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Reconceiving Food Security and Environmental Protection

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ABSTRACT

The twin issues of food security and environmental protection for the remainder of the century will be defined by expectations that the population will continue to grow to 11 billion, mainly in less developed countries (LDCs), as well as by human behavior. This paper considers conventional analyses of food demand and compares these with wider philosophical perspectives that may modify approaches to agricultural science. The conventional approach is indicated in IFPRI research which models scenarios to 2020 and predicts an increased demand for cereal of 40% to be met by increased production mainly in LDCs, with more developed country (MDC) exports possibly falling with prices. While production seems adequate for the higher population, continued distributional and nutritional inequities are foreseen.

Food production is likely to maintain priority over environmental protection in LDCs although environmental remediation should benefit from technology, particularly in MDCs. The agricultural environment represents human's widest spread of terrestrial environmental manipulation, and its monitoring is more economic than ecological in orientation. Rising understanding of the mutual causality between the impoverishment of people and the environment may well focus more on non-technological factors through this century than the last.

Outside agricultural circles, philosophical thought has advanced beyond the anthropocentric approaches of sustainable agriculture to consider the rights of nature, including humans. Increased societal awareness of such matters may influence the overall development paradigm within which rests most of our agricultural research. A reduction in total food requirements is implied in this paradigm as agricultural self-sufficiency is accepted as socially beneficial and as food security is conceived as a universal right of access to nutritious food. Such security implies increased protection of environments in LDCs. Whether such changes occur, there is value in widening the ethical perspective of all of us associated with the manipulation of nature and the planning of human development through the 21st century.

Food security is an essential precursor to environmental protection. From global and population perspectives, the issue may be cast in terms of poverty forcing otherwise environmentally responsible farmers in less developed countries (LDCs) to sacrifice long-term goals, or in more basic terms of the denial of basic rights to food, shelter, clothes, and essential medicines. Over the

past forty years, development approaches to global food security have moved with political imperatives and experience — with the emphasis shifting from food energy and protein supply, to equity of access, to malnutrition — all within an industrial market model.

Concern about natural resources scarcity broadened to degradation, in parallel with changes

¹ For example, the International Conference of the International Food Policy Research Institute on the subject of 'Sustainable Food Security For All By 2020' held at Bonn, Germany, September 4-6, 2001. <<http://www.ifpri.cgiar.org/2020conference/program/program.asp>>

in food security approaches, and linked the increasing population to emergent strategies for sustainable natural resource management, which may now be heralding 'sustainable food security'.¹ The fact that such terms imply, among others, that food security has somehow been achieved, may continue to distract us from the continuing failures of the market model in marginal and densely populated areas of LDCs.

This paper first examines the meaning of food security, and then introduces the conventional arguments concerning food availability, which are based on food production, human population, distribution, conflict, and environmental compromise, mainly in LDCs. The outcome of such environmental and food demand debates usually arrives at the need for sustainable production approaches, which themselves draw from a separately developing philosophical base in the West, and some traditions in the South. The discussion then considers an alternative conception of the contributors to food insecurity, and concludes that if these remain unaddressed, we may expect them to continue to undermine technological attempts to ensure food security, and environmental protection.

FEELING SECURE

Food security may be characterized as *informed confidence of all persons in a self-identified group within a society of their ability to access adequate nutritious food for their families at all times*. This definition is amplified in the following paragraphs.

Confidence is critical; assumptions that national average food production figures can indicate food security are belied by internal distribution constraints, political limitations on access, inability to purchase available food, over-consumption in segments of a population, policies which encourage farmers to shift from family food production into cash crops, crop failure, storage losses, and a range of other factors. An educational aspect to the definition is contained in the word '**informed**'; food-secure persons know the quality and amount of food needed by their family from tradition and general education. Unless all persons feel secure and are confident in their knowledge of the quality, quantity, and reliability of their food

supply, global food security averages cannot be extrapolated to specific cases.

The unit of food security is commonly assumed to be a country in global comparisons. In fact, feelings of security are more likely to be derived from the reactions of a **self-identifying group** within a society. Global statistics cannot readily be sorted into such small and unofficial units, and some governments are expected to discourage such manner of segregation (Renner 1996). This allows access to food to be used as a political mechanism in extreme circumstances, which can exaggerate food insecurity, and thereby make persons in such populations ready targets for recruitment by modern warlords (de Soysa 2000).

The ability to **access** adequate food covers industrial and cash-cropping farmers, subsistence farmers during crop failures, and non-agriculturists. Access can be limited by local storage failures, low purchasing power, and corrupt or inefficient distribution mechanisms, among other factors. Quality of food, in terms of its **nutritional** value, is determined by freshness or processing and handling techniques, variety, and chemical composition. A new component to food security is the rising occurrence of malnutrition in agricultural areas where cash crops replace local food crops.

The basic unit for food security within a poor community is a **family**. Parental sacrifices for children's welfare are daily demonstrated under conditions of scarcity. Families contain the effects of policies, which perhaps as externalities, create unemployment, inconsistent agricultural prices, and credit-based farming and lifestyles; they thus provide the logical focus for definitions of food security. Their food supply must be secure '**at all times**', not simply on average, thereby implying that local storage facilities must be effective, that staples are available out of season, and that distribution systems are uninterrupted by weather, political or budgetary cycles.

By way of comparison, the World Bank defines food security as 'access by all people at all times to enough food for an active, healthy life', omitting the elements of confidence, education, family and community within a market context. To understand food security implies more detail than national statistics. However, for a global perspective, this seems impossible at the present time; therefore the common expression of food

security calculations must serve for the macro-level picture. Perhaps the best of the conventional market-oriented analyses is the IFPRI model, sometimes referred to as IMPACT (Pinstrup-Andersen, Pandya-Lorch and Rosegrant 1999, p. 32).

THE IFPRI 'WORLD FOOD SITUATION'

Food security is of concern to all international development agencies, but as their perspectives are surprisingly similar, the IFPRI model is here discussed in more detail after an introduction of other agencies' approaches. FAO divides its analysis into sections, namely: people, institutions, knowledge, and environment. Further, it assumes that all people should be brought 'into the economic mainstream', that 'reconstruction of rural institutions [and laws] is vital to economic recovery', that new although different technologies are needed for both high-potential and marginal areas, and that 'ecologically sound technologies' can produce higher yields (FAO, 2001). The World Food Programme appears to acknowledge self-sufficient agriculture as a component of food security within its 'short term solutions' although it retains an overall orientation to economic growth as the source of increased food security (Bertini 1997).

USAID notes that more than 20 million US citizens are food-insecure at any one time, although its policy does not appear to relate this to social factors, and bases its international views on traditional macroeconomic approaches without reference to human or nature rights. It concludes that the private sector is key to food security in a free market that will stimulate widespread economic growth and thus provide income 'to help assure that the global community has access to the agricultural abundance of the United States' (USDA 1997).

The biotechnology company Novartis' statement on food security argues for public investment in LDC biotechnical research on the grounds that commerce will orient its research to wealthier markets, and that LDC dependence on MDC grain is unsustainable. Expanding cropping to new areas with an overall intensification in a second Green Revolution is implied within a competitive world market model, which suggests

that technology should be oriented to potential measured in commercial terms (Novartis 2001). The International Council of Science Union analyzes the issue broadly, including the need for local food production, and concludes that science might be directed to the problem areas in LDCs, although funding of such program is an acknowledged difficulty (Hall 2001).

The common approach of these agencies can be appreciated through the food demand and supply model of the International Food Policy Research Institute (IFPRI) which includes food production, population, and the range of factors which impinge on the 'average food security' calculations on which nations can base macroeconomic policy. In assuming that 'good governance' is an outcome of development, the model need not move beyond its national database. It also assumes, while noting negative effects, that free markets and free trade exist, and that agriculture can be viewed as similar to any other industry.

The major variables in global models such as IFPRI's are the populous nations. China and India can skew global interpretations, as can political change in a major agricultural producer such as the former Soviet Union. However, if national borders are ignored, the major variable remains population, as it has been since Malthus and his global predecessors and successors.² Globally, 'about 73 million people, equivalent to the current population of the Philippines, is being added to the world's population on average every year between 1995 and 2020, increasing it by 32% to reach 7.5 billion in 2020' (Pinstrup-Andersen, Pandya-Lorch and Rosegrant 1999).

Most of the growth in population is predicted to be in LDCs and increasingly in cities, such that the model predicts that by 2015 more LDC citizens will live in urban than rural areas. City residents have less opportunity to practice subsistence agriculture. As a consequence of these trends, 'almost all the increase in food demand will take place in developing countries' (Pinstrup-Andersen et al. 1999). China is predicted to represent 25% of the increase in global grain demand over the next 20 years, and as India is expected to exceed

² Hung Ling-Chi (1793) referred to in Ho, P.T. (1959) *Studies on the Population of China: 1368-1953*, Cambridge, Massachusetts: Harvard University Press.

China's population while continuing its economic expansion, increased affluence may increase demand figures further than currently estimated.

The result of predicted increases in population and food demand is that 2020 LDC citizens are expected to consume less than half the quantities of cereals of those in MDCs. The rising affluence of Asia, notwithstanding recent setbacks, is predicted to stimulate demand for livestock products, and as a consequence, double the demand for cereals used as livestock feed. Other shifts in demand include a global rise in popularity for maize over wheat and rice.

Grain demand in 2020 is predicted to be 40% above 1995 levels (85% of which will be in LDCs), while the land area available for its production will probably be less (land availability in Sub-Saharan Africa is difficult to factor into the model), thus leading to one of the conclusions that further yield enhancement research is warranted. We have come to assume that yields continually rise as an output of technological research, although recent curves indicate a slowing of the rate of yield increase. Analyses of prices indicate that grain, the major human foodstuff, will probably remain at its current low levels or perhaps fall further, thereby decreasing grain planting in MDCs. A 2030 population of 11 billion, mainly in LDCs, leads to the model indicating that average individual calorific intake in LDCs will rise to 2,800 per day from grain and meat consumption levels, 50% and 65% below those in MDCs, respectively.

IFPRI therefore concludes that food production in LDCs will need to expand more than in MDCs, and that inherent limitations will still necessitate a doubling of LDC cereal imports, about 60% of which will come from the USA, and an eight-fold increase in meat imports.

From the perspective of LDCs, the IFPRI model predicts that 'with increased production and imports, per capita food availability in LDCs will increase' (Pinstrup-Andersen et al. 1999). However, even under this 'average food security' approach, food insecurity is predicted to continue in the form of malnutrition in some 135 million children under the age of five. In South Asia for example, the incidence of child malnutrition is expected to be around 40%. The model is inevitably subject to unpredictable factors, some of which

have been enunciated by IFPRI and are summarized below.

CONVENTIONAL CONSIDERATIONS

Models are necessarily based on a number of assumptions derived from observations of the past. In the 1999 IFPRI Food Policy Report, six 'emerging issues' that may impact on the model's predictions are discussed. As summarized below, these are: new evidence on nutrition and policy, low food prices, trade negotiations, biotechnological advances, information technology, and the potential of agroecological approaches (Pinstrup-Andersen et al. 1999).

New evidence on nutrition and policy indicates that some 33% of LDC preschool children are probably stunted at present, a continuing reduction from 47% from 1980, albeit with rising incidence in pockets of absolute food deficiency. It also indicates that low birth weights contribute significantly to future malnutrition and premature death, that iodine deficiency affects some two billion persons, that iron deficiency anemia affects a similar number of mainly women, and that Vitamin A deficiency is 'widespread'.

Programs to address child malnutrition are constrained by income levels and national governance approaches according to the conventional analysis, which is based on observations that improved nutrition is associated with increased secondary school enrolments of women, and absence of civil disorder. Food insecurity is thus widened by new information, and is related to non-agronomic factors. In addition, FAO (2000) considers the trend of reducing malnutrition to have been interrupted in 1998 by economic and environmental factors, thereby highlighting the reliance of the overall approach on the continued well-being of the relatively more wealthy.

Low food (grain) prices have been observed for decades and in 1999, reached the lowest in one hundred years. Volatility of prices has been attributed to weather patterns, reduced rates of increase in yields, subsidy programs, and variations in planted areas. Global planted areas of grain are estimated to have decreased by about 3% between 1995 and 2000, which is less than was predicted

from the rate of decline in demand at the prevailing prices, including reduced imports of livestock feed grain by crisis-affected Asian countries. IFPRI notes optimistically that, as 2000 prices for wheat and maize are below the long-term trend line and, as demand for livestock products in Asia should rise significantly, rising demand for grain should cause a price adjustment.

Trade negotiations for liberalizing of markets may not benefit LDCs that are unable to obtain improved access to higher priced markets as they are constrained by poor administrative and legal capacity to manage such issues as food standards and plant varietal rights. IFPRI (1999) concludes that it is important to 'continue to pursue domestic policy reforms that remove distortions adverse to small farmers and the poor while facilitating access to the benefits from more open trade'. While oriented to trade, the approach could perhaps be interpreted to include an incidental subsistence orientation to local food security, in parallel with separate policies for commercial agriculture oriented to domestic needs before international trade income.

Biotechnological innovations offer the prospect of further large yield improvements. Opposition to genetically modified foods in the West is considered in conventional arguments to be deleterious to the interests of LDCs where the technology offers, among other things, higher yields, improved nutritive value of existing crops, and expansion of the environments in which preferred crops may be grown.

To use the technologies, it is suggested by advocates that aid be oriented to supporting LDC promulgation of intellectual property rights legislation so that the owners of the technologies will release them for use in LDCs. The argument is readily supported by researchers who seek environments in which they may continue to develop new crops and technologies, and may at times lose some objectivity.

For example, the issue in the West may appear to be mainly uninformed opposition to perceived risks in GMOs used as food, but may also reflect a rising concern in technological and ecological issues, and the concentrated private ownership of genetic material (Falvey 2000). The technology's greater value to commercial than subsistence agriculture appears to make it an unreliable basis

for food security in the short term when compared with other values discussed later.

Information technology, which allows processing of information for a fraction of past costs, offers prospects for widening rural access to education and other social services. It also applies to extension, market information, and farm-level technologies in such forms as geo-positioning for fertilizer application in commercial agriculture. In the educational mode, information technology appears more likely to be used to promote commerce in place of subsistence farming as a means of increasing food security through expected increases in purchasing power.

Agroecological approaches constitute an attempt of intensive agriculture to learn from traditional practices. This is usually viewed as evidence of the working of the iterative model of agricultural research and development, which is seen, for the sake of convenience, to begin with the Green Revolution. The very success of the Green Revolution has led to such environmental concerns as water shortages, chemical contamination, biodiversity reduction, unsustainable production systems, and reliance on external knowledge.

A few concerned NGOs and scientists have advocated local agricultural inputs consistent with natural cycles of decomposition and growth, with chemicals used only as a last resort. Requiring higher labor and lower capital inputs than commercial approaches, and implying lower yields in many cases, the agroecological approaches have the dual benefits of educating development specialists about alternatives to transplanted technological solutions, and of approaching sustainable agriculture to a greater degree than is evident from capital-intensive approaches. In addition, the approach allows a producer to participate with neighbors according to the existing culture and to make personal decisions. However, agroecological approaches in this guise are essentially a refinement of intensive commercial agricultural approaches, and therefore retain risks to subsistence farmers being brought ill-prepared into a credit-based, expensive, and commercial form of agriculture that can lead to loss of land and food security without compensating rewards.

Other commentaries are similarly cautiously optimistic of continued improvements in average food security, while noting that access to food is a

continuing constraint to real food security (FAO 2001). These 'emerging issues' will impact on such models in unforeseen ways, and have been highlighted by IFPRI to place a context around interpretations of the model. However, such models do not focus on smallholder self-sufficiency in agriculture, and this precludes their application in specific food security situations. Specifically, further factors critical to food security and environmental care include:

- Grain volumes stored across years
- Agriculturally induced environmental degradation
- Human and ecosystem rights in an agricultural context
- Differing policy requirements of subsistence and commercial agriculture
- Self-sufficient agriculture as the essence of food security
- The role of food as a basic right before its consideration as a commodity
- Environmental protection.

These points are amplified below. To allow the 'informed confidence of all persons in a self-identified group within a society of their ability to access adequate nutritious food for their families at all times' requires an understanding of food as more than one among countless traded commodities, and its production as more than an industrial process, even though those views may be useful to conceptions of commercial agriculture. Broad consideration of food security can be undertaken within an economic paradigm, although this requires a broader perspective of economics than has been common in recent decades. Concerned scientists may seek understanding of the context of their work within the philosophical and religious understandings of humans that complement economic research.

VIEWING FOOD SECURITY AND THE ENVIRONMENT FROM A WIDER PERSPECTIVE

1. The Role of Grain Storage

International free trade discussions can easily lead to assumptions that regional crop failures can

be remedied by grain supplied from unaffected areas, rendering grain stores obsolete. These arguments are based on observations in Western countries and the cost of storing grain. Past policies for grain storage have relied on ancient observations of cyclical weather, and in the minds of some persons, the ability to manage market prices by controlling large volumes of a commodity. Arguments for storage as part of human interaction within nature are being eroded by the arguments of free trade that focus on the obsolescence of storage as a price controlling mechanism in a global market now oversupplied at the price levels desired by MDC traders.

One logical outcome might be for LDC governments to assume responsibility for storage, but this appears to be precluded by inability to pay, alternative priorities, and the high costs of inefficiency and corruption in some countries. On-farm and local grain storage in LDCs rises in importance with such global changes. In any case, the outcome is that the food-insecure are rendered even more so by the global reductions in grain storage (FAO 2000) that are now at the lowest levels ever, having fallen below the reduced target of 16% of annual production to 14.2%.

It has been argued that 100 of the existing 650 million tons of grain fed to livestock can be used as a reserve for human food needs. Calling on such a 'reserve' would initiate competition for access to food of an unprecedented order. To take the extreme and simplistic approach: a global catastrophe would mean no reserve at all, as all standing grain would be affected.

A catastrophe affecting India and China would allow, say, 120 grams of grain per person per day from the 100 million tons, or perhaps 780 grams if all feed grain could be diverted – but commercial imperatives may easily preclude such generosity. FAO takes a more realistic if necessarily macroeconomic view.

However, the concept of storage is more than one of price manipulation and global averages of availability since it contributes to confidence that one has sufficient food for one's family. The issue of grain storage as a component of food security at national and international levels remains relevant, and the role of on-farm or local storage is of prime importance in ensuring local food security.

2. Agriculturally Induced Environmental Degradation

Misuse and overuse of some Green Revolution techniques have brought about environmental degradation, although one might argue that the rising population was the base cause, and that current knowledge is an unfair basis for criticizing past actions. Nevertheless, the continued use of damaging techniques is now untenable, despite continued degradation in LDCs, particularly in association with deforestation to create new agricultural lands, salinization of irrigated areas, and depletion of marine fish reserves.

Deforestation threatens biodiversity, increases soil erosion risks, and puts the rural poor who depend on food, fiber, medicine, or income from forests disadvantages. Rates of deforestation may be declining as forests themselves decline; in the 1980s, some 8% (11% in Asia) of global tropical forests were felled (Alexandratos, n.d.), mainly to suit agricultural expansion.

In agricultural areas, improper irrigation has caused salinization, which has reduced productivity and changed environments in other areas. Most analyses focus on the loss of agricultural land more than environmental impacts and indicate that up to 30 million hectares (12%) of global irrigated land is seriously salinized, and that more than twice this figure is moderately salinized (Umali, 1993). Offshore, fish catches peaked in 1989, indicating that extraction rates of the previous several years had exceeded sustainable levels, and that the natural resource base had been damaged, perhaps permanently (Brown, Lenssen and Kane 1995).

In considering agriculturally induced environmental degradation, it is most common for agricultural science reviews to focus on means of reestablishing lost capacity. Thus the comparison is made that, from some 8.7 billion hectares of land in the world, of which about 3.2 billion hectares are considered to be potentially arable and of which 1.5 billion hectares currently support crops, some 1.7 billion hectares of pasture, forest, and woodland remain, with the inference that these are closer to a natural state.

However, pasturelands are usually so designated due to their unsuitability for cropping often due to low rainfall, which renders them sensitive to overgrazing. Forest statistics, to an

increasing extent, includes plantations that under management systems may be better classified as crops than forests. Sara Scherr (1999) notes that "in South and Southeast Asia estimates for total annual economic loss from degradation [on agricultural lands] range from under 1% to 7% of agricultural gross domestic product." Concern over loss of productivity over approximately 16% of agricultural land in LDCs, estimated for the past 50 years at 13% for croplands and 4% for pasture-lands, is recognized as diminishing agricultural income and economic growth, with its major effect being on the food security in those localities (Scherr, 1999).

Environmental decline also results from natural phenomena, which can be exacerbated by population pressure. FAO's (2000) consideration of droughts in its food security deliberations highlights such medium-term effects, although it is usually assumed that affected areas will return to past levels of productivity. Our economically-biased concepts of sustainable agriculture have been mistaken for ecological sustainability and continue to cause confrontation between agriculture and environmental protection measures. Concerns of the Worldwatch Institute (Brown 2000) that environmental decline may prejudice opportunities for expansion of agricultural production form part of this wider scenario.

Poverty is both a cause and an effect of environmental degradation, and continues to pose the most serious environmental threat in LDCs. Millions of subsistence farmers, who would normally protect their immediate environment and have minimal external environmental impact, will eventually exploit natural resources when their food security is threatened; this is entirely understandable, and blame should be allocated to the mechanisms which produce poverty rather than to the farmers.

Conventional economic development theory advocates 'accelerated agricultural intensification [as] a key component of the strategy to alleviate poverty and protect the environment ... [and that] ... contrary to what some will have us believe, agricultural development is part of the solution to protect the environment, not part of the problem' (Pinstrup-Andersen and Pandya-Lorch 1995). This can be true within the narrow arguments about the relative benefits of intensive agricultural techniques compared to traditional approaches in situations

where population pressure has exceeded the capacity of traditional systems.

However, one must take a broader perspective in a general discussion of food security, and at the global level, acknowledge the causes of poverty in terms broader than incomes; at local levels, acknowledge the right of all persons to a secure food supply.

3. Human and Ecosystem Rights in an Agricultural Context

Human rights to food are espoused in theory, while denied in fact through such unfortunate acts as occurring in ethnic conflicts, and more subtly through misplaced optimism in governance and legal bases, and the ability of competitive economic systems to deliver equitable outcomes. Environmental compromise arising from agriculture can be conceived as a consequence of poverty induced by global forces, as well as population pressure, which itself may arise from inequitable access to knowledge.

While it may be attractive to argue for major revisions to international development approaches, commitment to the current approach is significant and unlikely to be influenced by non-competition based approaches. A more practical approach may be to work within the iterative nature of the LDC development model to guarantee human rights to local food security, before investment in industrial sectors, including export agriculture that targets higher-priced MDC markets.

Such an approach would inevitably lead to consideration of community-based actions that create value from cooperation itself, as distinct from the adoption of some traditional elements to enhance intensive agricultural production systems.

If a community is defined as a mutually beneficial network of interdependent persons sharing resources essential to the formation and sustenance of that network, past separation from community approaches and traditional law in MDCs may indicate a reason for development attempts to 'form', rather than acknowledge, communities. MDC actions flowing from Hobbes' 17th century rejection of humans as naturally social beings have created respect for the pursuit of personal interests.

This, in turn, requires regulation of human

individuality otherwise ungoverned by community moral codes. The concerns of communities, such as kinship, familial groupings, protection of offspring, preservation of lineage, and belief in the strength of the community against external dangers, contrast with national governance structures that assume homogenization of culture, rights, responsibilities, and lifestyles (Dyck, 1994).

To require that LDC farmers aspire to operate as individuals producing cash crops for income from which inputs, credit, and farm equipment can be paid before family food is purchased, acts against the social integrity based on the basic right to food produced by families themselves.

Deep ecological viewpoints are usually anathema to agricultural arguments. Nevertheless, they are informative when placed in the context of evolving intellectual conceptions of nature, and the effects of human interventions. Roderick Nash's (1989) history of the natural rights of nature itself, including humans, provides such a context for environmental ethics, at least in Anglo-Celtic cultures. He considers philosophical investigation of the moral relationship between humans and nature to be 'one of the most extraordinary developments in recent intellectual history' (Nash 1989, p. 4).

Social evolution from a pre-ethical past where the self was primarily expressed through family, tribe, and region, is traced to current ethical concerns relating to nation, race, humans, and to an extent animals, and future considerations of universal environmental ethics. Such change in moral perceptions is compared to the abolition of USA slavery in 1865 when slaves were no longer considered to be ownable chattels but humans with equal rights.

Nash's expanding concept of rights complements the evolution of ethics, and incidentally assists our understanding of the human and environmental rights expectations of international aid donors that seek 'good governance' in LDCs.

John Stuart Mill's observation that 'every great movement must experience three stages: ridicule, discussion, adoption' (Nash 1989, p. 8) may well apply to the ridicule attracted by doubts of the efficacy of solely technological solutions to

poverty, food security and environmental degradation. However, some such views have already affected moral viewpoints concerning cruelty to animals; views vary from cruelty demeaning humans, to the ascribing of specific rights to animals. Evolution of thought from the rights of living beings and life supporting matter to the ascription of rights to an ecosystem seems to be the next stage, with humans acting as spokespersons for inarticulate and abstract concepts such as ecology, mountains, and forests.

Denial of natural rights produces moral outrage in Western societies. Liberation commonly requires the revision of rules that oppress a minority, which in Nash's analogy is nature itself. The rights of land and livestock, for example, conflict with long-held concepts of human property, thereby providing a direct parallel with the 1850s' movements, which liberated slaves from being considered personal property.

From the 1960s' insights of Murray Boochee (1965) whose arguments foreshadowed Rachel Carson's 'Silent Spring', his further philosophical development into the 1980s notes the manipulation of ecology to serve human dominance of nature through technological means of redressing negative impacts rather than preventing them (Boochee 1980). In so doing, he provided a clear description of the sustainability arguments that we commonly employ in supporting industrial agriculture.

From an LDC perspective, NGOs' and other institutions' advocacy of traditional approaches to agriculture, as well as the dispirited farmers' failed expectations of commercial successes, highlight the value of food self-sufficiency as the first priority of small farmers. Traditional community-based systems, and affinities with the natural environment echo some of the sentiments of the leaders in Western environmental philosophy, who are in turn introducing the factors which will probably modify our approaches to development in the longer term.

If such similarity of viewpoints continues, agricultural science may well be revealed as having neglected its responsibility to ensure food security and environmental protection when it supported commercial agriculture to the exclusion of self-sufficiency.

4. Differing Policy Requirements of Subsistence and Commercial Agriculture

Agricultural policies in LDCs have reflected progressions in development thought, which has encouraged emulation of the wealth creation mechanisms of richer nations, thereby confirming to advocates that there is a desire for global economic development (Biot, Blaikie, Jackson and Palmer-Jones 1995). Food security, once a general national objective, became subsumed within industrialization fueled by the developmentalist arguments which grouped agriculture with other industries examined for international comparative advantage.

This economic analysis allowed such conclusions as, 'a country should not pursue food self-sufficiency where the natural resource endowment is uncompetitive and where potential returns from export oriented industrial investment are high'. The resultant modernization based on foreign funds, which later widened to include private sector borrowing, investment and speculation, created the excessive volatility recently experienced. Cash-cropping, in place of food-cropping, and contract growing as encouraged in industrial agriculture thus exposed small-holders to food insecurity and global price risks.

Foreign influence has visited development theories on LDCs with the approach of incremental improvement of the Marshall Plan successes of post-World War II Europe (Leys 1996) which assumed adequate education levels, rule of law, and codification of moral values.

As each was found to differ between individual LDCs, interest in the social values of specific cultures arose. The evident social and environmental costs caused reconsideration of the model through emotive analysis, which produced social and individual choice models, and commitments to basic human values, including the right of each person to food, shelter, clothes, and health care (Long and Douwe van der Ploeg 1994). The early intuitive link between development projects and local requirements is thereby given belated credence in a two-tiered development approach, where the first tier concerns national structural adjustment including legislation, and the second aims at specific local needs.

The Asian financial crisis highlighted the forgotten assumption of adequate governance, thereby completing the circle of social-economic factors early on defined by Adam Smith (1976). Sustainable development, arising from this historical context, might therefore be conceived as a recollection of past insights into human behavior and experience in international development. However, an entrenched technological and financial orientation (Redclift 1987) encourages commercial agricultural expansion to marginal areas, which continues to mask the social realities that the majority of agriculturists are poor smallholders whose prime concern is family food security, followed by the access to non-agricultural social services that will benefit their children.

If one accepts the iterative learning aspects of the development model, the conclusions from 50 years of experience in the World Bank (1999) indicate such lessons as:

- Macroeconomic stability is an essential prerequisite to achieve the economic growth essential to development;
- Economic growth does not filter down to poorer elements in a society and must be addressed through specific human needs projects and programs;
- A comprehensive group of integrated policies is essential to stimulate development; and
- Sustained development requires socially inclusive and responsive institutions.

Thus one might define self-sufficient smallholder agriculturists in these points as:

- a. Contributing to stability through feeding themselves – food security means stability in this context (de Soysa 2000);
- b. Meeting rural human needs of food, shelter, clothing, and health care before other needs;
- c. & d. Acknowledging self-sufficient and commercial agriculture as having different institutional needs, which may include minimal interference in some agricultural practices. For example, perceived transition of power from traditional spirits to institutions has been shown to reduce the viability of communal actions such as irrigation and forest use (Mulder 1968).

Keynes' warnings against the subordination of matters of permanent significance to short-term avariciousness (Schumacher 1973) have not been heeded in technically oriented development practice. Human factors and natural resources have thus been unwittingly valued at zero, and all income has been considered of the same value regardless of whether it was derived by human effort or speculative activities.

As is clear to those experienced with smallholders, a working animal has a broader inherent value than a tractor; why then would mere work output determine the relative values of a tractor and a buffalo? If the animal and tractor are considered a metaphor for agricultural and industrial development, the paucity of understanding about agriculture engendered by its treatment solely as an economic activity may be clearer. Smallholders, practicing a traditional self-sufficient agriculture may be shown to be more important than commercial agriculture when such a broader social paradigm is used (Falvey 2000).

Reliance on generic Asian remedies ignores different economic structures between countries. Trade policy similarly has special needs where the majority of the population is supported by agriculture and where agriculture embodies much of the cultural values of the society. In such circumstances, self-sufficient agriculture, including social issues, determines success, rather than the national income from agricultural exports. The latter may require little input by government as the expected rise in demand for agricultural products should provide windfall profits to Southeast Asia's agricultural exporters.

Alternatives to intensive commercial agriculture may be profitably considered in terms of their origin, application, and success. Self-sufficiency implies quite different qualities of life in different countries in terms of health services, access to education, opportunities for one's children, and communication. Sometimes grouped as alternative agriculture, these are associated with low capital inputs and ecologically considerate forms of food production that incorporate essential human values including self-reliance, healthy food, and occasional income from sale of surpluses. Inclusion of this, the widest agricultural sector,

under policies for commercial agriculture, leads to distortion of outcomes and food security failures.

5. Self-Sufficient Agriculture as the Essence of Food Security

Self-sufficient agriculture contributes to stability and food security as introduced above. It may take the form of lost concepts being reintroduced, adapting approaches from other areas, or selectively modifying traditional approaches. These forms are evident in such 'alternatives' as the Japanese Fukuoaka (Wasi 1988) farming system which eschews plowing, weeding, commercial fertilizers and pesticides, and pruning, while emphasizing spiritual aspects of the practice of farming and producing sufficient food for the family, possibly with a small surplus for security or sale.

A modification, the Kyusei Nature Farming system, aims to produce high quality food while contributing to economic and spiritual objectives for both farmers and consumers (Matsumoto 1993) through the use of microbial inoculants to improve soil quality and plant growth.

Permaculture (Mollison 1988), a system based on industrial chemical-free integration of forestry with agriculture, a multi-crop mix, and hydroponics linked to aquaculture, appeals to some concerned MDC individuals, and in fact shares many aspects of the existing integrated agriculture of LDCs (Wetchaguran 1980). 'Organic farming' while sharing much of the rhetoric of these approaches, is increasingly a commercial typology that should not be confused with the essence of self-sufficient farming, which is family food security.

An example from Thailand is instructive: Thai national policy and respect for righteous leadership has encouraged common persons to continue to view His Majesty the King as the ultimate human authority. Such special cultural characteristics produce outcomes unforeseen by foreign observers, such as the rapid adoption of the self-sufficiency ethic advocated by the King (Phongpaichit, 1999). Self-sufficiency is a bold initiative that may be difficult to consider in the absence of such a respected leader, and yet it illustrates that traditional values residual in rural areas can be re-instilled more broadly as a moral

concept with economic, if not always financial, benefits to a society. The Thai form of self-sufficiency applies to all aspects of life, drawing on Buddhism and common sense in advocating frugality, thrift, self-awareness, and basic moral precepts (Board of the Royal Projects 1999).

Application of the approach to the Thai rural sector has been codified in recommendations that aim to produce sufficient food for a farm family on-farm, and to use limited resources, particularly water in an equitable and frugal manner. Farm land would be allocated, for example, 30:30:30:10 to: on-farm water conservation for irrigation, integrated poultry production, aquatic plant production and aquaculture; wet rice production; cash and other crops including perennial trees; and housing, composting, and backyard production.

Indicative rather than prescriptive, the approach provides a starting point within an overriding theme of sustaining a family without reliance on external assistance and without requiring credit-based links to commerce. It further promotes cooperative action within a community for self-improvement in such areas as collective bargaining, sharing of capital items, and negotiation with outside parties, including government officials and business.

Recognizing the existence of two agricultures in LDCs, self-sufficient and commercial, is indicated from the above conceptions. Self-sufficient agriculture may also be seen as perhaps the major economic sector of most LDCs (if labor inputs are costed at common rates and social welfare savings are considered) and as the major component of food security.

Self-sufficient farmers cannot subsidize the lifestyles of the relatively wealthy, which includes the middle classes in LDCs. Subsidies seem to exist wherever rural poverty continues. However, current definitions of poverty also confound the debate. Financially based definitions of poverty neglect such factors as the right to work in a creative and productive manner in order to look after one's self and one's family while enjoying basic social services. Assumption that cash receipts of less than one dollar per day constitutes poverty (FAO 2001) tends to orient arguments to financial solutions without addressing wider concepts of poverty including access to education and health care, and feeling secure about food.

Self-sufficiency in agriculture is difficult to factor into international development agency agenda. For example, the World Bank, which operates through loans to LDCs oriented to macroeconomic matters, is basing its post-Asian crisis investments on:

- Restoring competitiveness through corporate restructuring, financial sector strengthening, and fiscal stimulus;
- Strengthening public sector governance through capacity building in private expenditure management, administrative reform, and privatization; and
- Sharing growth through support for the unemployed and the vulnerable, empowerment of local communities, and financing of social programs.

Such financial perspectives on development are likely to pervade, and leave the parallel approach of self-sufficiency to others, most likely responsible national governments and, so far as they operate separate from lending agencies, aid donors including UNDP.

Self-sufficient smallholders require a different approach from commercial producers. While this can be supported by the separation of agricultural from poverty alleviation policies, the latter can also acknowledge self-sufficiency that occasionally sells surplus production. Thus conceived, agriculture embraces social more than financial and technical sectors in most LDCs, because the majority of the population is involved in it and earns little. Smallholders and food security may not necessarily be best served by projects of development banks that must take a financial perspective, even on social programs.

Therefore it remains to government, with its many unsolicited advisers, to be the responsible voice for complete development, through policies that overtly acknowledge the distinction between self-sufficient and commercial agriculture.

6. The Role of Food as a Basic Need Before its Consideration as a Commodity

So far, the argument for food security has brought together the disparate views of development practitioners and academics concerned

with the sector, and the philosophers who interpret the evolving value system in which we operate. The basic needs approach to development as is implied is common in NGO more than financing institution reports; however, the discourse now steps beyond usual approaches to suggest that food, and hence some aspects of agriculture, should be excluded from financial analyses.

The right to eat may be the same as the right to breath. The basic needs of food, clothes, shelter and health care, as mentioned in this paper, are drawn from 2,500 year-old insights into human life, which incidentally address the essential development questions of equity, stability, and happiness. This is more far-reaching than the Universal Declaration of Human Rights, Article 25(1) which states that 'everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food'.

The development of agriculture allowed civilizations to emerge, which produced increased sophistication of culture. It also increased the ability to hoard grain, destroy crops, and create a social hierarchy supported military expansionism, as well as, intellectual and religious development. Intellectual, and particularly, spiritual insights of nature and humans indicated the benefit of moral codes, at one level for social stability, and at another for spiritual development, which in turn also produced stability (Moore 2000).

As the essentials of life were critical to stability, these were the focus of equity and rights codified in, for example, the laws of Judaism adopted by Christianity (Banks and Stevens 1997) concerning periodic release from agricultural debt and fallow periods for land, and in the case of Buddhism, the specific listing of the basic human needs as food, clothing, shelter and health care. Once these needs were met, individuals could pursue spiritual development.

For a whole society, the ruler was charged with the responsibility to govern in a manner that allowed food security for all and to make his life an example of moral virtue (Swearer 1996). Pragmatists note that communities that adopted this approach were easily dominated by aggressive neighbors; nevertheless, the essence of the insight that basic needs differ from other material human endeavors is worthy of consideration in the food security debate.

As the main source of modern technology has been the West, its separation of natural science from the church over hundreds of years has influenced our views about the amorality of technology in itself, with its use by individuals or groups determining morality.

However, the weakening influence of moral authority itself has revealed a relative morality emerging in Western personal life with society being governed by laws that similarly are reinterpreted as morality shifts (Goss 1997). Through the period that this has occurred, the concept of stability has become associated with material comfort and the rule of law, with obvious success in material aspects of life.

However, in terms of global food security, it has obscured factors that constantly undermine our attempts to meet humanitarian goals, even when based on the best information, models, and technology.

One of the factors that limit success in humanitarian goals is that humans continually use food (and other basic needs) as military tools, and superior powers that purport to redress such inequities have probably attained their position through similar military or economic domination. The outcome of such compromises in moral behavior can be seen, for example, in inconsistent policies concerning domestic agricultural subsidies, development assistance plans which ignore population issues, and international market access. Pressures to treat food as a traded commodity may therefore conflict with the basic right of all humans to food. Deeper insights, while usually considered impractical, offer the alternative paradigm of food being produced for home use, sharing, and sale of any surplus, with income applied to socially beneficial outcomes.

Many of the assertions of this section can be readily challenged; many other aspects such as physical and spiritual integration with nature have not been developed. My purpose in introducing the argument is to elicit a basis for effective discussion about food security, without which discussion of environmental protection is largely academic. If ancient intellectual considerations and mystical insights produced this concept of basic needs (Payutto 1995) being separate from

avariciously traded goods, we may do well to consider food security in terms other than gross national production and trade figures.

7. *Environmental Protection*

Protection of the natural environment from the 'collateral damage' of agricultural technology is presently conceived as a regulatory function on behalf of society. The amoral approach of science has allowed it to be viewed as benign, and for us, scientists, to be trusted as informed persons on the subject of environmental side effects. This has occurred at the same time as our management and funding have shifted from mainly impartial and informed government modes, to a financial outcome orientation linked increasingly to commerce.

The impartial role of such bodies as the Consultative Group on International Agricultural Research (CGIAR) which work to assist the marginalized persons of the world, becomes more critical in such a circumstance. However, in general, our credibility is slipping in the public's perception, and in modern democratic governance systems, the response to environmental risk must be increased regulation.

We need therefore to consider carefully our moral stance in publicly advocating the use of potentially dangerous technologies lest we be perceived to act on behalf of commerce before society or the environment.

The argument made herein for environmental protection to be an outcome of food security is particularly relevant to LDCs. Regulation is unlikely to be any more effective than it has been in the past when a human right is violated.

However, technological innovations suited to environmental rehabilitation will continue to be developed and applied, and in MDCs, probably serve an industry based on rehabilitation itself. In the same manner that agriculture is better conceived as two separate activities, self-sufficient and commercial, so environmental protection may follow suit for self-sufficient food security allowing protection of an environment, while commerce sells environmental technologies in richer markets.

SUMMARY AND CONCLUSIONS

Food security, more than poverty *per se*, determines the degree to which the natural environment is protected. Our earlier argument continues to hold, that intensive agriculture allows the maximum residue of natural wilderness areas compared to less productive forms of agriculture being spread across a wider area (Falvey 1996).

However, while the production orientation is commercial, objectives of environmental protection are undermined when expected financial returns do not lead to food security, and agriculture must expand to other areas. This scenario illustrates the two most powerful forces of environmental decline in LDCs; food insecurity forcing families to abandon traditional values of the environment, and avarice encouraging the introduction of cash crops in place of household food crops with the expansion of cash economies to peoples excluded from the full benefits of the economic system.

Conceiving food security as an average of food production on a global, or even a national basis, produces conflicting policy initiatives, such as environmental regulations that must be ignored in rural areas where food is insufficient as a result of farmers being coerced into cash crops. The widening debt problem of smallholder farmers in such situations continues to contribute to foreclosure of families' lands, and so, create landless farmers whose traditions of land care no longer apply to their new tenanted situation, thus further contributing to degradation.

We are therefore faced with two apparently opposing viewpoints on food security. One view states that the world produces sufficient food now, and with appropriate research, will continue to meet food demand as far as can be foreseen. The other view states that the causes of past and current food insecurity relate to inappropriate human interventions in distribution and production systems. The IFPRI model produces the first view while the second view is the wider argument presented.

IFPRI's conclusion that LDC food production and imports must increase substantially supports the need for research to increase yields, and to integrate aspects of agroecological approaches into intensive commercial agriculture. However, the risks to individual subsistence farmers in costly credit-based commercial agriculture are easily

overlooked, and the past assumption that farmers will become a low proportion of the population seems to continue unspoken.

Before self-sufficient smallholders, who have been encouraged into commercial agriculture, can be said to have benefited, they require an income equivalent to the purchase cost of food, capital return on investment and operational costs of the commercial venture, risk insurance against price, weather, and other variations, and compensation for lost traditions and values, which may also increase community costs in the future.

Thus the focus for food security research, both technical and social, may better conceive its field application as a subsistence farm than a monocultural agribusiness. Our economic paradigm can be readily broadened if we so reconceive food security as all persons having informed confidence in their ability to access adequate nutritious food for their families at all times.

In reconceiving food security, local grain storage is of prime importance, while national and international storage remain relevant. The millions of subsistence farmers would continue to protect their environment through traditional taboos on exploitation and knowledge of the capabilities of the resource and food needs of their families. This conception may be accommodated within the iterative LDC development model by simply acting on the universal human right to local food security, before investment in industrial sectors, which in this definition includes export agriculture targeting higher-priced MDC markets.

Once this human right is overtly acted on, the emerging forces of ecological rights among the influential nations might be assumed to dictate international assistance policy and so interpret 'good governance' in all countries to include ecological sensitivity. The congruence of thought in traditional community-based systems and rising sentiments of Western environmental philosophy will probably modify our approaches to development as the influence of the commercial agricultural model recedes from government and development thought and moves towards its major commercial beneficiaries.

Current encouragement of commercial agricultural expansion to marginal areas continues to disrupt millions of poor smallholders whose prime concern is family food security, followed

by access to non-agricultural social services that will benefit their children. Nevertheless, commercial agriculture in socially and environmentally appropriate areas, including in MDCs, continues to service the food security of urban dwellers and the relatively less populated regions. Agriculture can therefore be conceived as two distinct activities; self-sufficient and commercial—with self-sufficient agriculture as perhaps the major economic sector of most LDCs.

The distinction cannot be made by parties with vested interests, as the level of moral hazard is high when informed international corporations influence poorly educated LDC smallholders. It therefore is government, including its scientists, who should be the responsible voice to distinguish between self-sufficient and commercial agriculture, and where this is compromised, scientists remain responsible for ethical behavior, public education, and impartial government advice.

To conceive food solely as a traded commodity can easily conflict with the basic right of all humans to food. The argument made herein, that ancient insights suggest that restricted access to food cannot be ethically considered as an opportunity for profit-making, supports the separation of agriculture into the two types. For smallholders, the best approach may remain that of food production for home use, sharing, and sale of any surplus, with income applied to socially beneficial outcomes. Commerce may find its better fields in wealthier markets for both agricultural and environmental technologies. Food security and hence environmental protection for the rest of this century may well see us increasingly focused in redressing the imbalances constantly introduced through competitive behavior over this basic right to food, as we learn from experience and seek to civilize agribusiness.

REFERENCES

Goss, Rita. 1997. Buddhist Resources for Issues of Population, Consumption, and the Environment. In *Buddhism and Ecology: The Interconnection of Dharma and Deeds*. Edited by Mary Tucker and Duncan Williams. Harvard University Center for the Study of World Religions, Cambridge, Massachusetts.

Hall, D.O. 2001. Food Security: What Have the Sciences to Offer? A Study for ICSU. <<http://icsu.org/publications/foodsci/fs.html>>

Ho, P.T. 1959. *Studies on the Population of China: 1368-1953*. Harvard University Press, Cambridge, Massachusetts

Leys, C. 1996. *The Rise and Fall of Development Theory*. James Curry, London.

Long, N. and J. Douwe van der Ploeg. 1994. *Heterogeneity, Actor and Structure: Towards a Reconstitution of the Concepts of Structure*. Ch. 3 in *Rethinking Social Development* (Booth, D. Ed). Longman, England.

Matsumoto, Y. 1993. *Kyusei Nature Farming: A Sustainable Farming Method for the Twenty First Century*. In *Kyusei Nature Farming: Third International Conference*. United States Agency for International Development, Washington DC

Mollison, B. 1988. *Permaculture - A Designer's Manual*. Tagari Publications, Australia

Moore, Thomas. 2000. *Placebos, Faith, and Morals: Or Why Religion*. Hoover Institution, Stanford University. <http://www.stanford.edu/~moore/Placebos.html>

Mulder, J.A.N. 1968. An Investigation of the Motivational Qualities of the Buddhist Concept of Merit in Thailand. Center for South East Asian Studies, Northern Illinois University, Dekalb

Roderick Nash. 1989. *The Rights of Nature: A History of Environmental Ethics*. The University of Wisconsin Press, Madison. Pp 290.

Novartis. 2001. *The Socio-Political Impact of Biotechnology in Developing Countries*. <http://www.foundation.novartis.com/biotechnology_developing_countries.htm>

Phongpaichit, Pasuk. 1999. *Developing Social Alternatives: Walking Backwards into a Klong*. Chulalongkorn University. Paper presented at National Thai Studies Centre Conference, Australian National University, Canberra.

Pinstrup-Andersen, Per and Rajul Pandya-Lorch. 1995. *Poverty, Food Security, and the Environment*, International Food Policy Research Institute 2020 Vision Brief: 29

Pinstrup-Andersen, Per, Rajul Pandya-Lorch, and Mark Rosegrant. 1999. *World Food Prospects: Critical Issues for the Early Twenty-First Century*. Food Policy Report, International Food Policy Research Institute, Washington DC. Pp32.

Phra Prayuth Payutto. 1995. *Buddhadhamma: Natural Laws and Values for Life*. Translated by Grant A. Olson. State University of New York Press, Albany. pp302 Page 94.

Redclift, M. 1987. *Sustainable Development: Exploring the Contradictions*. Methuen, London.

Renner, Michael. 1996. *The Transformation of Security*. Chapter 1 in *Fighting for Survival*. Worldwatch Institute's Environmental Alert Series. Washington DC.

Scherr, Sara. 1999. *Soil Degradation: A Threat to Developing-Country Food Security by 2020?* International Food Policy Research Institute, 2020 Brief 58.

Schumacher, E.F. 1973. *Small is Beautiful: A Study of Economics as if People Mattered*. Blonde Briggs, London

Smith, A. (1986. reprint) *The Wealth of Nations* (1976). Penguin Books, New York.

Swearer, Donald. 1996. *Sulak Sivaraksa's Buddhist Vision for Renewing Society*. In Christopher Queen and Sallie King. (1996) *Engaged Buddhism: Buddhist Liberation Movements in Asia*. State University of New York Press, Albany. pp446. Page 216.

Umalis, Dina L. 1993. *Irrigation-Induced Salinity: A Growing Problem for Development and Environment*. World Bank, Washington, D.C.

USDA. 1997. *Discussion Paper on International Food Security*. <<http://www.fas.usda.gov/ icd/summit/discpapr.html>>

Wasi, Prawase. 1988. *Buddhist Agriculture and the Tranquillity of Thai Society*. In *Turning Point of Thai Farmers*. Moo Ban Press, Bangkok

Wetchaguran, K. 1980. *Integrated Agriculture-Aquaculture Farming Studies in Thailand*. In *Integrated Agriculture-Aquaculture Farming Systems*. International Centre for Live Aquatic Resource Management, Los Banos

World Bank 1999. *Report and Recommendation of the President of the International Bank for Reconstruction and Development to the Executive Directors on a Proposed Public Sector Reform Loan in the Amount of US \$40 Million to the Kingdom of Thailand*. World Bank, Washington D.C.