapid expansion of farming meats production tendency, especially poultry farming in Asian LDCs, the demands for feeds, basically maize are met largely by imports, seemingly relatively higher costs (Braun 2007). Under such realities, it is not an easy task for farmers in Asia to change their production strategies.<sup>19)</sup> Some larger LDCs, such as India and China, may overcome their problems partially through regional adjustment and/or shifting their production strategies for their large domestic as well as international markets but it would be difficult for densely-settled smaller ones, like Bangladesh.

Global business as usual could mean increased misery, especially for the world’s poorest populations; and without restoring food security immediately, social unrest and political instability would spread further and number of failing states likely to increase quickly. Apparently, placing agricultural and food issues onto the international trade and climate-change policy agendas, may be a critical option, even if, it would not be enough for ensuring an efficient and pro-poor response to the

emerging risks.<sup>20)</sup> So far, a mix of policy actions that avoids damage and fosters positive responses is required, and to achieve stable households, the food and nutritional security persist to be a primary development of most LDCs.

It is important to recognize that the essential preconditions for food security are — availability, access and stability. At the macro-level, the government of LDCs needs to readjust their national policy agendas and diversify their production strategies under changed market environments and local conditions as well as with highest priority in rural areas. In all three dimensions at the micro-level, food and nutritional security concerns are associated with the capacities of the rural individuals and households to produce, buy and use food of right quantity and quality at the various phases of life-cycles.

### III. SOCIO-ECONOMIC, AGRO-ECOLOGICAL, AND DIETARY FACETS IN ASIA

Asia immensely differs with other parts of the world socio-economically, culturally, and agro-ecologically. Agriculture itself has been suffering from highly uneven distribution of input resources, low per capita holdings and landlessness, numerous uncertainties, etc., and all above characterized the production processes. Most importantly, there is considerable controversy, in most Asian LDCs, concerning the existence of protein deficient diets, and the protein gap has been amazingly attributed to a lack of enough food rather than insufficient protein. In some areas of Asian LDCs the peoples, regardless poor or rich, are too much dependent on carbohydrate, basically rice-sourced. We better nose-down our eyes on such issues in Asian LDCs.

#### **Socio-economic Environments and Resources Degradation in Asian LDCs**

Apart from the generally high poverty levels and low per capita incomes, there are large differences in the income level of different segments of the population. In average, resources degradation is higher than other parts of the world. Size limitations, land redistribution and productivity, and owner-tenant relationships are crucial concerns of the governments and development analysts alike.

***Disguised Labor-force and Self-employment Provisions for Rural Poor:*** The important aspect of the rural poverty and food insecurity is that, even with an adequate supply of food at the prevailing price, often because most rural dwellers in Asian LDCs are either unemployed or underemployed, mostly disguised labor-force; and in fact, it is not easy to detect their actual professions. Basically, the most rural poor dwellers are either marginal farmers or seasonal day-laborers, and they sometimes either depends on low outputs farm or non-farm crude activities or a mixer of both for their survival. Traditionally women in LDCs, half of the labor-force, are economically inactive; even if they do longer hours per day than their male counterparts (*see* Hossain 1999); and besides household works (e.g. *child-bearing and rearing, cooking, cleaning, and so on*), poor rural women had been engaged in

agricultural post harvests and processing activities but such scopes reduced drastically because of the increasing landlessness as well as availability of related low-cost technologies. Many poor rural women in LDCs also have been working as household servants/maids and/or migrated to urban areas for their surviving.

Besides many traditional government-run rural development strategies, in last two-three decades, reportedly there have been many new developments to tackle poverty, as a means of employment generation initiated by the non-government organizations (NGOs) for the vast rural labor force, mostly women. So far, most tremendous development is, worldwide women-focused millions of self-employment generation in rural areas through collateral-free micro-finance provisions (*see* Hossain 1999), basically several hundreds types of tiny-enterprises are now run by poor women those financed by the semi-formal micro-credit programs (MCPs).<sup>21)</sup> There are also reportedly many impressive scattered women-focused programs in many parts of Asia, as for instance, in Thailand, NGO-Government collaborative approach, by shifting industrial factories at the grassroots, has created thousands rural employment for the poor women (*see* Hossain, *et al* 2006). Again, the rapid growth of export-oriented ready-made garments factories in urban and suburb areas in many Asian LDCs, such as Bangladesh, Cambodia, China, Vietnam, and so on, is the largest another development that created millions of women-focused jobs.<sup>22)</sup> All those are important and even need further promotion but alone would not be well enough for sustainable food and nutritional security of the rural poor dwellers.

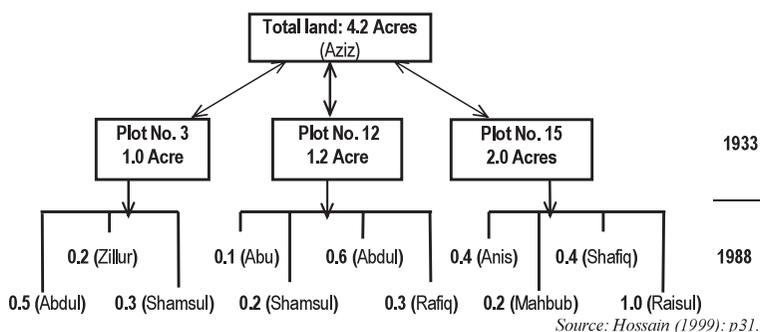
**Resources Degradation and Low Per Capita Holdings:** In Asian countries, in average, degradation of resources are higher than other parts of the world. Agriculture itself has suffered from highly uneven distribution of input resources as well as low per capita arable holdings, and numerous uncertainties, exploitation, and corruption have characterized production processes. Poor access to water, especially perennial water, reduces options for agriculture-based livelihoods. As for instance, due to over-dependent on underground aqua-reserves, mainly for irrigation, the arsenic in drinking water became a severe health threat to millions of rural dwellers in densely-settled Bengal basins (*see* Hossain 2002b). The predicament of livelihoods insecurity in some cases, are further aggravated by the lack of fuel resources. In South Asia animal manure is used for fuel thus breaking another source of on-farm recycling of nutrients.

In many LDCs, especially the more populous ones, the most important challenge arises from the increasing numbers of *landless* poor in absolute terms.<sup>23)</sup> Among the set of classic causes population pressure, inheritance patterns and exhausted ecosystems and natural disasters (*such as* floods, cyclone, river erosion, etc.) separately or in combination, can accelerate the process of landlessness (Jazaary *et al.* 1992).

Size limitations, land redistribution and productivity, and owner-tenant relationships are crucial concerns of the governments of LDCs and development analysts alike. Per capita arable land and average farm sizes has been drastically decreasing in most Asian countries, basically due to rapid

population growth. Even *Land Reform*,<sup>24)</sup> which has been considered in literature, involves the redistribution of land from large to the small farmers that actually had increased near landless people rather than the numbers of cultivators. Most importantly, the average farm size in Central Java is less than 0.6 ha (hectares), while in Bangladesh it is as below 0.4 ha only. The world has observed successful redistribution and resettlement of land in Japan, Taiwan and the South Korea after the World War-II. If it could be done successfully in those countries, the assumption was that the same methods could be used elsewhere. This has turned out not to be the case in now-LDCs.<sup>25)</sup>

**Land Fragmentation – An Example from Bangladesh:** Most Asian LDCs have been engaging in difficult developmental struggle amplified by the persistent pressures of population growth on limited land base, such as densely-settled Bangladesh,<sup>26)</sup> where each year arable land is falling by 1.6 per cent; and the landlessness and fragmented landholdings have been rising harshly due to house construction, road building, setting up of industries, expansion of towns and cities, river erosion, etc (Smith and Biggs 1998).



**Figure 6: A Case of Land Fragmentation in Rural Bangladesh**

*Notes: Visualized by author (based on official records, mobilized by Nahtan: 1989). Location: Mauza (Administrative village) No. 4, Union - Rampur, District – Lakshmipur. Names in the bracket indicate the owner of the respective plots; and 1 Acre = 0.404 hectare.*

Land fragmentations are drastic in many Asia countries, and smaller farms are said to lack the capacity to withstand recurrent economic hardships, and ultimately, forced land sales are common. In South Asia, specifically in Bangladesh, due to complex inheritance system,<sup>27)</sup> generation-by-generation, farmland becomes more and more fragmented. The fact that landholdings are not consolidated but dispersed further exacerbates the trend toward small farm size. Figure 6 provides summary picture of this reality. It is not uncommon for an individual to hold five to ten geographically separate parcels in a total land ownership of one acre or less. At the same time, large landholdings are also subject to the same re-division process, and landlords do not own land on a large scale as they purchase land from different small farmers at different times and in different places. Such fragmentation creates managerial

inefficiencies, although the dispersion is a form of diversifying small farm production and risk.

In fact, among all rural dwellers, over three-fourth households are not basically producers but net consumers of food grains, basically rice; and the major benefits of the GR were being monopolized by rich and middle farmers to the relative exclusion of small peasantry, tenants, landless and near landless poor (Hossain 1988). Rice is the dominant staple food crop in Bangladesh and most part of Asia, particularly for the humid tropics, having 96 per cent of global production that in recent years reached roughly 600 million tons of un-husked rice (Hossain 2004). Under GR in Asia, the production has increased faster than population for three decades, and most of the growth in production originated from technological progress in the irrigated and the favorable rain-fed ecosystems.

### **Asian Dietary Perspectives and Strategies Change *De-Rigueur* in LDCs**

Almost 90 per cent of global rice is produced and consumed in Asia, despite being produced on small and marginal and tenant farms with extreme population pressure on limited land resources. A typical farmer in Asian LDCs plants rice primarily to meet family needs, and hence the marketed surplus is small, however historically the international rice trade has been very much Asia-centered.<sup>28)</sup> Variable natural conditions cause shortages and surpluses to occur from year to year. These in turn produce wide fluctuations in trade-able surplus and make prices in both domestic and international markets highly unstable. Other than Asia, the USA - that produces small quantity of rice, is a dominant exporter of rice (*see* Table 4) with highest productivity at lower cost than do some Asian countries (*see* Table 5/notes).

***Rice Dependency in Asian Diets:*** A typical Asian farmer plants rice primarily to meet family needs, and hence the marketed surplus is small. Even rice grown on small family farms, almost 96 per cent of global rice is produced and also over 90 per cent consumed in Asia. In Asian LDCs, at low levels of income, when meeting energy needs is a serious concern, rice is considered a luxury commodity; and sometimes the rice consumption is equated more with habit rather income-increase or export and import substitutions.

Traditionally, as incomes rise, consumers go for a diversified diet and replace rice with high-cost quality food with more protein and vitamins, such as vegetables, bread, fish, and meat. Growing urbanization, which accompanies economic growth and industrialization, further dampens the demand for rice with higher claims of non-food basic needs on the family budget. However, the consumption patterns of rice in some Asian LDCs are little bizarre. For instance, in most Asian LDCs with income increases per capita rice intakes decreased, whereas Bangladesh, Philippines and Vietnam reveal the opposite (*Table 5*). Bangladesh case is little typical as background features of the country differs drastically with other Asian LDCs.<sup>29)</sup> Having highest population density in the world, in per capita annual rice consumption, the country's position is yet 3<sup>rd</sup> along with Cambodia; and Probably would overtakes even Vietnam and Myanmar, if more rice are available!

**Table 5:** Changes of Rice Consumption, Yield and Unit Cost in Selected Asian Countries

Country	Per Capita Consumption (Kg/Person/Year) <sup>*1</sup>				Rice Yield <sup>*2</sup> [Eco-system: ES] (Tons/Hectare)	Unit Cost <sup>*5</sup> (US\$/Ton)
	1970–72	1989–91	1999–2001			
			Per Capita	Total (Mil. Tons)		
Bangladesh	150	153	155	21.37	3.64 [All ES: 2000]	133
China	79	93	89	113.51	n/a	n/a
Cambodia	163	158	155	2.03	n/a	n/a
India	69	79	76	76.45	5.16 [Irrigated: 1995–96] <sup>*3</sup>	88
Indonesia	105	147	149	31.62	n/a	n/a
Japan	89	65	59	7.53	6.41 [Irrigated: 1999]	2290
South Korea	119	104	88	4.12	6.60 [Irrigated: 1999]	868
Myanmar	160	209	203	9.71	n/a	n/a
Malaysia	123	81	88	1.96	n/a	n/a
Pakistan	29	14	13	1.78	n/a	n/a
Philippines	86	96	101	7.65	3.08 [All ES:1999–2000]	170
Sri Lanka	95	93	94	1.77	n/a	n/a
Thailand	152	110	109	6.83	4.20 [Irrigated: 2000] <sup>*4</sup>	70
Vietnam	157	154	167	13.03	4.18 [Irrigated: 2000]	79

Notes: <sup>\*1</sup>Based on FAOSTAT database, and direct rice-intake; <sup>\*2</sup>Based on IRRI World Rice Statistics, except Korea and Japan (national statistics); and rice yield is for un-husked rice. The attainable yields are about 8 ton/ha in the temperate zone and 6 ton/ha in the tropics, which are about to be reached in many countries. *The average Irrigated rice yield trends in Asia reported as (ton/ha): 3.16 (1967–69), 5.01(1984–86) and 5.80 (1997–99); whereas in Largely-irrigated areas for the same periods as: 1.62, 2.44, and 3.42; and in Rain-fed ecosystem as: 1.45, 1.77, and 2.12 respectively. S. Korea: South Korea.* <sup>\*3</sup> In India Rain-fed yield reported as 2.26 ton/ha with a cost of US\$115 (1995-97), and <sup>\*4</sup> In Thailand, it was 2.24 ton/ha with cost of \$103 (2000). <sup>\*5</sup> So far, world highest yield/ha has reported in USA (irrigated: 7.04 tons/ha) with cost of \$331 only.

Sources:Compiled from Hossain (2004: tables 1& 4, and figure 1).

The nutritional security is a complex phenomenon in most Asian countries, attributable to a range of factors that vary in importance across regions, countries and social groups, as well as over time. For instance, in rural Bangladesh, rice of the total is the staple and only basic food for the poor. The country in recent times has been producing much more rice<sup>30)</sup> compared to three decades before at the cost of non-cereal food products, those were good source of protein, minerals, vitamins as well as foreign currency (Hossain 2002a). In Bangladesh, with higher growth of calorie-consumption than most Asian LDCs (Table 6), albeit, the peoples are yet solely dependent on rice-sourced carbohydrate, basically one of the prime reasons of severe malnutrition in the country.<sup>31)</sup>

In Bangladesh, the share of cereal in diet has been typically over four-fifth of total calorie consumption, which probably highest among all LDCs, and so far around 23 per cent even higher than

**Table 6:** Per Capita Calorie Consumption Trends in Some Asian Countries

Country	Daily Calorie Consumption		Growth in Calorie Consumption	Share of Cereal in Diet	
	1992-94	2002-04		1992	2002
Bangladesh*	1990	2200	10.6	83.7	81.8
India	2340	2470	5.6	63.9	58.9
Indonesia	2810	2890	2.8	63.2	63.2
Pakistan	2370	2320	-2.1	54.6	51.7
South Korea	2270	2180	-4.0	59.9	58.8
Vietnam	2290	2630	14.8	77.0	76.5
Asia	2314	2444	4.1	65.5	65.3

Notes: \* Carbohydrate intake is mainly rice-sourced, which exhibits around 94% of total cereal, in rural areas. The annual per head rice intake had increased to over 5kg in 2001 (155kg) compare to 1971(150kg).

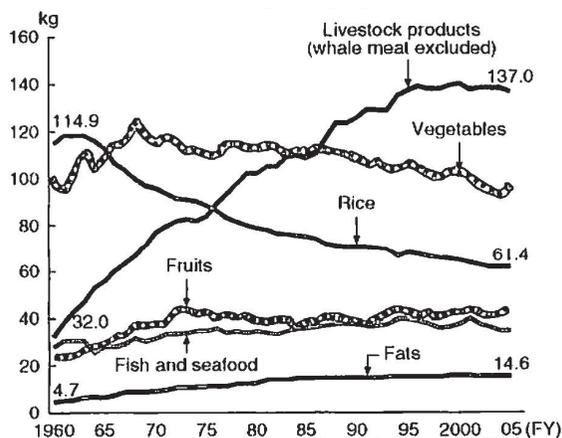
Source: Compiled from Meade et al. (2007).

the India, a country with many restrictions on animal-proteins and also grasps huge vegetarian-people. Traditionally almost all people in Bangladesh, regardless poor or rich, mainly prefer to eat rice rather balanced food, not only due to shortage of other foods but habit.<sup>32)</sup> The nature of contemporary food insecurity in some countries, such as Cambodia, is due to inadequacy of households' access to food rather than food availability.<sup>33)</sup> Household food security is the application of this concept at the family level, with individuals within households as the focus of concern. Conversely, the Japanese diet has been recognized as most balanced in the world, typically differs with other protein-rich dietary-tables.

**Food Consumption Transitions and Calorie-Intake in Japan:** Growth in demand for a staple grain depends on - *the level of per capita income; the rate of growth of population, and the change in prices relative to those of substitute crops.* With increases in income, people tend to substitute low-cost sources of energy such as coarse grains, cassava, and sweet potato for rice. But, at high levels of income, rice becomes an inferior item in diets (Ito et al., 1989).

As income grows, per capita rice consumption is expected to decline as consumers substitute rice with high-cost quality food containing more protein and vitamins such as processed rice, vegetables, bread, fish and meat. Japan, Taiwan and the South Korea have already made this transition, and rest of the Asia will be making it in proportion to the pace of their economic growth. The Japanese people used to had consumed annually over 160kg of rice per head prior World War-II; however, in post war periods, the consumption has decreased drastically. In 1960 per capita consumption of rice was around 115kg, whereas in 2005 it has reduced to just 61.4kg, which is based on average of net supply (Figure 7); however, the actual consumption of rice and rice products now reportedly below 60kg (see Table 5), as they now eat different kinds of food beside rice with rapid piercing of meat consumption.

In most Asian LDCs, rice in diets is yet dominant, *almost similar to the pre-war periods of Japan,*



**Figure 7: Per Capita Food Intake Trends in Japan by Food Category**

*Notes: Based on Food Balance Sheet of Japan (Approximate calculations: MAFF 2007). Livestock products include meats, milk, eggs, and related processed items. Amount of consumption is defined as supplied net food; Annual per capita direct rice consumption reached below 60kg in late-1990s, and possibly will be below 50kg by 2025 (FAO & other estimates). FY- Financial Year.*

even if, in last two decades, worldwide many drastic changes have happened in food systems and consumptions due to increasing diet-globalization as well as food traceability and accessibility. Bangladesh, and some other Asian countries, beside their already heavy rice-intakes, yet imports rice! The people of those countries need to end their sole dependence on rice and diversify their food and feeding habit. Moreover, balance-diet not always means to high protein-rich diet, which usually changes with income increase, but depends much on people awareness-building about health and food-nutrients.

Japanese vocabulary for breakfast, lunch and dinner are rice-related, like Bangladesh (*see, note 32*). They have not changed the vocabulary and custom but have changed the rice proportion and their eating habit; and even if it is not fully justified to compare Japan with any LDCs but there are many lessons to be learn from Japanese case. The contemporary Japanese dietary pattern particularly differs with any other protein-rich dietary-tables, which have been recognized as most balanced in the world, and within last 2-3 decades, worldwide Japanese food became popular among many peoples.<sup>33</sup> Albeit, in average, Japanese peoples take fewer calories than the people in other DCs, and their proportions of nutrients also differs much, especially fat-intake is much lower than France and USA (*Table 7*). Conversely, higher incomes in some Asian LDCs, *e.g.* India and China, have made hundreds of millions of people rich enough to afford meats and other protein-rich foods, whereas most rural dwellers are becoming poorer and malnourished.

**Table 7:** Comparative Supplied Nutrients in Selected Countries  
(As % of Per Capita Calorie Intake)

Country (Year)	Calorie from (in %)* —			Remarks
	Protein	Fat	Carbohydrates	
Japan (2005)	13.0	25.5	61.5	National Average
USA (2003)	12.2	37.2	50.5	„
France (2003)	12.9	41.8	45.3	„
Thailand (2003)	9.3	19.0	71.7	„
Vietnam (2003)	9.9	16.2	73.9	„
China (2003)	11.1	29.5	59.4	„
India (2003)	9.5	19.4	71.1	„
Bangladesh (2002) (2006)**	n/a	n/a	81.8	„
	8.7	4.9	84.1	Selected Ultra-Poor
	8.7	3.8	85.3	Non-selected Ultra Poor

Notes: Compiled from MAFF (2007), except Bangladesh from Hossain (2004) and Haseen & Sulaiman (2007).

\* Due to genetic and varied physical conditions, the proportions of calorie requirements may differ from country to country, e.g. fat-standard for Japanese is roughly 25% of total calorie intake, whereas for European countries and USA between 27~30%, etc.

\*\* Total 400 poor households those who are considered as food insecure, and Selected Ultra-Poor means those are now under BRAC's ( NGO) vulnerable food program and Non-selected Ultra-Poor are those who not under the program.

**Food-Consumption Shifting and Rice-Limits in Future:** Higher incomes, urbanization, and changing preferences are raising domestic consumer demand for high-value products in Asian LDCs. The composition of food budgets is shifting from the consumption of grains and other staple crops to vegetables, fruits, meat, dairy, and fish. Consumers in Asia, especially in the cities, are also being exposed to non-traditional foods. Most of the Asian LDCs yet show very slow decreases in per capita rice consumption because of their slow economic growth, with little exceptions of China and then India. However, due to diet globalization, the consumption of wheat and wheat-based products, temperate-zone vegetables, and dairy products in Asia has increased (Pingali 2006). The demand for *ready-to-cook* and *ready-to-eat* foods is also rising, typically in urban areas.

In future, with rapid population increase, the global rice production continues to grow but not the per capita rice consumption.<sup>35)</sup> Due to rapid economic growth in many Asian LDCs, specifically China and India, further decreases of rice consumption will result in the over supply of rice, and the market price of rice would be getting lower; thus, the paddy-plantation may not be profitable in future. Most recent drastic rice-price hikes is unusual, and such situations may not be stabilize for long; and the international rice-trade probably would be limited in future, as rice is staple food basically in Asia. Moreover, since the unit cost of producing rice is much higher than other grains and corns (e.g. maize), rice will unlikely be used as livestock feeds, whose demand has been growing very fast with increasing

incomes and meats consumption. The above situations probably would make rice under pressure for its survival in international trades; if not take special measures by the Asian countries, specifically China, India and Japan.

### **Low Livestock Protein-Intakes in Asian LDCs: *What Obligatory Strategy be in Future?***

At Asian villages, traditionally rice, fish, and vegetables always dominated the diets of all groups of households. Basically natural fishes and other aquatic products were major nutrient-rich easy-accessed food items of the vast rural dwellers, even if in last few decades all those have been reduced to the danger level of disappearing due to over-catching besides negative impacts of agricultural intensifications. Conversely, we should keep in our mind that in Asia, the breed-house of all major religions, traditionally many peoples either not dependent of livestock-based proteins or have restrictions on particular meat due to socio-cultural conditions and religious beliefs. Traditionally, livestock meats and related products have been luxury items even to the rural better-off dwellers due to very low outputs of the ruminants. A recent feature of the livestock sector in Asia, however, has been a divergence in ruminant and non-ruminant production systems. There has been a rapid increase in poultry and pig production using modern large-scale operations, particularly in those countries experiencing rapid economic growth due to relatively straightforward technological transfer from temperate regions and an expansion in international trade of feedstuffs. However, meat-based protein have been always a rear item in diets of the Asian poor people, especially for resource-poor rural dwellers, as livestock, like fishes and other aquatic animals, not available free from natural-sources.

The development strategies for the contemporary LDCs must be designed *de novo*, taking full account of present conditions and future prospects. So far, there is no given prescription for complete solution of poverty or/and food and nutritional insecurity, as all those are multi-dimensional phenomenon. The concern of many people today is how those that live in abject poverty can be raised to a reasonable level of existence. In present situation, besides more efficient promotion of non-farm productive activities, the basic challenge to policy is to devise surrogate ways of using the under-utilized labors and other resources to produce more goods, specifically balanced foods. Hitherto, it is clear that as there is limited scope for further crop-only intensifications and/or horizontal land expansion to cope up with the future food demand, rather vertical intensifications through integration of different agricultural enterprises (*vegetable/fruits+livestock+fish, etc.*) could help to meet expected increases in production demand and quality.

## **IV. RATIONALES AND POTENTIALS OF ASIAN INTEGRATED FARMING SYSTEMS**

In Asia, the majority of the population — *vast poor and food-insecure* live in the rural areas. A more vibrant rural economy is therefore a prerequisite for reducing poverty and malnutrition. There is no

short-cut solutions rather need comprehensive ways. There are many traditional forms of integration, which farmers in countries like China, Cambodia, Indonesia, Thailand, Vietnam, etc., had developed over many generations. No external input was provided for the livestock, fish or plants; and usually waste/s of one farm had used for another one. In fact, the whole life style had been based on cycles and recycles. The innovative integrated farming is one strategy that can be adopted to increase farm returns from per unit area of land (Amarasinghe 1991). The question is how best to use our limited resources has become one of crucial importance as we face today's many socioeconomic and environmental problems.

### **Rationales and Prime Cravings of IFS in Asian LDCs**

Much more dependent on agricultural intensifications, which have been practicing since post World War II,<sup>36)</sup> might be a harmful option to environment and human health. The farm-resources interdependency, the old practices in Asia, characterized by various cycles and recycles, offer new hopes. There is no other way for most Asian LDCs, to much depend on renewable natural resources, and they should capitalize on their sunny and hot climate for optimum microbial processes for recycling all their wastes and residues as fuel, fertilizer and feed to produce food, fiber and raw materials for their livelihoods security. In this sub-section, the author tried here to focuses on background-features and prerequisite of Asian IFS.

***Natural and Ecological Misery:*** In last four decades, there have been many harmful events in farming production activities; and some LDCs were even forced to accept polluting industries to locate in their poor communities to provide lowly paid jobs, without any provision for environmental pollution control or even workers' safety. There were also many man-made cultural constraints on reutilization of wastes in many parts of the world, with many official bodies making things worse by arbitrary laws and regulations. They resulted in scores of human settlements living in squalor because the wastes were not disposed of properly. These problems were compounded with inappropriate, imported technologies, which usually not took full advantage of local and environmental conditions to make the processes more effective and less costly. There are enough horrible examples in some countries to make the concerned leaders stop such disastrous development strategies, and adopt more appropriate systems.

The universally known problems also of commercial farming in LDCs are the prohibitive costs of external inputs, such as feed for livestock and fish, fertilizer for crops, and energy for processing, while most wastes and residues are left to pollute and even degrade the environment when they should be recycled as useful resources. The traditional knowledge and farming practices along with adjustment of modern scientific and technological innovations can improve all the farming and agro-industrial processes involved without upsetting the ecological equilibrium, and provides a new concept of development that can prevent environmental degradation while benefiting both investors and

communities' concerned, with production of foods and renewable raw materials first.

***Rural Livelihoods and Job-Creation Worth:*** Food and nutritional security basically linked with sustainable improvement of people's livelihoods depends much more on employment generation and basic amenities, such as provisions for health and universal education, and so on. Across the Asia, women have crucial but diverse responsibilities, in all aspects of the production system with individual differences among the countries. In their social obligations and kinship network ties nurtured through local cultures, women's social roles in LDCs are important in ensuring household food security. Even if, there are awesome developments in last two-three decades, especially women-focused job-creation, as indicated earlier (*notes: 21 and 22*). Besides such developments, vast women in rural Asia are yet economically inactive or hidden-treasures due to strong socio-cultural and religious norms. Indeed, it is also possible for poor landless women to make linkages with broader agricultural sub-sectors (Hossain 2002a), which indeed essential for efficient business promotion in rural areas.

Since there is little ability or chance to increase the amount of cultivated land and further intensifications of crop production would be environmentally harmful, as especially due to near productivity-saturation of rice and other crops. The alternative only way to increase employment, farm production, and income is to increase the productivity of the available resources, along with a shift of crop-only to more on integrated production strategies, as arable land has been reducing alarmingly with rapid population increase. It is also obligatory to enhance farm-productivity, and the efficient possible way is sustainable utilization of all available resources; and besides further promotion of existing non-farm activities, probably there are no alternatives other than the strategy of various farming-integrations.

***Small-Scale Enterprises and Rural Resources-Interdependency – Core Pulpit:*** Small-scale farmers dominate Asia, and livestock is an important socioeconomic aspect of indigenous farming systems, but both land and capital resources are limited. Farmers rarely use concentrated feed and only fallow land or arable land between crops is used for grazing. Ruminants depend on large quantities of low-quality roughages; they are fed agricultural residues, farm wastes and graze on grass and weeds along waterways and roadsides. Farmers are more inclined to cultivate crops rather than use land for grazing or pasture; fodder cultivation by small-scale farmers is practically non-existent because of land constraints.

Until the recent past, in most East and Southeast Asian countries, the usual livestock was 2-3 pigs per family behind the residence, raised not so much for meat production but as scavengers to eat anything that humans did not eat. They usually provided the meat for various festivals for families, those were close relatives. All over Asia, ducks and birds, also scavengers were reserved for visitors or as festival fare. There are some differences in the swine and/or cattle production, varied from area to area.

Most livestock are produced under a traditional village scavenger system with low levels of

production for subsistence consumption – scavenger chickens or pigs, small sheep and goatherds for meat and sometimes milk, and milk from traditional dairying in South Asia (Boer 1982). Very low or negligible amounts of the output are sold. A major aspect of cattle and buffalo production in Asia is the low off-take per unit, since large ruminants are used for draught power and only enough livestock needed for traction are kept. Milk consumption is not widespread in the humid tropics of Southeast Asia since dairy is not a traditional farming activity. Milk is widely consumed in South Asia but indigenous cattle have low productivity with an average milk yield of only about 2–3 kg per day.

Traditionally, integrated farming in Asia is not merely a concept but a popular practice in many rural areas since ancient times. The traditional forms of integration, which farmers in countries like China, Indonesia or Vietnam have developed over many generations. Most farmers in Asian LDCs own small plots of land and they are subsistence in nature and mainly engaged in producing field crops like rice, vegetables and fruits, doing fish culture, and the rearing of livestock and poultry with no or less harmful means. Hitherto, small-scale farming systems can create employment for whole family and there may have enough scopes for agro-processing based job opportunity for women. An important element in such a consideration is, beside traditional resources interdependency, increased labor absorption through new integrations in broader agricultural sub-sectors.

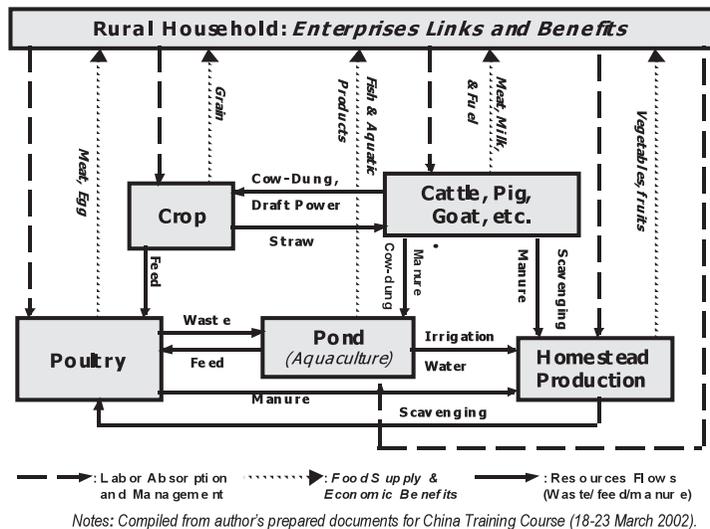


Figure 8: Rural Enterprise-Links and Waste-Recycles and Related Benefits

By tradition, they have been interrelated their resources among different enterprises for their survival. Indeed whole life-cycles of subsistence farmers have been characterized by various cycles and recycles (see Figure 8). The farming wastes were taken daily to the field and also used as raw fertilizers for the fish ponds to produce various plankton as fish feeds, and the only supplement was

either rice barns for livestock and fish. Basically, in densely-settled areas, the farm family preserved any surplus produce from the farm without any input from outside, and nothing was thrown away, not even human wastes.<sup>37)</sup>

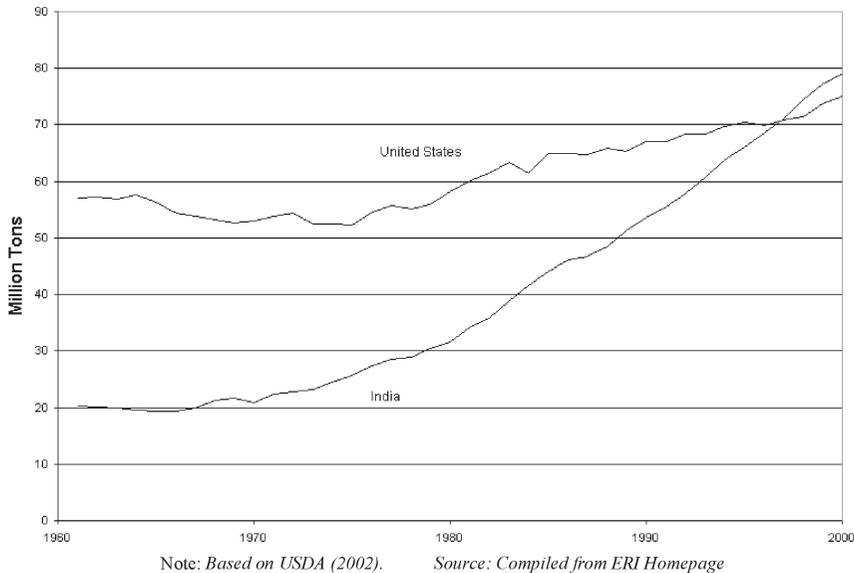
The same principles can be used, after necessary adjustments with current conditions, to meet the requirements of a modern society, instead of adopting systems those have been designed for other climatic and environmental conditions that requiring imported and costly input such as fossil fuels, agrochemicals and complex equipments. Any future focuses on such alien-rooted strategies would be unjustified, locally-unsuitable and shaky, both environmentally and economically. Apparently, an integrated system of livestock, fish and crop with the wastes and residues of all being used as feeds for livestock and fish, and as fertilizers for fish and crop cultures, can be viable economically, ecologically and socially. Then, under existing environments, both socio-cultural and ecological, what should be the priority areas and deciding factors for the promotion of IFS in Asian LDCs?

### **Prime Concern and Requisite Strategy of IFS in Asia**

If more food is to be produced, apparently, the existing stock of land must be cultivated more intensively with recycling of the available resources. Land scarcity and degradation of other resources as well as small, intensive, traditional farming practices, and diversified production systems in the humid lowlands bring in mind to the image of new farming integrations. For centuries, most Asian LDCs have followed ecological principles for subsistence and self-sufficiency from their small farm, lush forests and rich aquatic life. Traditionally, the IFS demonstrates that the only way for both subsistence and commercial farming to be viable economically is to recycle all wastes and residues as means to maximize productivity at lowest costs. All available crop and processing residues, *with simple physical meting-out and requiring no complex equipment or any microbial procedures*, taking advantage of the warm climatic conditions, should be used as livestock feeds.

***The Wits of Core Focus on Asian Traditional Practices:*** Asia is only continent where small farmers typically grip multiple-cropping in same unit of land for their subsistence need, and traditionally interdependencies of farming (crop-livestock-fish) resources are common in all over Asian LDCs. However, in recent decades, the intensifications of rice-only strategy brought much havocs to environments and people's livelihoods, specifically health and nutrition. The question is how best to use our limited resources has become one of crucial importance as we face today's many socioeconomic and environmental problems. One important option is agro-industry development in the rural areas that can give various advantages to the rural society, even if it would not be well enough to fully solve the problems. Along with modern IFS, more dependent on traditional forms of cultivations probably would be most desirable.

In South Asia, specifically in India prominently figure in the dairy industry, both cattle and water buffalo, which are particularly good at converting coarse roughage into meat and/or milk. Due to



**Figure 9: Milk Production Trends in USA and India: 1961–2000**

religious restrictions on meats as well as following a path of steady growth, milk became India's leading farm product by expanding production from 20 million tons in 1961 to near 79 million tons in 2000 — roughly four-fold increase. In fact, India overtook the USA to become the world's leading total milk producer in 1997(see Figure 9); and remarkably, it did so almost entirely by using farm byproducts and crop residues, avoiding the diversion of grain from human consumption to cattle.

Albeit, this is not a lot by any western standards, and indeed the per capita consumption is yet much lower than the USA due to over three-fold populations of India. Conversely, as of FAO recent food statistics, the cereal consumption in India remained almost unchanged between 1990 and 2005, while consumption of oil crops almost doubled; and consumption of meats, fishes, fruits, and vegetables also increased remarkably. Today's shifting patterns of consumption in Asian LDCs are expected to be reinforced in the future. For instance, with an income growth of around 5.5 per cent per year in South Asia, annual per capita consumption of rice in the region is projected to decline from its 2000 level by 4 per cent in 2025. The consumption of milk and vegetables is projected to increase by 70 per cent and consumption of meat, eggs and fish is projected to increase by 100 per cent (see Kumar and Birthal 2007).

The obligatory way is, beside dependent on ruminants, to look for alternative protein sources, such as fishes and other aquatic products. The innovative IFS demonstrates that the Asian LDCs can have more viable agro-industries, with their wastes used as inputs in surrounding integrated farms, while solving the waste and pollution problems effectively and efficiently and making local enterprises highly rewarding in a healthier environment.

***Food-Habit and Socio-Cultural Matters:*** The food production and consumption trends usually

changes with economic development; however also equated with food habits, socio-religious and cultural aspects and other local conditions. In most part of Asia, the humid tropical and/or sub-tropical ecology, religious and socio-cultural characteristics, above all the beef-products in *vitro* might not be a privileged option,<sup>38)</sup> and the sole-dependent on grain-feed farming of meat production by keeping vast poor hungry may also not be acceptable.<sup>39)</sup> Although specialized animal production in Asian LDCs is now more common for non-ruminants, particularly pig and poultry, a major role for large ruminants for draught is likely to persist for many years.

To overcome crises related to modern meat products, the best ways may be to return into traditional forms of meats production and much dependent on ruminants, a very real alternative as long as peoples would accept the psychologically difficult and politically unpopular notion of eating less of *meat produced in vitro*. If we consider health and nutritional aspects of the poorer rural dwellers, some considerable promotions of farming meats production would be necessary. Due to some basic reasons (*see note 14*), the poultry industry probably would be most convincing and promising industry in coming years, even if, there are growing fears of bird-flu as well as import-dependent grain-feed becoming costly. Conversely, in majority of the Asian countries, traditionally fishes and other aquatic products have been an important source of proteins to the population.<sup>40)</sup> Aquaculture has been growing more rapidly than all other animal food producing sectors. Indeed, in Asian LDCs, the acceptability of fish would be much higher than meats from the socio-cultural and religious viewpoints.

### **Rural Aquaculture in Asia: Status, Potentials and Prime Obligatory Strategy**

Aquaculture is becoming as emerging sub-sector for global protein diets of the poor; and in last three decades, some tremendous progresses have been achieved in Asian rural aquaculture. Traditionally, fishes and other aquatic products are important source of proteins in Asia (*see note-40*), basically balanced diets of most rural dwellers in Asian LDCs. Reportedly, aquaculture accounts around one third of total fisheries production (FAO 2005); and ostensibly, the rural aquaculture, specifically the fresh-water rural aquaculture would be most emerging industry in future under changed environments, both natural and socioeconomic.

**Fishing to Fish Culture:** Asian LDCs with limited adaptive capacities to climate variability and changes are faced with significant threats to food security; and with little exceptions, the rural people had been dependent on fresh-water natural fishes. In recent times, the global fish harvests have been increasing with prompt fish-raised on farms (*see note-10 and table 2*), and among all major animals protein sources aquaculture exhibited highest growth during 1990s (*Table 1*); indeed worldwide the sector has increased at an average compounded rate of 9.2 per cent per year since 1970, compared with only 1.4 per cent for capture fisheries and 2.8 per cent for terrestrial farmed meat production systems (*see FAO 2002*).

Traditionally rice, fishes and vegetables dominated the diets of all groups of rural households in

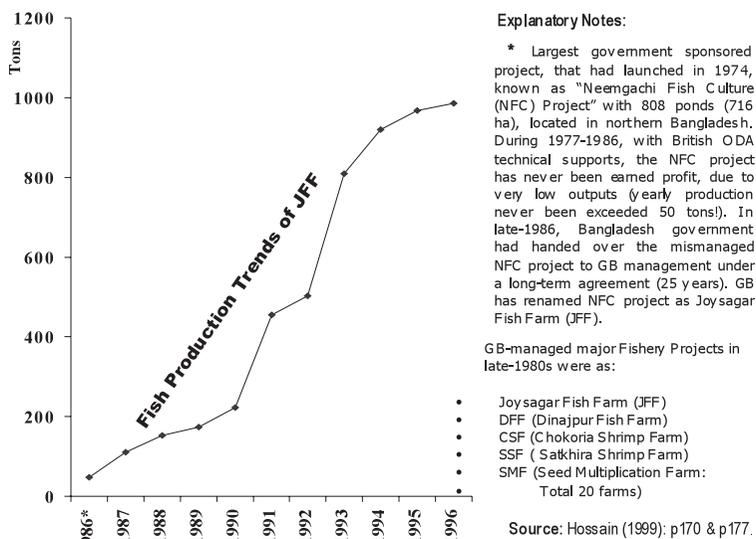
Asian LDCs. It is only within the past three decades that fish culture has gained momentum in most tropical and sub-tropical Asia in response to decreasing supplies of wild fish due to population growth and over-fishing, land-based pollution due to intensive agriculture practices (e.g. use of fertilizer, insecticides and pesticides, etc.), environmental degradation (e.g. rivers running dry), and so on. For the rice farming communities in lowland areas of Asia, wild fish and other aquatic produce collected from rice-fields, such as crabs, frogs, etc., were important sources of protein-food. As for example, Heckman (1979) documented 18 aquatic animals (10 fish species) regularly consumed by rice farmers in Udorn Thani of Northeast Thailand and concluded that despite low per capita income at that time, villagers were able to manage adequate-diet free rice-field foods. Indeed, worldwide the fish catch per person dropped from an average of 17 kg in late-1980s to 14 kg in 2003 — the lowest figure since 1965 (Larsen 2005).

Increased population growth and intensive agricultural practices on the natural fishery are thought to result in the decline of aquatic animals to the point where farmers have to move from “*fishing to fish-culture*” in order to get adequate fish consumption in their diet. Again, it can be argued that successful aquaculture development calls for a market with purchasing power (income-dependent fish-consumption), but it also relies on the fact that the commodity fish is already available and accepted. Any further intensification in grain-production under *GR* policy would not only be severe havocs to land fertility and water quality but might also exacerbate the undernourishment.

***Subsistence to Business-Oriented:*** Rural aquaculture has been defined as - the farming of aquatic organisms by small-scale households using mainly extensive and semi-intensive husbandry for household consumption and/or income (Edwards and Demaine 1997). The contemporary rural aquaculture practices in Asian LDCs, we may broadly categorize as below: (1) Small-scale subsistence farming (2) Midium-scale consumption cum business farming (3) Large-scale business enterprises, and (4) Collective business and/or community-based fish-culture, etc. In recent two-three decades in many parts of Asia, beside dramatic changes of fresh-water pond-cultures, the coastal pond-based export-oriented shrimp-culture became popular practice.

In most cases, the rural small pond-fish farming basically are yet subsistence in nature; however, some cases have found as subsistence cum business-oriented in South and Southeast Asian countries. With little exceptions, most medium and large scale aqua-farming are basically business-oriented. Even in densely-settled areas including Bangladesh, some large-scale scattered aqua-farming, both shrimp and fish, are also reported; albeit, such farming are owned and managed by the large owners urban and/or rural rich and elite classes. Even if, such initiatives are important to economy but reportedly has less-linkages and bring less-benefits to the poor people’s livelihoods, except limited employment generation.

In fact, without collectivizing the rural-dwellers, any large-scale aqua-farming promotion would not be easy. Indeed, some scattered cases of the collective business and/or community-based aquaculture



**Figure 10: Example of Collective Aqua-Project with Involvement of the Poor**

Notes: GB - Grameen Bank (*rural or countryside bank*) of Bangladesh, the world's first poverty-focused micro-credit bank, basically financed small non-farm activities; and GB-founder and GB jointly received the Nobel Peace Award 2006 (see Hossain 2008). After successful experimentations of some fishery projects, the Grameen Motso (*fishery*) Foundation, a separate company in GB-family, was created in 1993.

practices are also reported in some areas, as for instance, in late-1990s, the Grameen Bank (GB)<sup>41)</sup> of Bangladesh had experimented various fishery projects very impressively including the government's mismanaged project (see Figure 10), and it was done in collective means, in fact successfully by involving the near-by thousands of poor GB-members.

**Potential Insights of Rural Aquaculture and Asian IFS - Needs for a Blue Revolution**

(?): Now, basically, the majority of rural aquaculture production derived from freshwater and coastal pond aquaculture that contributes to alleviation of poverty both directly and indirectly (Muir 2005). Aquaculture does not always nor exclusively serve the objectives of domestic food security, but it may have a number or mixture of other objectives as well. These can include trade and foreign currency objectives,<sup>42)</sup> employment objectives and objectives to increase the rural incomes, etc. Poor households benefit through employment and income generation as well as enhanced subsistence production and improving livelihoods (Yap 1999, Halwart 2005), even if most statistics probably may not always reflect the all actual insights of aquaculture.<sup>43)</sup> So far, as many of our experiences and observations, the aquaculture has diverse roles towards the improvement of rural livelihoods; and specifically small-scale farm can potentially contribute to improving household food security and supplementing family income of the poor (see Little 2000, Edwards 2002, New 2003, Muir 2003 and 2005).

Higher production did not lead to increased consumption rather households availed financial

advantage through selling fish. Further, a health claim is often attributed to fish consumption in view of fish having high amounts of poly-unsaturated fatty acids relative to the amount found in domestic animals. Even if practiced at a level, aquaculture could provide the much needed animal protein and other elements of diets (i.e. fats and lipid associated vitamins, calcium and other micro-nutrients) the lack of which are typical causes of malnutrition. Increased productivity also helped building social capital through sharing produce among the neighbors (Langworthy *et al.* 2001), although distributed-amount not so big. The dietetic importance of fish does not seem to be correlated with economic development but food culture since Japan still has high per capita fish and seafood consumption (*see* Figure 7).

Even if, worldwide aquaculture is considered as most emerging sector in terms of rapid growth as well as dominant protein-sources, it is not generally appreciated how few farmers actually culture-fish, even in Asia. Probably less than 10 per cent of small-scale farms in the region were farm fish (APO 1998), even if aquaculture probably originated in Asia, which dates back several thousands years. Aquaculture in family ponds is also developing as a gender-sensitive family farming practice (Shelly 1998). Potentially farming fish has a less strenuous and shorter daily labor requirement, occurs close to the homestead, and has a good return on investment. All these factors potentially make aquaculture acceptable as an innovative enterprise and could empower and improve households' health security and livelihood outcomes. If we look on current status and potential insights of aquaculture, a *Blue Revolution (BR)* in Asia, like previous *GR*, would be obligatory in future. Since Asian countries are inhabited by roughly 61 per cent of the world population, it is obvious that the importance of fish relative to meat can regionally be very high, particularly in South and Southeast Asia. Traditionally, Asia produces over four-fifth of the total outputs (FAO 2005) and probably would be so for many more years; even if, we are yet far behind to call it as *BR*.

In densely-populated Asian LDCs, further productivity increases in basic foods are essential in all possible means due to their ever growing population. A study covering 58 LDCs concluded that a one per cent increase in agricultural productivity was associated with a reduction by between 0.6 and 1.2 per cent in the proportion of people living on less than \$1 a day (Thirtle *et al.* 2002). However, as rationalized earlier, any further intensification in grain-production under *GR* policy would be severe havocs not only to land fertility but peoples' livelihoods. At villages, rice, fish and vegetables dominated the diets of all groups of households; and apparently the production of vegetables suggests that increased investment in fish production is complementary rather than competitive with associated vegetable production. Probably there are no alternatives other than the strategy of various farming-integrations (crops+fishes+poultry, etc.). So, an innovative approach towards balanced food-security in Asian LDCs would be aquaculture-centered IFS. Considerable promotion is required to intensify production of existing farmers and to facilitate new entrants to farm fish so that aquaculture can approach agronomy and animal husbandry as a major food producing activity. Reductions in poverty and

malnutrition would be a major expected benefit of such integrations. The remaining part of this paper delineated such aspects in details.

## V. RURAL AQUACULTURE-CENTERED FARMING INTEGRATIONS IN ASIA

In most part of Asia, the amount of land is limited and cannot easily be extended much further. Alongside aquaculture, agriculture products such as vegetable and fruits are also major nutrient-rich food items providing both macro and micro nutrients (i.e. vitamins and minerals) to the population. Moreover, small-scale poultry-farming also becomes a popular practice in most Asian LDCs. Hitherto the most vivid alternative option is aquaculture-centered farming integrations. There are many traditional forms of integrations, which farmers in countries like China, Cambodia, Indonesia, Thailand, Vietnam, and other Asian LDCs have developed over many generations. The case of fishponds is most potential and appropriate example in Asia where farmers learn to manage water, nutrients, crops, livestock, and fishes. There are also cases of “new” integration driven by newly introduced ideas and technologies. Some overviews are provided here on modern IFS-centering rural aquaculture, based on the author’s formal and informal interactions with fish farmers as well as hand-in-experiences with fish-culture in Asian LDCs.

### **Asian IFS Centering Aquaculture: *Requisites, Basic Models, and Rural Livelihood Security***

The term “*rural aquaculture*” has recently been introduced to differentiate intensive and/or industrial aquaculture to practices that meet the needs of small scale to medium farmers through extensive and semi-intensive culture (Edwards *et al.* 2002). Reduce of free protein sources in past few decades in many LDCs – are drastic, and mostly the resource-poor rural dwellers are becoming undernourished. However, fish yet plays a vital role in the nutrition of people of most Asian LDCs. There are many valid contemporary and traditional features for obligatory needs of farming integrations among broader agricultural sub-sectors rather further crop only intensifications; and in densely-settled Asian LDCs, some IFS are emerging as *de rigueur* to enhance the production of animal (*poultry, eggs, milk, fish, etc.*) and plant (*vegetables, fruits, etc.*) foods from the same unit of land. “*Necessity is the mother of invention*” and indeed during last two-three *decades*, in resources-scarce Asian LDCs, many new and innovative ideas have been emerged, and there are also cases of “*new*” integrations driven by newly introduced ideas and technologies. Specially, the recent surge of interest in aquaculture-centered IFS is due to the growing concern to maximize productivity through optimum utilization of resources in a world undergoing rapid population growth, increasing malnutrition and diminishing per capita resources.

In targeting fish, livestock, and crop production is basically a Chinese practice that had refined over a period of some 2000 years, and in last 3 decades has been garnering worldwide attention. Basically,



(Tilapia+Fish fingerling +Fruits) + (Pond-side Pig farm) + (Varieties of Craps /Catfish + Duck)  
**(1). An aquaculture-based multi-purpose integrated farms in Cambodia (photos: 8/2003).**



(Pond Preparation) (Rice residues/straw for cow) (Duck and Fish)  
**(2). An Aquaculture-centered Multipurpose Farm in Northeast Bangladesh (2004-).**  
 [Fish+Rice+ Vegetables+Fruits+Duck+Cattle (Cow), etc. ] (Photos:12/2005)



**(3). Catfish & Dragon-fruits Project;** (4). Fish-Duck Culture (Pond-dike) (Northeast Thailand)  
**(5). Small Fish-Duck Culture Suburb Bangkok, Thailand/ (11/2003) (Experimental Project)**



**(6). Motivation for Community-Based Pond-Dike System (Kampong Speu, Cambodia): 3- 8/2004-.**

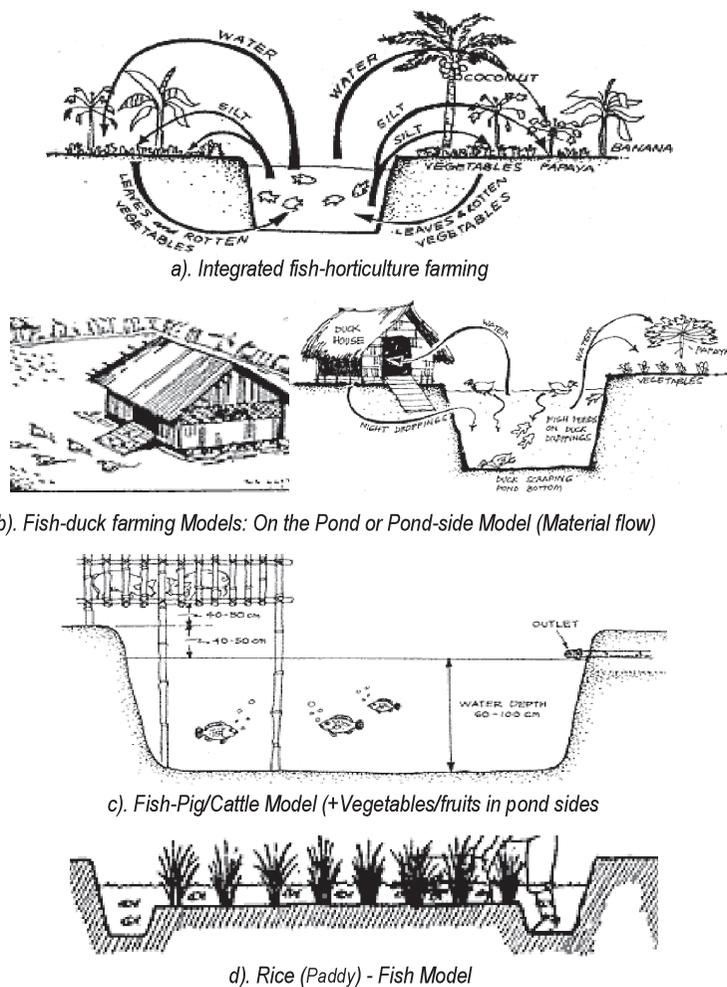
**Figure 11: Aquaculture-based Integrated Farming Systems in Selected Asian Countries**

Notes: \*All photos by the author, except the cases of (4) & (5), are scanned from secondary sources.

(1). Family managed and completely business-oriented aquaculture-centered IFS having near 7ha of land (rental land & has been operated by a fishery teacher since late-1990s, which is around 20 km far from Phnom Penh). The project has total 8 ponds (varied sizes) with fish-fingerlings facilities as well as farming integrations of fish+pig+duck+fruits+vegetables, etc.; (2). Around 11.2 ha multi-purposes business enterprise (under construction after land purchased from a fishing community in 2003, and total 5 owners having 13 workers (part-time and day-labors) with various farming facilities including plantations (e.g. >5 thousands trees had planted within 2005); (3) A rural small group's side project under One-Tambon One-Product (Hossain and Takeya 2004), (4) Individual integrated fish-duck business farm in Northeast Thailand (5) A Southeast Asian experimental fish-duck IFS with duck house constructed over the pond (Vietnam) & (6) As part of some voluntary projects for community development (Initiated by the author: started from 3/2004~ in Kampong Speu, Cambodia. Motivation stages: Minister of Rural Dev. +Province & District heads+Village development groups, and Village heads) as well as individual tiny projects for female-headed households (Hossain 2004).

beside traditional practices of rural resources-interdependences, in many densely-settled Asian countries some unique integrations centering aquaculture are tremendous development in aquaculture-based IFS. There are some basic differences between traditional and modern integrations; as for instance, in traditional practices, resources interdependencies were common among various scattered farms, whereas modern IFS is one strategy that can be adopted to increase farm returns from same unit of area (*land or water surface*) uses parallel for various rural enterprises.

Since early millennium to recent past, the author had many interactions with aquaculture and fish-farmers, and also investigated dozens of aquaculture-based IFS in Asian LDCs.<sup>44)</sup> Some selected IFS project examples are provided here (see Figure 11); and all of the sample cases are somehow representing aquaculture-based IFS. In addition to all above, some *Rice (paddy)-Fish* IFS sites were



**Figure 12: Some Small-Scale Aquaculture-centered IFS Models**

Notes: Scanned from FAO documents.

**Table 8:** Aquaculture-centered Small-scale Asian IFS: *Prime Advantages and Benefits*

IFS	Prime Advantages and Benefits	Remarks
Integration of Fish-Horticulture (Pond-Dike System)	<ul style="list-style-type: none"> <li>&gt; <i>The farmer gets additional income from growing fruits and vegetables on the pond embankment that normally lies fallow;</i></li> <li>&gt; <i>The nutrient-rich pond mud is used as fertilizer for growing crops, eliminating the cost of organic manures;</i></li> <li>&gt; <i>Manure-pond water is used for irrigation of plants;</i></li> <li>&gt; <i>Fruit and vegetable residues are used as feed for the fish;</i></li> <li>&gt; <i>The plants on the embankment strengthen the dikes; and</i></li> <li>&gt; <i>Ponds near to the rural house help in easy management and in discouraging poachers.</i></li> </ul>	<p><i>Suitable for all pond and land sizes. [Case (a)/Figure 12])</i></p> <p><i>Popular in regions where there are restrictions on meats, e.g. South Asia, specifically in India.</i></p> <p><i>Suitable for women to manage it, in addition to their traditional household duties.</i></p>
Raising Birds (Boiler) over fish ponds (alternative is beside fish ponds)	<ul style="list-style-type: none"> <li>&gt; <i>House/s construct on pond (or pond-dikes); hence, no additional land is required for poultry farming activities;</i></li> <li>&gt; <i>No additional feeds needed for fish-culture; and sometimes grass grown in pond-side for herbivorous fishes (e.g. grass carp)</i></li> <li>&gt; <i>Income further increase, if consider for Fish-poultry-vegetable/fruits.</i></li> <li>&gt; <i>Even house-roof use to grow pumpkin or bottle-gourd that keep house little cool during summer times.</i></li> <li>&gt; <i>Farmers normally use rice bran as feed, both for fish and birds. Poultry-feed supply would provide much better outputs.</i></li> <li>&gt; <i>Supply meat and eggs (after family-needs, remaining sell for income).</i></li> </ul>	<p><i>All house materials are locally available; and a pathway from pond-dike to house needed [see Figure 13].</i></p> <p><i>Suitable for small and marginal Farmers or near landless; Small pond size is also suitable; Popular in densely-settled Asian LDCs, e.g., Bangladesh, China, Thailand, Vietnam, etc.</i></p>
Raising ducks over or beside fish ponds	<ul style="list-style-type: none"> <li>&gt; <i>House/s construct on pond or pond dikes; hence, no additional land is required for duckery activities;</i></li> <li>&gt; <i>Ducks keep water plants in check; ducks loosen the pond bottom with their dabbling and help in release of nutrients from the soil, which increase pond productivity;</i></li> <li>&gt; <i>Ducks aerate the water while swimming; thus, they have been called «biological aerators»;</i></li> <li>&gt; <i>Ducks get most of their total feed requirements from the pond in the form of aquatic weeds, insects, larvae, earthworms, etc; and</i></li> <li>&gt; <i>Ducks need very little feed, and farmers normally give kitchen wastes, molasses and rice bran, for the purpose.</i></li> </ul>	<p><i>Same as above</i></p> <p><i>[See cases (4) and (5)/Figure 11 as well as visualized case (b)/Figure 12].</i></p> <p><i>Houses construction almost same of Fish- Boiler system but in case of over-pond system, the climbing pathway needed from water</i></p> <p><i>Popular in densely-settled Asian LDCs</i></p>
Raising Cattle/Pigs over or beside fishponds	<ul style="list-style-type: none"> <li>&gt; <i>Cattle house/s build on the pond having path-links with pond-dike (Almost same as Fish-Boiler or Fish-Duck systems but well-structured house is needed)</i></li> <li>&gt; <i>Farmers normally give kitchen wastes for the pigs (as eat anything human not eat) and farm byproducts (crop residues, oil-cakes, etc.)</i></li> <li>&gt; <i>Provider of meats and milk (from cow or goat)</i></li> </ul>	<p><i>Popular in Southeast Asia, e.g. Thailand and Vietnam (basically pig farming); however for South Asia more potentials may be cow, goat, etc. Larger Pond-size is appropriate</i></p>
Rice (Paddy) - Fish farming	<ul style="list-style-type: none"> <li>&gt; <i>The system - both the traditional and improved, is essentially trapping &amp; on-growing of wild fish, requires little labor &amp; material inputs.</i></li> <li>&gt; <i>The soil is primarily clay, and rice is double-cropped and short-season; and in recent times, high-yielding rice varieties are used having sufficient water depth, usually 15–30 cm.</i></li> </ul>	<p><i>Suitable for large and medium farmers.</i></p> <p><i>Popular in South and South Asian LDCs (Fishes, like Cat-fish, Tilapia, Grass-crap, etc).</i></p>

Notes: As of field level investigations, the small-scale IFS indicated that farm-income increases rapidly that varied from project to project and area to area. In general, rice-fish culture became popular as it is relatively need less incentives (albeit, fish provides side income, even sometimes near to double than the rice only culture), whereas others IFS model experienced much better productivity, usually 3 to >4 times income increase, when compare to traditional non-feed fish-only culture. If pond-dikes use for vegetables/fruits, then the returns would be higher; and some experimental projects indicated 5–6 times income increase when compare to traditional fish-only practice in real fields.

also visited in Thailand, Malaysia, Cambodia and Bangladesh. Indeed, the *Rice (paddy)-Fish culture* is an old and long traditional practice in many Asian countries, even prior economic development in Japan, the rice-fish culture was popular in many rural communities.<sup>45)</sup>

### **Small-scale Aquaculture-based IFS in Asia: *Potential Insights and Basic Models***

It is clear that there is limited scope for horizontal land expansion to cope up with the future food demand, rather vertical intensification through integration of different agricultural enterprises could help to meet expected increases in production demand and quality. Integrated fish farming is attractive to small-scale farmers under pressure to produce higher-value crops, as well as to communities seeking to augment food production and income increase.

Links between the pond and surrounding land for horticulture is a distinctive feature of farming households in Asian LDCs, specifically in South and Southeast Asia. A typical small farm produced neither specialized crops nor only rice crops, but has combined other enterprises such as cattle, poultry, and fish farming through which farm families maximize their returns and family satisfactions. Some popular and potential visualized models of the small-scale aquaculture-based IFS are provided through *Figure 12*.

The experiences reported here demonstrate that basic model has many variants but the principles are the same; and the fishponds in integrated aquaculture systems have potential insights towards improving rural livelihoods and poverty alleviation as well as food and nutritional security. *Fish-Horticulture* (fruit and vegetable) farming on the fishpond embankment has been tested in many areas of Asia, especially in South Asian countries. Small-scale all IFS models mentioned here consisted of fishery, agriculture (rice or vegetables/fruit-tree, etc.) and livestock (duck/boiler or cattle, etc.) production; and each model indicated various advantageous points to farmers in many ways (*see* Table 8). For instance, the *raising ducks (alternative is boiler) over fishponds* very well with the fish poly-culture system, as highly compatible with cultivated fishes.

### **Small-Scale IFS Centering Asian Rural Aquaculture: *The Bangladesh Perspectives***

All of the mentioned IFS models have implied that a farmer could earn greater profit by investing resources on pond fish production. Such programs aim to provide income for the household and should be included in strategies to improve household food security, nutrition and livelihoods (HKI, 2004). Aquaculture-centered small-scale IFS has opened up a new horizon of high animal protein production at low cost in many Asian LDCs, and it is surprising, those IFS not yet widely practiced in rural Bangladesh, the most densely-settled LDCs in the world (*see endnote-25*), albeit there were very impressive experimental results reported since late-1980s to throughout 1990s. Prior to focus on those aspects, we better rationalized first here the prime requisites behind rapid expansions of aquaculture-centered IFS in rural areas.

***Situating the Problems:*** Land is very clearly the most important natural asset of farming

households (Muir 2003); and Bangladesh has most fragmented (*see* Figure 6) and lowest per head land in the world without any efficient agrarian and/or land reforms. Arable land is decreasing by 1.6 per cent per year in Bangladesh due to river erosion, house construction, road building, establishment of industries, expansion of towns and cities etc (Smith and Biggs 1998). Over 60 per cent of the rural people in Bangladesh are landless and near or *functionally* (defined as: who owned <0.5 acre or 0.202 ha of arable land) landless poor (Hossain 1999), however among labor force 48.1 per cent are yet engaged in agriculture for their somehow survival; and landless (day laborers or disguised labor), marginal and small-holders exhibit 79.1 per cent (*see* BBS 2007); total 25.20 per cent have less than 0.02 ha and 31.40 per cent equal to 0.20 ha land with living place; and the average family size is 5.19 with as high as 3.60 dependency ratio.

Land resources and their distribution and tenure structure have been viewed as key issues in the nation's developmental strategy for long (Jannuzi and James 1980, Wennergren 1986). The impressive progress made in food production during last four decades and half is often referred to as green revolution triggered by high-yielding varieties (HYVs) of rice and other crops, which responded well to irrigation and fertilizer application, however, Bangladesh is one of the most food-insecure countries with the very high prevalence of undernourishment people (*see* note-31 and FAO 2006). Many rural peoples gradually becomes poorer and food insecure, above all vulnerable due to increasing natural calamities, and new environmental hazards to human health, such as arsenic contamination in drinking water has been emerging a severe health treats to the malnourished poor in most rural areas (*see* Hossain 2002b). The unbalanced intensifications for land productivity increase (*e.g.* 3 rice crops a year from same land in some areas) and over use of natural resources (*e.g.* underground water for irrigation), the vast rural peoples have been dwelling with vicious-cycles of many lows – *low resources (e.g. land) entitlement, low purchasing power, low productivity, low soil quality, low inputs, low productivity, low nutritious food-intake, low-weight baby and so on*, those jeopardized their livelihoods. While maintaining a focus on long-term challenges is vital; and regarding food and nutritional security there are some national macro and micro policy planning and actions that need to be undertaken obligatorily.

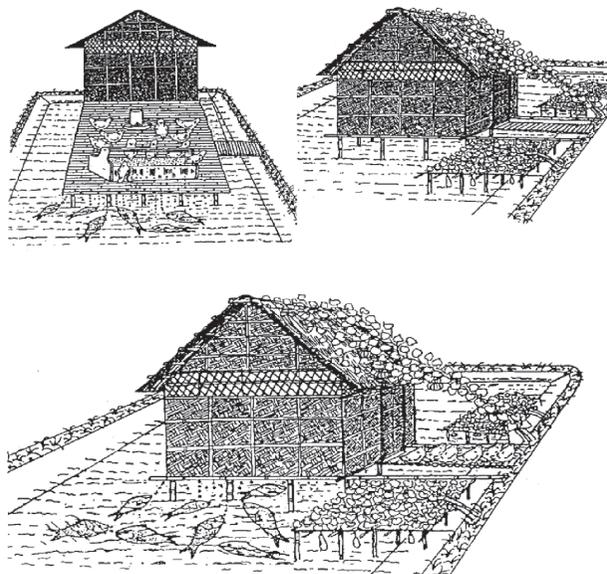
Since there is little ability or chance to increase the amount of cultivated land, the only way to increase employment, farm production, and income is to increase the productivity of the available resources, especially land through various IFS. Documented information of farming integrations in the country is scarce; and data from Fisheries Department and private operators are not ease-accessible. Institutional research on the integrations of agriculture and aquaculture began just mid-1980s, when many NGOs, specifically largest one, the BRAC's direct support for aquaculture and fisheries research had increased throughout 1990s to recent years, and some promotion of rice-fish culture became very popular. Even if various aquaculture-centered IFS have been experimented under experiment stations of the Bangladesh Fisheries Research Institute (BFRI) but those seldom replicated in rural areas due to lack of government incentives and/or insufficient extension services.

***Most Advantageous Option – Huge Fishponds:*** Most marginal farmers have used on-farm and off-farm resources according to traditional patterns, but with the advent and adoption of aquaculture into farming systems, the resource use pattern has been changing gradually in recent times. One important point is -- the majority of rural households in Bangladesh have multi-purpose homestead ponds or ditches, and the country perhaps has 1.3 million ponds (WB 1996). Most of those were created when households excavated earth to raise their homesteads above normal flood levels and function as refuges/asylums for people and their livestock during periods of severe flood (Chatterjee 2001). The role of the pond for family use, which was a major objective for pond construction, is significantly different now due to changing dynamics of socio-economic situations. Fish culture is now the dominant use of ponds for households irrespective of their focus on vegetable, orchard or fish production and they are utilized less for general domestic use and much more on selling for cash income. Ponds are also relatively more important as a source of irrigation water in most rural communities.

Fish plays a vital role in the nutrition of people in Bangladesh; and according to Quazi (2002), the maximum average fish yield was attained with manure fertilizer; and the fish production can be increased further by increasing the size of pond (see, Rahman: 1988; Rahman and Talukder 2001); albeit, in land-scarce Bangladesh such Scope is very limited. Conversely, small farmers earned the largest portion of their net return from cattle husbandry because they were able to provide constant care and attention. A major nutrition-related problem cluster is that of inadequate maternal child care. There is virtually no exclusive breastfeeding and complementary feeding is inadequate for 60 per cent of children at 9 months of age. Women suffer social discrimination, which manifests itself in very low literacy rates, a large demand for domestic and poorly-paid productive labor, intra-household mal-distribution of food and inadequate time and facilities for child care. If the rate of nutritional improvement is to be accelerated such factors will need urgent attention. So far, for rural food, nutritional and livelihoods security perspectives in Bangladesh, there no such thriving options other than the aquaculture-based small-scale IFS.

***Most Obligatory Needs - Pond-based Small-Scale IFS:*** Most farmers in Bangladesh are mainly engaged in producing field crops like rice, vegetables and fruits, fish culture, and the rearing of livestock and poultry. If small pond aquaculture is promoted as integrated food production strategies that increase the production and consumption of animal and plant foods from same unit of land. On the basis of benefit cost ratio, small-scale fish-culture with poultry farming on the pond or pond-dikes is the potential and would be a most profitable component of the agricultural enterprises; and the author in mid-1990s (Hossain 1996) had argued that beside household and rural job creation, substantial income increase would be possible, if integrated *fish-boiler* farming includes vegetables/fruits farming in pond-dikes; and the Figure 13 shows the basics ideas of such integrated fish-poultry-vegetables/fruits model in a visualized form.

In this model, water surpace and also the roof of livestock-sheds could be usual for vegetables



**Figure 13: The Proposed Integrated Farming Model in Bangladesh**

Note: *Fish, Livestock, and Fruits/Vegetables Model* (Prepared by the author in mid-1990s using BFRI materials).

(e.g. bottle-gourd, pumpkins, cucumbers, etc.); and such practice not only brings additional income to farming household but usually keeps pond water and poultry-sheds cool enough, sometimes essential in tropical and sub-tropical areas during summer times. Indeed the above model could be adjusted with other small-scale models, those mentioned earlier (*see* Figure-11/ Cases 4 & 5, and then Figure-12/ Cases b) & c)); and such integrations should essentially be preferred for Bangladesh and also other densely-populated Asian areas.

### **Asian Small-Scale Aquaculture-based IFS: *Potential Insights, Impacts and Related Experiences***

There is growing under-nutrition in Asia in spite of substantial gains in grain-food production. It is in this context that a multi-pronged strategy to generate greater opportunities for income, employment, and food security in rural areas becomes urgent. If small-scale aquaculture is promoted as part of homestead food production programs, which increases the production and consumption of both animal (poultry, eggs, milk, fish, etc.) and plant foods (vegetables, fruits, orchids, etc.) products. Such programs aim to provide income for the household and should be included in strategies to improve household food, nutrition and livelihoods security (HKI 2004).

Behera and Mahapatra (1999) undertook a study in rural areas of India on a pond-based farming system comprising poultry, duck, and mushroom enterprises, and those IFS, indicated rapid income

increase and substantial employment generation among small and marginal farmers. Again, Rangasamy *et al.* (1996) concluded that in the irrigated lowlands of Tamil Nadu of India, a rice-poultry-fish-mushroom system was the most successful and could be adopted to yield higher net returns and increase productivity. In recent years, *rice-fish* culture also becomes popular practice in all tropical and sub-tropical areas of Asia due to rapid expansion of irrigated areas (and also reservoir) as well as ease-incentives of the system; and the system may be suitable for big and medium farmers, and several studies already have confirmed it due to their comparatively larger landholdings (e.g. Kundu and Sato 2003; Mandal *et al.* 1995).

Small-scale integrated fish-poultry farming has high potential in Bangladesh (see Quazi 2002); and various IFS models have been experimenting by various organizations, especially under Bangladesh Fisheries Research Institute (BFRI) with very impressive results. The author, as part of his graduate

**Table 9:** Costs and Returns from Broiler-Fish Farming in 1-Hectare Ponds  
(For Culture of 1 Year)

Items	Quantity	Rate (in US \$)	Amount (in US\$) <sup>4/</sup>
<b>1). Total Capital Costs</b>			<b>\$262.50</b>
<i>Pond lease value</i>	1 hectare	\$187.5	\$187.5
<i>Cost of chicken house<sup>1/</sup></i>		\$125.0	\$62.5
<i>Feeders and waterers<sup>2/</sup></i>		\$50.0	\$12.5
<b><u>Details of Operating costs:</u></b>			
<b>(a). Total Broiler Costs</b>	(for 5 batches)	(\$692.13 / batch)	<b>\$3460.65</b>
Broilers Cost (for one batch)			\$692.13
<i>Broiler chicks</i>	500 nos.	\$0.375/chick	\$187.50
<i>Broiler feed</i>	1935 kg	\$0.225/kg	\$435.38
<i>Vaccine</i>	-	-	\$4.25
<i>Labor</i>	60 man-days	\$0.75/day	\$45.00
<i>Miscellaneous</i>	-	-	\$20.00
<b>(b). Fish Culture</b>			<b>\$127.75</b>
<i>Lime</i>	250kg	\$0.075/kg	\$18.75
<i>Fingerlings</i>	6000 nos.	\$1.00/hundred	\$60.00
<i>Labor</i>	32 man-day	\$0.75/day	\$24.00
<i>Cost for Pumping Water</i>	-	-	\$25.00
<b>2).Total: (a) + (b)</b>			<b>\$3588.38</b>
<b>Total Costs:[1)+2)]</b>			<b>\$3850.88</b>
<b>Total Income</b>			<b>\$10,485.00</b>
<i>Fish Income<sup>3/</sup></i>	5,589 kg	\$1.00/kg	\$5589.00
<i>Broiler meat (816kgX5 batches)</i>	4,080 kg	\$1.2/kg	\$4896.00
<b>Net Profit: (\$10,485.01 – \$3850.88)</b>			<b>\$6634.13</b>

**Notes:** <sup>1/</sup>Life expectancy two years, <sup>2/</sup>Life expectancy four years, <sup>3/</sup>Average of three carp treatments, <sup>4/</sup>All amounts were calculated from local currency to US \$ according to project period average exchange rate (\$1 = Tk40.00 during mid-1990s). *Source: Calculated from BFRI Project database.*

research (see Hossain 1996), had collected various documents from various organizations during mid-1990s, basically from NGOs related to rural job-creation; and some experimental documented results on small-scale aquaculture-centered IFS under BFRI research stations were also gathered through personal links;<sup>46)</sup> and one experimental project findings was further analyzed here and the costs-returns and related aspects of the project are presented here (see Table 9).

Studies were undertaken in 0.1 ha earthen ponds in order to determine fish species combinations that would result in optimum production levels in integrated broiler raising systems. Chicken sheds were constructed over ponds, and hybrid chicks were raised at a density of 500 chickens/ha of pond area. The ponds were stocked with fish fingerlings at a density of 6000/ha. Four combination of fish-species were tested, each treatment with two replications. The ponds were neither fertilized nor were the fish given supplementary feed, except for the chicken excreta falling into the ponds. After twelve months rearing, gross fish production levels between 5,821 and 3,041kg/ha was obtained. Fish survival rates ranged from 85 to 97 per cent. Five batches of broilers were raised in seven to eight week cycles. A total of 4,080kg (live weight) of broilers was produced per hectare, in one year. An economic analysis of the operations showed a net profit of Tk265, 365 ha/year or US\$6634 (Table 9).

The above result was estimated as over 4-fold income-productivity increase when compare to the traditional non-feed fish-only culture; and if pond ownership belongs to farmer then pond-lease portion also would save. So far, if more integration is possible (e.g. Fish-Bird-Vegetables/Fruits: *see* Figure-13), the productivity would further increase. It is instructive here to consider that a small-scale integrated duck-fish-vegetables or chicken-fish-vegetables farming could satisfy the animal protein requirements of a typical rural family of five-six persons or even more. In various areas of Thailand different types of IFS has been practicing for long. Edwards (1991) had suggested two possible models of small-scale livestock and fish integration: a duck and fish system, and a proposed ruminant and fish system. Data were obtained from 13 family level duck and fish integrated systems from a total of four villages in two provinces in Central and Northeast Thailand. A mean annual net yield of 175 kg of fish was obtained from a 200sqm pond fertilized with the manure from 27 ducks. It is instructive to consider to what extent such a small-scale integrated duck and fish system could satisfy the animal protein requirements of a typical rural Thai family of five persons.

The pond-based IFS contributed to the livelihoods in many ways providing food, irrigation for crops and livestock, income and help in maintaining other domestic requirements (bathing, washing clothes etc). *Rural households benefited more* through direct consumption of both fish and vegetables; in contrast households near to urban markets benefited more through cash sales of both fish and vegetables than rural households. Higher productions also not always lead to increased consumption, rather households benefited financially through selling fish. The roles of these systems are many folds and enhance livelihoods in many ways especially through directly providing food (fish and vegetables) for the household and indirectly by ensuring improved financial security, especially critical at certain

times of the year, ultimately reducing the vulnerability of adopting households. Moreover, inputs costs are lower under IFS than fertilized pond-culture, as farmers need not to use feed for fish-culture, even if sometimes lowcost rice-bran use as fish-feed, that most common pond input for fish-only or pond-dike systems (see Xin 1989, Karim 2006). Indeed, small-scale IFS could reduce input dependency drastically, as for instance, in integrated Fish-Ducks farming, ducks have been termed as manure-machines for their efficient and labor-saving method of pond manuring, resulting in complete savings on pond fertilizer and supplementary fish feed which accounts for 60 per cent of the total cost in conventional fish culture (FAO 2001).

The nutrients added to pond water from fertilizer, uneaten feed, fish feces and fish metabolites account for the build up in nutrient-rich organic material (Rahman *et al.* 2004). Use of pond sediments, thus could potentially reduce vegetable production costs by sparing valuable nutrients. As Karim (2006) indicated from other studies that production of vegetable (red amaranth) showed that application of pond sediment with pond of 10 per cent tilapia and increased input, resulted in more than 200 per cent increased vegetable yield than other groups, folks, no use of sediment. However, a major unresolved issue is the high labor costs associated with removal and reuse of pond sediments.

**Prime Constraints and Obligatory Needs for Promotion of Aquaculture-based IFS:** Links between seasonality (especially critical rice pre-harvesting periods) and other seasonal changes in natural conditions included water scarcity or drought during the dry season, the impact of flood destruction of some fishponds, and so on are prime natural constraints, basically disaster-pron areas like Bangladesh. Limited financial capital to invest in productive activities during lean periods of the year was seen as a chronic constraint, which has been found to constrain poorer households in general (ADB 2005), and in particular the poorer fish farmers (Ahmed, 2001, Muir 2003, Ahmed *et al.* 2005).

Lack of transportation and poor communication, especially in the wet season probably hindered access to larger markets for rural households compared to those in near to urban areas (Muir 2005). Low quality earthen roads that link extremely rural areas are a major constraint to market and information access, especially during the wet season in many Asian LDCs. Rural better off and near to urban households sell fish and vegetable through auction markets while rural households mainly sell their product at the farm-gate (to middlemen) or in local markets. Poorer peoples' ponds are smaller than better households and their ponds tend to be more seasonal, with lower water holding capacity and higher dependency on the pond water for family use and watering the vegetable crops (Little and Muir 1987, Pant *et al.* 2005).

This greater reliance on the pond for multipurpose use may also contribute to an understandable reluctance to use various nutrient inputs, especially during periods of greatest water scarcity. Devastating natural calamities occur frequently in Bangladesh,<sup>47)</sup> and it could be anticipated that raised dikes for growing fruits and vegetables better safeguarded the pond and vegetable crops against flood compared to ponds without raised dikes. Lack of knowledge was a particular problem for farmers

growing fish and vegetables in the rural areas. Much has been written about the potential role of technologies to bring about sustainable livelihoods, and to reduce poverty, but to be effective farming households have to be informed about such technologies. Neighbors and relatives roles in transferring information on agricultural technology appeared stronger than formal information providers. Fish disease, high price of input, lack of money were also identified as constraints by fish producers.

There may have also other underlying factors appear to support or hinder the adoption of efficient IFS. So far, among all, rural finance is one of the critical issues for the success of integrated farming households but that the current mix of institutions providing credit are, at least to some extent, needs to delivering credit, where required. Greater investment in pond-based IFS, however, might require new mechanisms. Probably Government agencies in LDCs can play important roles, especially in rural areas, despite a widespread perception that only NGOs are effective service providers in rural areas. In fact most NGOs seldom finance agricultural activities including IFS as their micro-credit programs usually designed for rural non-farm activities, basically operated by the poor women.<sup>48)</sup> So far, fish culture was equally important as an enterprise among richer and poorer men, whereas vegetable cultivation was more important to men than women but wealth and location also affected its importance. However, the recent relaxations of micro-credit providers' products (loans and savings) and loan operations (e.g. reduced rigidity of group formation and quick loan utilization as well as women as loan-borrowers but utilization by their male-counterparts, etc.) possibly would create better environments for the poor to more involvements in farming activities including possible chance for agricultural sub-sectors (e.g. crop, livestock, and fishery) integrations (*see* Hossain 2008).

Apart from satisfying basic needs, sustainable development implies sustaining the natural life-support systems on earth and extending to all the opportunity to meet their aspirations for a better life (Little *et al.* 2003). As such, resurrect the old questions about our ability to meet economic, health, and environmental objectives. Can the world satisfy increasing demands for broader agricultural sub-sectors products over the long term? Are sustainable resource use and productivity as well as food and nutritional security for the poor achievable? The fish-culture industry, however is currently facing a number of problems including the deterioration of resources and environment, efficient utilization of fish farming areas, pollution and fish diseases, just to name a few. First of all, on the policy-level, the question whether or not more fish is required and for what reason (food security, export, or otherwise) should be answered. As there is an unresolved growing deficit of food-fish in many LDCs for both poor producers (small-scale farm households) and poor consumers as well as vast rural aquafiers are not yet under fish culture, the "*blue revolution*" in aquaculture is obligatory for rapid promotion of IFS centering on aquaculture, and national policy strategies should fix towards such end.

## VI. OVERALL DISCUSSIONS AND CONCLUDING REMARKS

The food security is now far more complex issue than it was a generation ago, and a fast-unfolding food shortage is engulfing the entire world, driving food prices to mind-bogglingly high; albeit, in the past half century, the global food production has grown even more rapidly than population due in part to changes in technologies, input uses, and market incentives. Yet these changes have been haphazardly intensified that increased havoc and pressures on the earth's land, water, and genetic resources. In the past, the negative effect of unusual weather events was always temporary, within a year or two things would return to normal. But with climate in swelling-flux, there is no norm to return to normal. On the demand side, the trends include the continuing addition of 70 million people per year to the earth's population as well as mounting grain-demand dilemmas - *Calorie-for-Calorie* and recent *Food-to-Fuel*, made world's food situations more complex; and now not a single country in the world, regardless rich or poor, so as to be totally food self-sufficient. Around the world, a politics of food scarcity is further emerging; and the prime sufferers are the poor communities in third world nations, specifically import-dependent Asian LDCs.

The WFS and MDG set a goal to reduce half of global hunger by 2015, even if, in LDCs, the undernourished peoples have reduced just 3 per cent during 1990-92 to 2001-03 (*Table 3*)! Conversely, under recent grains-demand dilemmas, the poor peoples increased from 804 million to 849 million between 2005 and 2006 in 70 countries (*see Meade et al. 2007*), which means that more people are now vulnerable to food insecurity; and if such trends continue, many more would join to the hunger lists across the globe. Growing crops for fuels on cropland initially sounds like a great idea, albeit it's a grand brain-washing hoax.<sup>49</sup> Farmers are facing a record growth in the demand for grain at a time when the backlog of technology to raise grain yields is shrinking, when underground water reserves are being depleted, and when rising temperatures threaten to shrink future harvests. If such trend continues, it would not only be havoc to the vast poor people's food and nutritional security but would be severe environmental threats in the coming years. Indeed, the food bubble is now starting to implode, which means that as recent economic and climate realities unfold, the world is facing massive starvation and food shortages. Many poor countries are just one-step behind the famine situations, and already some socio-political unrest reported in grains import-dependent LDCs, and may have every possibility of total social outbreaks in near future.

Food and nutritional security, above all livelihood security, exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Most Asian peoples yet consume huge rice-based carbohydrates that probably comparable to prior World War II period of Japan. Indeed, the food situations gradually becoming worse in import-dependent LDCs, especially in densely-settled territories, like South Asian countries, more specifically in Bangladesh, where vast poor peoples are

facing severe food shortage and drastic prices increase of basic foods; and also suffering from severe malnutrition due to imbalanced food-intake, basically carbohydrates dependency in their daily diets. The higher cereal prices are not only leading to the deterioration of their diets in terms of quantity and quality, but also significantly eroding their overall purchasing power, as they bound to spend up to 70 to 80 per cent or even more of their total expenditures on basic foods alone. For them, it is the next meal that is the overriding concern, and even a modest rise in food prices can quickly become life-threatening.

Most Asian countries are engaging in a difficult developmental struggle, the enormity of which has been amplified by the persistent pressures of population growth on a limited land base; and in many Asian LDCs yet achieving self-sufficiency in locally-favorable food grain production is a key development objective because of the lack of foreign exchange to finance major international purchases including feeds for livestock in reasonable prices. In reality, the grains neither uniformly produced in all regions of the world, nor accessible to the vast hungry peoples in third world due to trade-barriers, and nor even consume only as human-foods; indeed, huge use of grains now being driven by the fast growing farming-meat demands in rapid growing economies, specifically China and India (*see* Braun 2007). The desire of most people in third world to move up the food chain and consume more grain-intensive livestock products is usual; basically obligatory for Asian LDCs from the viewpoints of balanced-food and/or nutritional security; albeit, the sole-dependent on grain-feed meats production would not be an acceptable option in LDCs by keeping huge poor, folks in stravation.

Due to diets globalization and the expansion of world trade-markets, balanced-food security has been generally viewed as consisting of three important components, namely availability, access, and utilization. The former concerns the ability, particularly of LDCs in the region to provide enough food for their ever-increasing population. Second one, on the other hand, relates to the ability of the population to obtain food necessary for a healthy life economically and/or physically. Utilization deals with the nutrition status and health provisions. Thus, food and nutritional security equated not only calorie-intake but balanced or healthy diets that depends much on national food production strategies and distribution, and availability of foods by balancing import and export or ease access of foods in reasonable prices as well as national health provisions and dietary policy planning including awareness programs at all levels - the households, community and national, etc. Thus, demand-oriented production strategies, both for human-foods and livestock-feeds, are obligatory.

It is increasingly recognized that poverty and food security, above all human security is a complex and multi-dimensional concept (*see* Hossain 2002c). Towards such ends, a mix of policy actions that avoids damage and fosters positive responses is required. Satisfying the demand for protein in a protein-hungry world where water scarcity is likely to translate into grain scarcity is now a great challenge to policymakers everywhere. Meanwhile, the backlog of agricultural technology that can be used to raise cropland productivity is dwindling. Under contemporary rural vulnerability perspectives

of densely-settled Asian LDCs due to low resources-entitlement and low purchasing power, and growing food insecurity and malnutrition as well as agro-ecological characteristics, religious and socio-cultural conditions, some changes in production strategies in Asia emerged obligatory. To fight malnutrition, the people of Asian LDCs in general and densely-settled areas in particular requisite changes food production and distribution in such ways to diversify their carbohydrate-dominant eating habit. Most Asian LDCs need to reduce their rice-dependency, not only for nutritional viewpoints but requisites as there are huge production access as well as rice is unlikely be used as livestock feeds since the unit cost of producing rice is much higher than other grains (*e.g.* maize). The weakening rice demand downward in Asian region means greater opportunity for other nutritious crops, such as lentil, mug-bean, soybean, corn, and so on, and some farmers may concentrate more on livestock feeds production (*e.g.* maize) to reduce import dependency (as example given for Bangladesh, *note-19*), and such production strategy also may be able to increase export share.

There are probably several potential alternatives to increase animal protein supply without consuming more grain, such as, improve the efficiency of grain conversion into animal protein; shift from the less efficient forms of conversion, such as beef or pork, to the more efficient ones, such as poultry or farmed fish; and rely on ruminants to convert more roughage into nutritious foods (as mentioned earlier for Indian case), and so on. Once the limits of rangelands and fisheries are reached, then the growing demand for animal protein can be satisfied by feeding cattle in feedlots or fish in ponds; by expanding the production of cattle, livestock and related products, such as milk and eggs, all largely dependent on feed concentrates; or by producing more milk. As consumers in LDCs diversify their diets away from staple cereals and adopt more western diets and consumption practices, about 80 per cent of the growth in meat utilization is expected to occur in third world, basically in Asian LDCs, even if still the level of per capita consumption is near one third than that in DCs.

Low-income countries with limited adaptive capacities to climate variability and changes are faced with significant threats to food security. More important concern in livestock production in developing tropics is how to involve the small-scale farmers. In present situation, besides more efficient promotion of non-farm productive activities, the basic challenge to policy is to devise surrogate ways of using the under-utilized labor and other resources to produce more goods, specifically balanced foods. The traditional backyard system of livestock growing can be viable alongside modern, intensive livestock production since, although outputs may be less than modern, intensive production methods, capital and labor inputs are low. It is clear that as there is limited scope for horizontal land expansion to cope up with the future food demand, rather vertical intensification through integration of different agricultural enterprises could help to meet expected increases in production demand and quality. The innovative IFS demonstrates that the Asian LDCs can have more viable agro-industries, with their wastes used as inputs in surrounding integrated farms, while solving the waste and pollution problems effectively and efficiently and making local enterprises highly rewarding in a healthier environment.

Integrated fish farming is attractive to small-scale farmers under pressure to produce higher-value crops, as well as to communities seeking to augment food production and income increase. So far, rationale of ruminant dependency for protein-supply would be viable in Asian LDCs; in fact, a combination of ruminants and non-ruminants probably would be viable or be a welcome expansion in a protein-hungry country as the case shown for Indian milk production. If grain becomes scarce as well as crises related to vitro meat products remain, as now seems likely to continue for many more years, the DCs, such as, the USA, Canada, France, etc., may follow Asia's example of using ruminants to systematically convert more crop residues into food. Small-scale farmers dominate Asia, and livestock is an important socioeconomic aspect of indigenous farming systems, but both land and capital resources are limited. The major benefits of the green revolution were also being monopolized by rich and middle farmers to the relative exclusion of small peasantry, tenants, landless and near landless poor. Moreover, there is considerable controversy concerning the existence of protein deficient diets and the protein gap in Asian LDCs has been attributed to a lack of enough food rather than insufficient protein.

So far, there is no other subsector in Asia as prosperous as the rural aquaculture, if we look on potential insights. As it is now impossible to fully depend on natural fishes, small-scale fish-culture has been valued as an important enterprise by both better-off and worse-off rural households in many Asian LDCs. Potentially farming fish has a good return on investment as well as less strenuous, need shorter daily labor requirement, occurs close to the homestead, and also developing as a gender-sensitive family farming practice (Shelly 1998). The persistent and widespread malnutrition is an even stronger reason to increase animal production, however there is a clear rationale for increasing the production of worldwide aquatic products due to crisis regarding modern farming sources of major meats (see notes: 7, 8 and 13). Towards such ends, reference here is frequently made to a "blue revolution" analogous to the "green revolution" in agronomy.

Indeed, small-scale rural aquaculture has diverse roles towards the improvement of livelihoods; potentially it can contribute to improving household food security and supplementing family income of the poor (Little, 2000; Edwards, 2002; Muir, 2003; New, 2003). The IFS combines aquaculture, animal husbandry and agriculture, form a self-reliant system which recycles organic wastes, such as weeds, crop by products from fields, wastes from poultry and livestock, and natural food production from photosynthesis within the farm itself. In this system, substances that may otherwise be considered wastes are viewed as resources. Even if the small-scale aquaculture practiced at a subsistence level, and also promoted as part of homestead food production programs -- *that increases the production and consumption of animal (poultry, eggs, milk, fish, etc.) and plant foods (vegetables and fruits, etc.)* -- could provide the much needed animal protein and other elements of diets (i.e. fats and lipid associated vitamins, calcium and other micro-nutrients) the lack of which are typical causes of malnutrition. Such programs aim to provide income for the household and should be included in strategies to improve

household food security, nutrition and livelihoods (HKI 2004).

In this article, the author has basically focused much on basic models, and rationalized that rapid promotion of aquaculture-based IFS is essential to overcome food and nutritional security of the rural poor above all their livelihoods improvement. The experiences reported here demonstrate that basic model has many variants but the principles are the same. The innovative IFS have opened up a new horizon of high animal protein production at very low cost. In IFS of livestock, fish and crop with the wastes and residues of all being used as feeds for livestock and fish, and as fertilizers for fish and crop cultures, can be viable economically, ecologically and socially. One additional aspect, which should not be overlooked, is the establishment of more efficient promotion of self-employment for the individual farm family with relatively small area of land and low investment which can be recovered within a couple of years, with the prospect of its members becoming entrepreneurs as the integrated farm expands.

**Concluding Remarks:** The globalization of world economy has brought many changes, both good and bad, in food distribution, dietary systems and food habits, and people's livelihoods. Around the world, a politics of food scarcity is further emerging. The *destroy-and-consume* model of free market enterprise and the dilemma - *only have to protect the economy, not the environment (!)* simply would neither be sustainable nor be happy events, rather leads to severe destruction. Global business as usual could mean increased misery, especially for the world's poorest populations. One thing that has become abundantly clear in all this is that *the era of cheap food and cheap fuel is over.*<sup>50)</sup> The first place this will be felt is the poor communities in third world nations, specifically basic foods import-dependent LDCs.

Placing agricultural and food issues onto the national and international climate-change policy agendas is critical for ensuring an efficient and pro-poor response to the emerging risks. We have overpopulated the planet to a point where we are wiping out non-renewable resources at an alarming rate. This means a population correction is due, basically in third world, more specifically in Asian LDCs, which depends much on efficient short and long-term national policy strategies for population control. Regarding food and nutritional security, so far, some cautious policy-measures are necessary for grains-based poultry products, especially development of collaborative support systems (global-national-regional-local) are necessary to overcome bird-flu and related crises, balancing distribution and pricings policies of both meat and grains products as well as enhancing national policies and programs to ensure ease-access of those products at reasonable prices to the vast malnourished rural dwellers. Towards such ends, a mix of policy actions that avoids damage and fosters positive responses is required. There is need for some policy changes in production and marketing strategies, such as to give more attention on traditional production practices, look export-oriented market for locally non-eatable items, and careful analysis on potential insights of various IFS, etc., are supposed to be realistic approach.

Besides situating the prime problems, global to local, related to food and nutritional insecurity in

Asian LDCs, the author has indicated here some alternative measures, basically argued that Asian traditional resources interdependencies (farming wastes cycle and recycle) along with innovative modern IFS would be highly potential option towards farming productivity increase. The traditional backyard system of livestock growing can be viable alongside modern and intensive livestock production since, although outputs may be less, capital and labor inputs are low but environmentally be sounds. It was hypothesized that the role of fishponds in small-scale IFS has many potential insights with respect to improving livelihoods, poverty alleviation and above all food and nutritional security. As of field investigations in South and South Asian LDCs, some basic IFS models project experiences, both experimental and replicational, have indicated affirmative results. So far '*Ease-of-Production*' is a major incentive for farmers to integrate fish and vegetable production or other such as poultry. The experiences reported here demonstrate that basic model has many variants but the principles are the same.

So far, most of world's contemporary policy strategies, both international and national are not in favor of hungry peoples. Besides macro policy shifts, micro-levels intensive production strategies and related incentives are essential. If we are trying to help the poorest of the poor farmers in the third world, with limited land and monetary resources, there is no way they can grow fodder to feed their livestock, and they have to depend on residues from their food and raw material crops for local utilization first, with any surplus for export. Under such circumstances aquaculture-based IFSs should include: A safety-net for the producer, like guaranteed selling prices, credit schemes, and marketing and other inputs assistance; Introduce those types of aquaculture, which can link to, and do not compete with present and accepted agricultural and environmental practices; and Be of long-term character and not only have the objectives of biological and technological success but should also include a certain production volume for national health-nutrition need and the economic viability, etc.

Indeed, the public agencies in LDCs can play important roles, despite a widespread perception that only NGOs are effective service providers in rural areas. Finally, integration is more than diversification, and it is far more complex. Specially, learning to keep fish is much more difficult than handling a new crop variety. The environmental pre-requisites need to be assessed before deciding to try it out. Here prime focuses were basic models of aquaculture-centered IFS. Much more target specific in-depth investigations on particular type of integrations are essential preferences, and those remain also as future research interests.

## End Notes

- 1) The global population is estimated to expanding annually by 1.2 per cent or over 76 million (UN 2003), of which over 94% people added in third world compared with only around 4% in the industrialized or developed countries (DCs). So far, after birth-death balance, at least 70 million additional peoples each year are added to the global

population.

- 2) The feeding systems to produce modern-farming animal-products have been using the same feed resources as are eaten by humans, namely cereal grains and soya-bean meal (FAO: 1993). It was estimated that livestock consumed almost half of the grain supply in DCs. In emerging markets an income gap has opened up between cities and countrysides over the past 2 decades, and then recent rapid economic growth in some LDCs, such as China and India, the drastic changes happened in farming meat production and consumption. For instance, from early-1970s to the mid-1990s, meat productions in LDCs grew by 70 millions tons – more than 3 times as much as in DCs. We need more grain if people eat it transformed into meat than if eat it as bread.
- 3) Evidence of the excessive human demands, both foods and modern non-foods, can be seen in collapsing fisheries, shrinking forests, expanding deserts, rising atmospheric CO<sub>2</sub> levels, eroding soils, rising temperatures, disappearing species, falling water tables, melting glaciers, deteriorating grasslands, rising seas, rivers that are running dry, and so on. For global perspectives of various such contemporary crises and related projections, please consult with WWI (2006) and ERI (2007).
- 4) The world's most important fisheries are being harvested at rates that well exceed their long-term sustainable yields have collapsed as many varieties either have already disappeared or are in danger. Traditionally most peoples depend on natural fish catches, specifically most LDCs much dependent on fresh-water wild fishes, whereas total marine fish catches and consumptions are dominated by DCs. The fresh water natural fisheries in Asian LDCs are in danger as in the face of over fishing, and the traditional resource management practices, like collecting natural fishes and crustaceans from canals and paddy fields, are threatened by agricultural intensifications, over use of resources, land-based pollution, etc. There are alternative measures to protect marine fishery in DCs but virtually nothing for the fresh water fisheries in LDCs, except promotion of fish-cultures for specified varieties.
- 5) Globally, urban population has grown more than the rural population; within the next 3 decades, 61% of the world's populace is expected to live in urban areas (Cohen 2006). However, three-quarters of the all poor remain in rural areas, and rural poverty will continue to be more prevalent than urban poverty during the next several decades (Ravallion *et al.* 2007). Traditionally, in most Asian LDCs, usually 70 to 80% peoples lives in rural areas, even if one-way rural to urban migration became striking feature in many densely-settled areas, basically for job-hunting; that expands slums areas and create many social crises in urban areas.
- 6) For instance, Chinese integrations in agricultural sub-sectors are more than 2000 years old; and basically livestock and crop with the all wastes and residues being cycled and recycled as fertilizers for crop cultures as well as feeds for livestock and fish; and wastes also being used as household cooking-logs, and so on.
- 7) BSE is the commonly used name for Bovine Spongiform Encephalopathy – *had dubbed as mad cow disease by the media, first reported in 1986 in the UK*, a slowly progressive, degenerative, fatal disease affecting the central nervous system of adult cattle. The likely cause of *BSE* is infectious forms of a type of protein, called *prion*, normally found in animals, and may have become infected when fed feed contaminated with scrapie-infected sheep *meat-and-bone meal* (MBM). Now scientists generally agree that *BSE* is transmitted when cows consume meat scraps (*discarded parts/feed-offal from other cows or pigs, etc.*), for long had been practicing by farmers of the UK and later became common practice in many DCs. In cattle with *BSE*, the abnormal *prions* initially occur in the small intestines and tonsils, and are found in central nervous tissues, such as the brain and spinal cord, and other tissues (*prions usually create tiny holes in the brain tissue, making it appear sponge-like and resulting in severe brain damage and eventual death*). A disease similar to *BSE* called *Variant Creutzfeld-Jacob Disease (vCJD)* that is found in people, and is believed to be caused by eating products from *BSE*-affected cattle meats, and there is no cure

for *vCJD*. Until-2003, a total of 153 *vCJD* cases had been reported of which 143 cases in the UK alone. Since after only 2 additional cases were confirmed; albeit, *vCJD* fears yet among millions, those may have consumed *BSE*-contaminated beef products.

- 8) Bird-flu refers to the highly pathogenic Avian Influenza - *sometimes as Avian-flu, caused by viruses, basically H5N1 virus adapted to birds*, is an emerging virus that has been causing global concern as a potential pandemic threat. Bird-flu is a phrase similar to “Swine flu”, “Dog flu”, “Horse flu”, or “Human flu” in that it refers to an illness caused by any of many different strains of influenza viruses. Since the first *H5N1* outbreak occurred in 1997, there have been an increasing number of bird-to-human transmissions (HPAI *H5N1*) leading to clinically severe and fatal human infections. Even if, the virus may not easily cross over to humans as there is a significant bird-human species difference. So far, total 335 humans had infected globally (11/2007: as of WHO), of whom 206 died. <<http://www.irinnews.org/Report.aspx?ReportId=75318>>: retrieved 2/2/08). Latest (2/2008) severely *H5N1 virus* affected countries were India and Bangladesh. In Bangladesh, the *H5N1* was first detected in 3/2007 and after 55 farm outbreaks in 19 out of the 64 districts had been reported; and after 4 months in 10/2007, some new outbreaks across the country has reported, which gradually became severe threats to most producers, currently represents around 150 thousands.
- 9) Global meat production has increased over 5-fold since 1950s - basically happened in DCs, and over doubled since 1970s with a domination of LDCs. Towards such ends, in LDCs, consumption of basic meats (beef, chicken, and pork) and other animal products also were rapid. For instance, from early-1970s to the mid-1990s, meat productions in LDCs grew by 70 millions tons – more than 3 times as much as in DCs. Indeed, industrial systems now are source of 74% of the world’s poultry products, 50% of all pork, 43% of beef, and 68% of eggs (WWI 2006). Even if, DCs still dominate production but recent years LDCs are rapidly expanding and intensifying their production systems (see Braun 2007). Recent days 60% of the meat consumed worldwide is eaten by people in LDCs, even if by comparison, the average per person in the LDCs yet eats 31kg per year, whereas in industrial world per person eats 85 kg a year (see WWI 2006).
- 10) If we look on long term trends, the global fishes catch raised nearly 7 folds in 2003 when compare to 1950; and gap between dominant wild harvests and grown on farms gradually narrowing as cultured fish increased also over 91 folds for the same periods (see WWI 2006).
- 11) So far, as of reviews of related documents: a meat-based diet requires around 7 times more land than a plant-based diet. Each kilogram (kg) of steak from feedlot-raised steers that we eat comes at the cost of in-average 5kg of grain along with use of huge water (roughly 2500 gallons) and eroded top soil. Cattle in feedlots require roughly 7–8kg of feed concentrate per additional kg of live weight. For pigs, the ratio is nearly 4–5kg to per kg gain. Chickens are much more efficient, with a 2-to-1 ratio. Fully culture-fish, including both herbivorous and omnivorous species, require little below 2kg of grain concentrate per kg of gain.
- 12) The BSE outbreak in UK was responsible for the death of nearly 200 thousands *BSE-affected* cattle, and led to the pre-emptive slaughter of around 4.5 million non-infected cows until now. Although 95% of the BSE disease cases have been located in the UK, but *vitro-cultured* beef producing most countries have also identified infected cattle among their herds. The impact of the BSE epidemic on global markets has been huge. Several countries have closed their borders to European, British, American and Canadian beef imports for years. Japan, for example, was formerly the largest importer of U.S. beef, buying over US\$1 billion worth in 2003. When the first US case of BSE was identified in end-2003, Japan halted all imports from the U.S. Japan has since re-opened and then re-closed its doors to US beef. The country, once again, began to import the beef product in 2006 with very tight regulations

governing which plants can supply them (USDA 2007).

- 13) In Asia, as breed-house of all major religions, the huge people have meat-restrictions as well as culturally many peoples not eat easy-protein sourced items, such as many aquatic animals are not consume in South Asia. Indeed, some traditional food-cultures as well as religious faiths do not allow many people to consume major protein intakes. As for instance, around one fourth of world population are not eating pork or in India majority of people have restriction on meats, especially beef. So far, excluding vegetarians, around half of the global populations somehow have restriction on meats.
- 14) As consumers in LDCs diversify their diets away from staple cereals and adopt more western diets and consumption practices, about 80% of the growth in meat utilization is expected to occur in these regions, even if still the level is near one third than that in DCs. The poultry industry suppose to further expand rapidly in third world, specifically in Asian LDCs as - many people have restrictions on other meats (*see* note 13) and needs less management costs as small-scale home-based production easy to manage by the disguised family labors including women, most efficient converter of grain feeds as well as poultry farm also essentially providers of eggs. For instance, in Bangladesh, as of Islam (2003), by taking 2000 as base year, the future projection trends of the poultry and duck production estimated to increase several folds in 2025.
- 15) The world price of wheat in May 2007 had reported around \$200 a ton, however it had been gradually rose to over \$400 in early September 2007, the highest ever recorded; and since then wheat price has been fluctuating around \$350–400. Though in real terms its price is far below the heights it scaled in 1974, it is still twice the average of the past 25 years. In early-2007, the price of maize exceeded \$175 a ton, again a world record. It has fallen from its peak in late-2007 but at \$150 a ton was yet 50% above the average for 2006.
- 16) So far, whatever the increasing trends of meat production in LDCs (*see*, note 9), basically those have consumed by the rich and/or by the urban and rural middle classes, whereas in general lowest 4–5 deciles consumed nothing or very negligible portion that may differ among country to country. Moreover, most such farms are owned and managed by the family members of the economically better-off peoples.
- 17) We have to keep in our mind – who surpluses huge agricultural products and who actually control the international foods market. In general, prime losers are third world countries and prime gainers are resources-rich DCs, basically USA with huge surpluses of grains has been benefiting mostly. Previously, excess grains had been used as political food-aids to third world for the strategic needs and hidden objectives but such strategy probably not works well enough now; and the USA in recent years has started to play inhumane-game with excess grains through pull-and-push approach, only to maximize gains. Basically rapid promotion of food-to-fuel strategy (as of many people, it is *simply a crime with humanity*), USA has been benefiting two-ways. For instance, during 2007, one-fifth of total US grains had used for bio-fuels that reduced 4% gasoline import-dependency (even if USA has highest global gasoline reserves!); and conversely the grains prices in global market has increased drastically (*see* note 15). The USA, traditionally the biggest global grains exporter (*see* table 4) - also has been earning much from increased grain-prices, *both human-foods and livestock feeds*. So far, the net farm income of USA for the year 2007, as estimated by IMF, was \$87 billion or around 50% more than the average of the past ten years. Conversely, for instance, food-prices in Asian LDCs became drastically high, as of instance in India and Bangladesh (*see* Figure 4/& notes). Even if, Bangladesh became food (rice) self-sufficient in late-1990s but again becomes most severe grain-deficit country, and now most peoples are virtually under hidden-hunger situations, and the most recent drastic price-hike of grains in global market, especially rice (*see* Figure 5), the country no longer able to import grains, both human-food and livestock feeds.

- 18) As of the World Bank, around half of world's poor people now live in rural areas of LDCs, and among them 2.5 billion are involved in farming (WB 2007). Farms in LDCs are subsistence in nature, tiny in size, and many in numbers or most of them just engaged in farming as they have no other alternatives for their somehow surviving.
- 19) For instance, in Bangladesh, as of Islam (2003), the total use of grain for poultry feeds for the year 2000 had estimated by livestock department as 631 thousands tons, of which wheat and maize respectively accounted for around 22% (near *141 ths. tons*) and 78% (roughly *491 ths. tons*); whereas total production levels of wheat and maize were 1800 thousands tons and 65 thousand tons respectively for the same year. Thus, total poultry feed requirement was nearly one-third of wheat and maize production; and the requirement of wheat as poultry feed was nearly 8% of total domestic production, whereas the requirement of maize was as high as 8 times roughly of its domestic production! Maize is yet a minor crop in Bangladesh in acreage - only 0.2% of rice or 3% of wheat, even if maize rank second to wheat in world cereal production.
- 20) Apparently, under dominant position of DCs in UN systems and international trades, probably no drastic changes ever happen in favor of LDCs and their depressed poor. So far and so on, no major international crises yet resolved due to controversial role of the DCs and/or UN permanent members, especially of their own hidden business and strategic objectives; and conversely they have been created various new-generation crises worldwide. The current food-insecure situations in LDCs are artificially created by the DCs (*e.g.* note 17) to maximize benefits, politically and economically.
- 21) In the many region, basically in LDCs including socio-religiously conservative ones, traditionally many rural women now are managing separate several hundred types millions of micro-enterprises, and they through small group formation have been taking tiny loans from NGOs or specialized bank and MCPs., basically for of non-farm activities, with related many supports products and logistics (*e.g. savings, skill-trainings, social and health awareness-building, child educations and so on*). Currently, for instance, *around 97% of all 7.2 million member-borrowers of the Grameen Bank of Bangladesh are women*(see Hossain 2008). However, besides such development, the vast rural women are yet hidden-treasure in socio-cultural norms. The policymakers and other influential groups including the civic and religious bodies, should began to realize that the without economic involvement of vast women, especially rural poor women in economic activities sustainable livelihoods would be difficult.
- 22) For instance, in Bangladesh, the export-oriented ready-made garments (RMGs) industry has witnessed remarkable growth since its inception in the late-1970s. Total RMGs factories reached to 632 in 1984-85, and factories shot up to some 3000 in 2002 and by 2005 it reached to 3560 with total exports value of US \$6.4 billion in 2004-05. Among total 3560 RMGs factories, 47% was woven units, 42% knit units, and 11% producing sweaters. Total employment generated by these RMGs enterprises is estimated to be 1.9 million production workers, or 2 million if all employees are included (for some details, see WB 2005, and Siddiqi 2004). Most of these workers are women (an estimated over 80%) drawn from the rural areas. Many those women workers previously were disguised labor-force or non-paid family helpers and/or day laborers and even as hand-to-mouth servants/maids at the richer households and/or engaged in other odd activities for their surviving.
- 23) For instance, in Java (Indonesia) and Bangladesh around 60% of rural population are landless or near landless. In Cambodia, about 40 to 50% of the landless and marginal landholders possess only about 10 to 15% of all agricultural land in rural areas. The estimated Gini coefficients of land concentration range from 0.47 to 0.66 for the different surveys that target different population groups (*see* Boreak 2000), even the country hold much per capita land and other resources than many other Asian LDCs.
- 24) After World War II, during first 3 decades, almost every Asian country has enacted land and/or agrarian reform law

- (APO 1999). In the early years FAO of the United Nations was much concerned with the consolidation of small or scattered landholdings. It was then conceived as an important aid to improved agriculture. In subsequent decades it addressed the problem of redistribution and resettlement. However, with some exceptions little change has been made to the structure of land-ownership.
- 25) Bangladesh now is the 9th populous country in the world in terms of total population of around 150 millions, and with roughly 1000 persons/km<sup>2</sup> it exhibits the most densely settled country of any significant size in the world, except some city states, like Singapore and Hong Kong (Hossain 2002a). Amazingly, the country is roughly 40% the size of Japan but the home of a population more than that of whole of Japan. Even, it is 60% denser than Taiwan, thrice the density of India, four times that of Britain, seven times that of China and 32 times that of USA (see Caldwell *et al.* 1999). Conversely, the per capita land holdings in 1985 was 0.11ha which severely reduced to 0.078ha in 1995 and again as low as 0.052ha in 2005 (see BBS 2006); and the average farm size fell from 1.3ha in 1968 to 0.9 in 1984, around 0.5 in late-1990s, and now below 0.4ha. So far, over 60% rural peoples are “landless and functionally (*who own <0.5 acre or 0.202ha arable land*) landless (LL&FLL) (Hossain 2002a).
  - 26) History suggests that the effective implementation of land reform or redistribution programs in Asian LDCs in a peaceful manner has been very unsatisfactory. In the countries with unequal distribution of land, the case for land reform is sometimes based on a sentiment for equality. Opposition from landed interests, complex legal procedures, and the limitations of reform administrations has prevented substantial change in land entitlements. Those, who were likely to lose their land generally found innumerable ways to protect from any loss of their personal property - *by engaging in protracted litigation challenging the constitutional validity of the laws, by rearranging their property in the names of nominees, by slowing down implementation, or when ultimately forced to give up any of their property, and by surrendering only the least valuable parts* (see Booth and Sundrum 1985). For better understanding of Land Reforms and/or Tenure Systems in selected Asian countries, please refer to APO (1999). For more on Cambodia, China, and Bangladesh, *could be found in* Boreak (2000), Nyberg and Rozelle (1999), Khan (2004), Ahmad *et al.* (1998), Chowdhury (1990), and Hossain (1988).
  - 27) For instance, under Muslim law (in Hindu law, except for daughter), property must be divided among surviving heirs and, as re-division occurs over generations, the size of parcel holds by one person continually diminishes.
  - 28) Myanmar and Cambodia were major exporters in the world market before the GR began in the late-1960s, but since then they have lost the market because of civil disturbances, slow growth in production, and deterioration in marketing infrastructure. The global rice market has expanded over the last 3 decades with rapid trends in recent years. However, total trade volumes are yet comparatively low. For instance, only about 6.3% of the world’s rice production had traded internationally during the early new millennium, in contrast to nearly 18.1% for wheat and 11.6% for coarse grains (see Hossain 2004). Only a few countries participate actively in the export market; and among them 5 countries - *Thailand, Vietnam, India, USA, and China* alone account for nearly three-fourths of the supply in the global market, and Thailand alone controls about 30% of the market, even if, the country’s total production is less than Bangladesh. However, recent export restrictions by some rice producers (see Table 4) along with fragile grains market further besets the food security in Asian LDCs.
  - 29) It should keep in our mind that population in Bangladesh is much higher than those three countries, for instance, the population density is around 22 times higher than the Cambodia. Probably, the country would exceed even Vietnam and Myanmar in per capita rice consumption with huge differences, if enough rice is ease-accessible to all people under poverty (hardcore and moderate), the 40% of the country’s population (see BBS 2006).
  - 30) In hot pursuit of a policy of the GR, Bangladesh favored the production of rice, as in many Asian LDCs, which

accounts nearly 94% of the total food-grains and covered four-fifth of the total cropped area with the cropping-intensity of over 180% through introduction of IRRI and other HYV rice, and underground irrigation provisions. The country has greatly reduced its imports through a substantial increase in domestic production over the last one decade and half, and in late-1990s became food (rice) sufficient country due to bumper production, even if time to time frequent natural disasters (basically floods) has been hampering the food security situations. Even if, government had successfully tackled the severe flood of 1998 (*see Del Ninno et al 2003*). The country has started to import huge rice in recent months from India and elsewhere, as food situations became worse now, not only for price-hikes of the foods (grains) in global market but basically due to several natural calamities (basically two floods and one severe cyclone during 2007), and the emergency rule under a military-backed caretaker government since January 2007 (*see Hossain 2008*) has been jeopardizing economy. So far, rice production in per head consumption is yet several times more than a person actually needs to consume under any standard or balanced dietary-table.

- 31) Bangladesh has the highest prevalence of underweight children of any country in the world except North Korea (*see HKI 2002*). Almost one-half of children (47%) and one third of non-pregnant mothers (33%) are anemic, which is largely due to iron deficiency.
- 32) Culturally, even when any high-level government people mention food deficit he always seem to mean the shortage of food-grains only. Even when anyone is supposed to ask somebody whether he/she has taken lunch or supper, usually ask whether he/she have eaten rice or not. When anyone invites someone for a meal she/he simply asks the guest to come for rice (Hossain 1996). Until now, rice has been the largest share of the diet at all income levels, with the income elasticity of demand as high as 0.90 for the poorest deciles.
- 33) In Cambodia, where the strong belief of most peoples is that food security equals rice security equals rice production equals rice consumption, where rice on average rice sourced for 75% of total calorie requirements of rural dwellers (*see Koroma and Hossain 2003*). Due to current stable conditions and also well-endowed per capita natural resources including forests, inland and coastal fisheries, and wide diversity of agricultural zones suited to a range of crops and livestock than Bangladesh and other densely-settled Asian LDCs, and may overcome the situations that depends much on government policy strategies.
- 34) There are many reasons behind the worldwide healthy-image and popularity of Japanese food, locally known as *Washoku*; and some basic reasons are: Each meal comes with various items, proportionately includes huge vegetables but less fat and also uses less extra-oil than any other protein-rich tables. The way of food presentations, both serving and decorations, are also attractive and tastes also good-enough. There are no other nations in the world, which developed so rapidly, both economically and physically; and even now in average Japanese became highest-longevity peoples (female >86 years and male >81 years) in the world; and they are also no longer physically shorter nation (as image was to outside world) and probably also out-looking (*e.g.* eye) also changed due to improved-diets and balanced-food intakes (*see Figure 7 and Table 7*) with rapid economic growth. So far, worldwide, Japanese restaurants have been expanding very rapidly, as millions of Japanese usually go abroad every year, and most of them basically are not familiar with other diets. The Japanese government also recently has taken long-term projects for further popularizing their foods (*see MAFF 2007*). In last 2-3 decades, as huge numbers of foreigners have visited Japan for educations, trainings, and jobs (*legal and illegal workers*), etc., and many of them also have settled in Japan; and among them *Washoku* become popular and also imaged as balanced and healthy diets.
- 35) So far, rapid and higher growth in Asian population means an increase total production and consumption on demand for rice. Even if the demand grows at a slower rate, the global rice production must needs to reach about 800

million tons of un-husked rice by 2030 to match the demand, an increase of about 200 million tons over the peak production level reached in recent years (Hossain 2004). Albeit, it will not be an easy task to achieve such level, as the attainable rice yields are about 8 ton/ha in the temperate zone and 6 ton/ha in the tropics, which are about to be reached in many countries (*Table 5*).

- 36) Past development in the third world depended heavily on the strategies of the administrative powers, which used the land, people and natural resources to meet the material and industrial needs of the metropolitan nations. This development used huge areas of prime lands for livestock ranches and mono-cultural plantations for primary produce for export, very often at the expense of local nutritious food production. It is unbelievable that such development still continues in most countries of the third world, and it is not surprising that they remain poor or even become poorer.
- 37) The human wastes were retained in brick-lined pits in the courtyard and taken regularly in covered containers to the field and composted with coarser crop residues before being used to condition the plant beds -- the less coarse ones were used to supplement the pig feed. The human urine, for example, was always separated in a covered fired-clay jar used by males, and the females used chamber pots, which were then emptied, into the same jar. The fermented urine was used as fertilizer for vegetables, besides integrations of various backyards enterprises, had been provided most household diets.
- 38) Longer term, it no-longer seems lunacy to believe in the possibility of “*meat without feet*” - meat produced in vitro, by growing animal cells in a super-rich nutrient environment before being further manipulated into burgers and steaks. Albeit, whatever the acceptance of vitro-beef products in DCs and/or western societies, traditionally, the most peoples in Asia with little exceptions, probably would never be able to adjust with such beef vitro-culture. So far (as of author’s exchanged views with many Asian peoples) some generalized remarks were as -- How justified it is to force cows to consume meat scraps (*feed-offal*) of animals, even from other cows (!)? Is not it unethical or against nature?
- 39) The wheat, rice, and coarse grains, including maize and sorghum, are staple foods for the majority of the world’s population. In recent years, higher incomes in India and China and many other LDCs have made hundreds of millions of people rich enough to afford meat and other foods, whereas most rural dwellers becoming poorer and undernourished. That increase alone accounts for a significant share of the world’s total cereals crop. Not surprisingly, farmers are switching too, and they now feed about 200–250 million more tons of grain to their animals than they did 20 years ago. It has argued that if the entire world’s grain production were reserved for human consumption then there would be enough to feed the 10 billion inhabitants at which point the world population is expected to stabilize (*see* Preston 1995).
- 40) For instance, Japan, Korea and Indonesia were estimated to be taking 50–65% of their share of animal protein supply from fish while Bangladesh, Sri Lanka and Thailand are between 35–50%. Almost 80% of Asian production traditionally comes from East Asia, particularly China, where as South and Southeast Asia form only about 9% and 13% respectively (*see* APO 1998).
- 41) Besides rapid promotion of non-farm micro-enterprises, since the mid-1980s the GB also had started to think of comprehensive ways through which the poor can build a network for sustainable improvement of their livelihoods. GB founder and his expertise colleagues had much concentrated on the efficient use of low-cost and intermediate-level technologies as well as other available resources in broader agricultural sub-sectors (Hossain 2002a). Carrying out all these initiatives under the GB became hazardous and unwieldy, so from 1989 it began to establish new off-shoots organizations, now known as GB family organizations aimed at linking the poor with

- all major sectors. GB founder also took initiatives to establish several other business companies without any experimentations -- some solely for-profit, and some for profit but as a supporting entities of GB family -- now all those basically known as Grameen Network companies. In GB-family, the Grameen Motso (*fishery*) Foundation was created in 1993 as an aquaculture-based poverty-focused company. In total, now, there are over 2 dozen organizations (*Off-shoot and network companies*) in the Grameen Family, and other experimental activities (see Hossain 2008).
- 42) For instance, since 1980s, Indonesian government policy has aimed a foreign currency objective at enhancing shrimp cultivation for export. In Bangladesh shrimp forms the second most important export commodity and half of it is cultivated, also a foreign currency objective.
  - 43) As for instance, FAO simply defined extensive aquaculture as a system which does not involve, for instance, “*fish feeding*”; and semi-intensive aquaculture sometimes ensures feed partially thorough fertilization and/or feeding and intensive aquaculture entirely depends on artificial feeding (Muir 2005). Again, production of fish could be increased by a substantial level through increasing pond nutrient inputs rather than stocking an additional and/or imported species (e.g. Tilapias), folks, had been very popular practice in many Asian LDCs throughout 1980s.
  - 44) The author had visited almost all South and Southeast and also some East Asian countries, as part of formal assignments of UNCRD (as UN Researcher cum Trainer: 4/1999–3/2004, *basically under Human Security and Regional Development Project*), Postdoctoral Researcher (*JSPS under Nagoya University: 4/2004~3/2006*), and then time to time informal (*personal interest*) visits, *and* voluntary project activities (2003~). Some other aquaculture-based farming also had investigated (e.g. crocodile farming in Southeast Asian LDCs) but those are not very relevant to this article. Some IFS experimental documents were also collected from various LDCs, even if all folks not used here.
  - 45) Until 1960s rice-fish system had been practiced in some areas of Japan; however not practicing now due to various reasons. As an island-nation, the people in Japan are much dependent on marine fishes and other aquatic animals but consume only limited fresh-water fishes. Traditionally, due to number of reasons (e.g. raw fresh-water fishes are risky for health, improved-communication ensured regular and quick-supply of marine-products, now-take much more meat than fish, etc.) fresh-water fishes are not popular in Japan, but with economic development Japan started to imports huge fish, shrimps, other aquatic products and related processed-products from abroad. Indeed, Japan became the world’s largest importer of fish and aquatic products (see FAO 2002).
  - 46) The author himself had involved with the FRI projects during late-1980s to early-1990s, prior his decision for higher studies in Japan.
  - 47) A major flood in 1998 covered two-thirds of the country and caused a shortfall of 2.2 million tonnes in rice production and threatened the food security of tens of millions of households (Just, 2003; Del Ninno et al. 2003) as well as fishery sector. During 2007 two more severe floods and a cyclone had caused severe havocs to the pood production (Hossain 2008, see note 60).
  - 48) For instance, Bangladesh has one of the largest and most sophisticated NGO sector in the developing world and most programs basically defined their target groups as landless poor women (Hossain 1999 and 2008). So far, over 90% of villages in the country had at least one NGO in 2000 (Fruttero and Gauri 2005). Majority of NGOs (big and small) in Bangladesh focus on micro-finance rather than information or agriculture. An estimated 92% of NGOs overall counted credit provision - *90% of small NGOs and 96% of big NGOs* - as one of their services (see Gauri and Galef 2005).
  - 49) It was one of the dumbest “green” ideas ever proposed: Convert millions of acres of cropland into fields for

producing ethanol from corn, then burn fossil fuels to harvest the crop for ethanol, expending more energy to extract the fuel than actually get from the fuel itself! With a few exceptions, bio-fuels produce no net increase in energy output (e.g. in USA 20% grains used for 4% biofuels in 2007, and then again gasoline use for growing crops for ethanol!), and they cause food shortages while creating rapid food price increase and strong economic incentives for the destruction of the very rainforests we desperately need to stabilize the climate! Total impact leads to the inescapable conclusion that biofuels are largely some big corporate-pushed and government-sponsored scam DCs specifically in US, however some strategies such as Brazil's ethanol production policy sounds better than DCs. The growing and harvesting of sugarcane in Brazil, for example, provides an 8-to-1 return on energy investment. But even that pursuit is tarnished by claims of unsafe work environments and massive environmental pollution, as the sugarcane-fields have burned before being harvested - a process that releases massive amounts of CO<sub>2</sub> into environment.

- 50) As it turns out, cheap food is only made possible by cheap oil, and with oil now approaching \$160 a barrel (may exceed \$200) - a price that virtually no one thought possible just two years ago; and food prices are simultaneously skyrocketing.

[This article is based on author's training paper prepared in different name for the China Training Course on "Land Planning and Rural Integrated Development in Western China", organized by the UN Centre for Reg. Dev.(UNCRD), China Min. of Land and Res., and China Asso. for Sc. & Technology (Shian: 18-23 Mar.2002). The earlier version of this paper prepared for Lecture series of the Graduate School of Social and Cultural Studies (Kyushu University: 3/2003) and then for the Module of 'Human Security and Regional Development' at the 31<sup>st</sup> Intl. Training Course of the UNCRD (April-May 2003). The "Asian IFS centering aquaculture" part also had presented at the 73<sup>rd</sup> Conf. of the Central Japan (Chubu) Rural Economists Society held in Mie University (Tsu: 21.06.2003) and then the paper also discussed at the Graduate Seminars of School of Bio-Agri. Sc. (Nagoya Univ.:6/2005); and finally, the upgraded first part of this version - Milieu Features of Food Insecurity in Asia (in different name) has discussed at the same seminar of Nagoya University (6/2008), which then submitted to the 78<sup>th</sup> Conf. of the Central Japan (Chubu) Rural Economists Society (Shizuoka Univ. of Art and Culture: Hamamatsu, 28 June 08). The author is grateful to all persons and their organizations for supplying numerous documents, and also the permission to use the provided or available materials for the above gatherings. Thanks are due to the participants of all above gatherings for their helpful comments and suggestions to reshape the paper into its present form.].

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