

# In Pursuit of Sustenance

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*The Search for Food Security in the 21<sup>st</sup> Century*

*Food is a material and biological reality so deeply entrenched that culture as well as social movements are required to help set new food frameworks and paradigms... It is only people and organisations and social forces which can take this on and shape the food economy differently.*

*Lang & Heasman, 2007*

*The role of food in our lives is at once surprisingly complex and profoundly simple. Biologically, it provides the fuel to maintain our bodies. At a social level it forms the centre point for some of the most meaningful human interactions. Pursuit and acquisition of food has long been one of the chief concerns of humanity, and the various modes of food getting (foraging, pastoralism, shifting cultivation and intensive agriculture) are well detailed by anthropologists and archaeologists (Ember, 2002; Cipolla, 1967). Contemporary examples of each mode can be found across the globe, but it is intensive agriculture and its links with increasingly urbanised populations that have emerged as the dominant global system.*

*Since the early 20<sup>th</sup> century, international food policy has been forged according to the 'Productionist paradigm', a model that emphasises unleashing the productive capacity of the supply chain, increasing yield, efficiency, and ultimately profitability (Lang & Heasman, 2007). Large-scale industrial techniques apply modern chemical, transportation, processing, and genetic technologies to agriculture, with apparent success. Yields have*

*increased worldwide, and this means more food per capita.*

*But have more people been fed? Have global levels of hunger diminished? If the answer to this question is *no*, or even an inconclusive *perhaps*, then it may be that the Productionist paradigm has failed to deliver its promised benefits to the developing world (Lang & Heasman, 2007; Isbister, 1995). Because insufficient food security can be directly linked to poverty, the issue is not merely one of hunger, but ultimately one of livelihoods and basic human rights (Murphy, 2002).*

*Beginning with the assumption that food is necessary for the continuance of life, this paper will examine the extent to which this basic need is not being met for a sizeable portion of the earth's population. Is the problem, as adherents of the Productionist paradigm claim, a general lack of food, or a larger issue of accessibility and distribution? How do human numbers and population growth rates affect food availability? What are the impacts of impaired diet on the health of the individual and society in general?*

*Food security is a concern facing all of humanity, and one with strong social, economic, ecological and political implications. It is vital to understand that while this discussion is agricultural, it is not necessarily rural. Eating is an 'agricultural act' (Pollan, 2006), one that links even the staunchest urbanite to the soil. But the increasing complexity of the agri-food chain has caused many to abandon all concern for understanding 'what lies on the far side of the increasingly high walls of industrial agriculture'.*

*Rapid urbanisation and modernisation of agriculture in the South are helping to export this agricultural ignorance around the globe. Grasping the multifaceted issues surrounding agriculture is a critical part of the move towards food security and putting an end to hunger in the 21<sup>st</sup> century.*

### ***Pressure points***

*It has been suggested that in a traditional agrarian economy, the amount of tillable land determines whether the mass of peasantry is prosperous or destitute (Natsios, 2001). In other words, a large population living in a relatively small area with little cultivable land will experience greater hardship than one with large amounts of available land. To stave off widespread starvation, such a population will be forced to either increase productive capacity, or seek alternative means of acquiring food (primarily by exporting non-food goods and using foreign capital to import food).*

*This assertion encapsulates the basic interplay of three dynamic forces facing world food security: population pressure, social pressure, and ecological pressure. These will be examined at greater length here.*

### ***Population pressure***

*Although the fires of debate concerning the ‘population crisis’ seem to burn less brightly now than they did several decades ago, academics and policy makers are still keenly interested in the question of population and its relationship to food security. Clearly, population levels have some bearing on*

*food supply, and perhaps more so on food availability. In what may be the most well known and widely cited work on the population-to-food question, Malthus (1798, quoted in Devereux, 1993) writes:*

*First, that food is necessary to the existence of man. Secondly, that the passion between the sexes is necessary, and will remain nearly in its present state... The power of population is indefinitely greater than the power in the earth to produce subsistence for man.*

*With the assumption that any increase in food production will be linear, while increases to population will be exponential, it follows that population will inevitably outstrip food availability, and is doomed to face repeated food crises.*

*Devereux (1993) outlines the basic theory of Malthusian population-to-food conflict. First, as a population grows, its demand for food increases simultaneously. This increase in demand is met in either of two ways: by increasing the extent or the intensity of food cultivation (i.e. more land brought into use, or greater application of labour to agriculture). Neither of these approaches, Malthus argues, will succeed in the long run, as extending cultivation inevitably brings less productive land into use (with diminishing marginal productivity of land and labour), and intensifying land use faces diminishing returns to labour. Consequently, food supply will grow at a slower rate than population, with the ultimate implication that famine is inevitable, and acts as a mechanism of population control.*

*While this theory has received its share of criticism, vestigial arguments continue to profoundly impact academic and political attitudes*

towards population growth (Devereux, 1993; Arnold, 1988; Young, 1997). Pimentel (1979) states that 'Man cannot escape the answer that he... has allowed his numbers to increase... beyond the capacity of his biological environment to provide adequate supplies of needed resources', a position that resonates with the language of Malthus. Similarly, Lester B. Pearson (Commission on International Development, 1969) describes population growth as a 'shadow over the prospects for international development'.

The natural conclusion to these arguments is that population growth must be curbed, and has resulted in a variety of public strategies. For example, since the early 1950s India has experimented with a number of methods to control population increases (Ledbetter, 1984). This has included an increase in family planning clinics, widespread dissemination of information and slogans such as 'happiness is a two-child family', and campaigns to promote the use of prophylactics. Population control in India, however, is best remembered for the notorious forced sterilisations of millions of individuals conducted between 1976 and 1977. Sterilisation was seen as a necessary means of speedily bringing down the birth rate, and a decisive response to what was called 'the Emergency'.

Critics of India's sterilisation campaign claim that, due to age and social position, most of the individuals sterilised would have had no significant impact upon future population growth rates (Ledbetter, 1984). Furthermore, public perception of family planning suffered tremendously, and is no longer viewed as a panacea for larger national problems.

Moreover, there are those who do not view population growth as something to be checked at all. Far from the catastrophist belief that the 'battle to feed all humanity is over' (Erich, 1968), celebrators of population growth consider it an expanding source of human inventiveness and ability to overcome temporary deviations in food supply (Smil, 2000). However, Smil points out that if food production has no upward limits (as 'cornucopians' claim), then at the present average increase of 2% per year, the weight of annual harvests would surpass the mass of the earth in less than 1500 years.

### ***Social pressure***

In the human language, words such as *famine* and *starvation* are among the most powerful and evocative (Arnold, 1988). One of the 21<sup>st</sup> century's greatest paradoxes is the shameful fact that although food production has increased significantly in the last 60 years, over 800 million people still go hungry (Young, 1997). How can increases in per capita food production be reconciled with seemingly unchanged levels of world hunger? Clearly, there is more involved.

Sen (1981) states that famines often take place in situations of moderate to good food availability. In this case, starvation is not a symptom of insufficient food availability, but of insufficient *entitlement* to food. Entitlement is here used to describe individuals' ability to 'command' food, or acquire it through political, social or economic means (Young, 1997). Entitlement packages can change over time, and differ according to class, ethnicity, age, region and gender.

*At its root, hunger is a political and social issue. Changes in entitlement that disadvantage certain groups, together with failures in the public distribution system, can lead to widespread hunger and famine, even without significant changes in food supply (Sen, 1981; Natsios, 2001). Rather than relying predominantly on food supply as a guarantee of food security, planners and governments must use measures that are more dynamic.*

*Although poverty is generally assumed to have strong links to rural areas, adverse shifts in food entitlements often strike harder at urban populations (Sen, 1981). Rationally, this is due to the farmer's position as food producer. As pressure is applied to the food system, farmers become less willing to part with produce. As an example, when the public distribution system collapsed in North Korea in the mid-1990s, it was urban areas that were hardest hit. This is reflected in the fact that while farmers comprise 25% of the North Korean population, they made up only 4% of refugees fleeing across the border to China (Natsios, 2001).*

*So far, this analysis has looked at broad social impacts of food insecurity. But because society is made up of individuals, we must look at the consequences of insufficient diet on individuals' health.*

*Although humankind has long been aware that prolonged inadequate food consumption causes weight loss, growth retardation, wasting, emaciation, and even death, it is only in the past one hundred years that the more sophisticated concept of protein-energy malnutrition (PEM) has been developed (Shils, Shike, Ross, Caballero & Cousins, 2006).*

*PEM is called the most important nutritional disease in the developing world because of its high prevalence and relationship with mortality rates, impaired physical growth and metabolism of other nutrients, and inadequate social and economic development (Shils et al., 2006). Especially devastating is its impact upon children. According to WHO statistics for the developing world, 27% of the children under the age of 5 years are underweight, 32% display stunted growth, and 10% are wasted. In South Asia, the figures are significantly higher: 46% underweight, 44% stunted, and 15% wasted.*

*The causes of PEM are rooted in social issues. These include poverty, nutritional ignorance, declines in breastfeeding and improper weaning practices, and rural migration to urban slums. Also affecting PEM are issues such as maternal malnutrition, poor child diets, environmental factors affecting food supply, and postharvest losses (Shils et al., 2006).*

*Infants, young children, pregnant and lactating women, and the elderly are especially vulnerable to PEM, partly because of increased dietary needs, and partly because these groups typically have fewer food entitlements. In the case of children, food deprivation can lead to poor physical and mental development, damaging social prospects such as education and employment opportunities (Young, 1997; Shils et al, 2006). The effects of PEM are also socially devastating for pregnant women, as maternal malnutrition is associated with low birth weight babies, who are at greater risk for wasting. These babies, in turn, are likely to produce underweight children themselves, completing what is called the ‘vicious*



circle of female malnutrition’.

### ***Ecological pressure***

*Contrary to popular belief, agriculture is highly artificial. By its very nature, it transforms the environment from its native state into one that is more fragile. This is expressed in terms of diminished biological diversity, degraded water, soil and air quality, and weakened cyclical stability (Buckland, 2004; Mooney, 1996).*

*The impacts of agriculture on biological diversity are particularly interesting. As global demand for grain rises, pressure is brought upon the system to intensify production. This has led scientists to develop high-yielding varieties of seeds, or modern varieties (MVs) (Pretty, 1995; Lang, 1995). But as farmers adopt these seeds, it necessarily entails a movement away from indigenous varieties that have been developed over countless generations. As a result, many of these traditional varieties have been lost (Mooney, 1996).*

*This loss can have serious consequences for global food security. The assumption has been that a majority of the world gains most of its calories from only 30 different foods, and that food security is best achieved by developing better varieties of these foods (Mooney, 1996). However, this fails to acknowledge that, in reality, there are thousands of traditional food plants around the world that form a major component of many individuals’ diets, and could be drawn upon by others.*

*The ultimate effect of whitewashing the complexity of human dietary*

*sources is to reinforce northern attitudes (specifically of researchers and policy making organisations) which assume that focusing on 30 plant species will adequately address human food security. In practice, diminished diversity places humans (especially the very poor) at greater risk.*

### ***The backward sector***

*Development economics has long recognised that agriculture functions as a principal engine of growth in many developing economies (Lobe, 2007a; World Bank, 2008). On the road towards modernisation, the traditional or 'backward' agriculture sector is said to move through a series of transitions (Isbister, 1995). Low-income, less developed nations typically have a high proportion of their population working in the agricultural sector, either directly (i.e. actively farming), or indirectly (engaged in related activities such as transportation or selling produce). Furthermore, the income generated by this sector comprises a much higher proportion of the gross domestic product (GDP) than in developed nations (Food & Fertilizer Technology Center, 2006). If high-income countries rely less on the agricultural sector for income and employment, it follows that modernisation will not only increase the agricultural productivity of low-income countries, but will also necessarily diminish its overall role in the total economy.*

*The ultimate objective in all this, of course, is economic growth. But what does that mean, exactly? And why do we want it? Although the*

*intention is not to cloud this paper with inconclusive arguments concerning the desirability of growth, or to hammer out its proper definition once and for all, a few words of clarification may be necessary.*

*In their *Second Report to the Club of Rome*, Mesarovic and Pestel (1974) write that some believe the only way to save the world from impending crises (of population increases, environmental degradation, food security, energy and raw materials supply, etc.) is to stop growth altogether. Conversely, those in the opposite camp assert that the only means to circumvent these same crises is to press on with even greater levels of growth (Smil, 2000; Mesarovic & Pestel, 1974).*

*But clearly this debate requires an explanation of what is meant by growth to begin with. Daly (1987) calls it the ‘quantitative increase in the scale of the physical dimensions of the economy’. This he contrasts with development, which is the ‘qualitative improvement on the structure, design, and composition of physical stocks and flows, that result from greater knowledge, both of technique and of purpose’ (emphasis original). In this sense, economic growth does not guarantee that development occurs; the two may be completely independent of each other. Moreover, the implication is that development may enable greater understanding of purpose, or the reason that something is being done in the first place.*

*Location, context, and subject qualify the desirability of growth (Mesarovic & Pestel, 1974). Omitting these factors makes growth an abstract concept, and fails to account for differences in pre-existing levels of growth,*

*regional needs, and relative affluence. However, even here there is room for debate, because 'hard facts' are variously interpreted according to differing agendas or viewpoints.*

*These issues are especially relevant to agriculture: levels of growth vary widely throughout the developing world; interregional needs may be completely dissimilar or even opposing; and the distribution of income is rarely equal.*

### ***Economists' perspectives***

*Observations concerning the experience of many countries making the transition from agriculture-dependent to industrialised economies have led economists to develop several models for development. While these models vary, they rely upon agriculture as the driving force towards modernisation.*

*There is some irony in this. Nations must rely upon agriculture, however backward, to break free from the restrictions it places on their economy. They must exploit their limitations in order to gain new opportunities.*

*Two models for development will be examined here: the Lewis Model, and Rostow's Model.*

#### ***Lewis***

*Arthur Lewis presents a vision of the traditional agricultural sector of the economy as a limitless pool of labour, to be drawn out and transformed by the modern capitalist sector (Lewis, 1955). Surpluses produced in the*

*capitalist sector are reinvested, and the sector expands. This expansion draws off more labour from the traditional sector, and the cycle continues.*

*In this model, growth is seen to occur when all other sectors grow relative to agriculture. But Lewis also asserts that the imports of developed nations function as the engine of growth in developing nations (Lewis, 1978). This condition essentially eliminates any control or self-determination that the developing world may have, and has led scholars to examine domestic strategies that can be used to reduce dependency relationships (Browne & Hadwiger, 1986).*

*There are several prominent critiques of Lewis' model. Although his model assumes that the supply of labour in the traditional sector is infinite, and that rising productivity in the subsistence sector raises wages in the industrial sector, Lewis acknowledges that as the non-farm economy grows, food output per farmer will need to grow to compensate for decreased farmers. Additionally, Lewis expressly states that his subject is growth, not distribution, and that growth may occur while the mass of people are getting poorer. Inequality is seen, to some extent, as a by-product of economic growth. However, the fact that the income gap has narrowed in some developing nations provides strong evidence that inequality is not inevitable (Isbister, 1995).*

### ***Rostow***

*Walter Rostow, in his work *The Stages of Economic Growth* (1965), proposes that societies move through a series of predictable stages in the*

*transition from traditional to modern, or rural to urban. While initially in a state of low productivity, humankind's ultimate destination is an age of mass-consumption and beyond - where consumer sovereignty reigns. Much like the model presented by Lewis, this spectrum shift hinges, in its early stages, upon agriculture. The sector is, however, more than a faceless source of labour and export income. It is one with pre-existing modes and values. Rostow writes, for example, that modern techniques will spread in agriculture when farmers are prepared to accept new methods and the 'deep changes they bring to ways of life'.*

*While the benefits of these changes are named explicitly, no recognition is made of the losses experienced by a society making this transition. Rostow's logic would seem to imply that the transition from traditional to modern carries enough rewards that any losses are worthwhile. This is observed in the assertion that a predominantly agricultural society must shift to a predominance of industry, communications, services and trade (Rostow, 1965). The shift must also draw society away from a community or regional focus, to one that is centred on international commerce.*

*According to Rostow, one of the primary functions of agriculture in this early stage of development is to provide food for an expanding population. The alternative option, depletion of foreign exchange reserves, followed by mass starvation, is clearly not a desirable one. A second function is to feed a rapidly expanding urban population that no longer has*

*the means to produce its own food directly. Finally, agricultural exports will finance industrial growth. In short, the rate at which the agricultural sector is transformed will set limits to the total transformation of the overall economy.*

*The implications of this model are profound: modern technologies must be brought in to raise agricultural production. These include chemical fertilisers, modern seed varieties, and irrigation. Secondly, major educational campaigns must be launched to ‘demonstrate patiently the advantages of the newer methods’ (Rostow, 1965).*

### ***Constructing the Productionist paradigm***

*Clearly, increasing production forms a central pillar in these concepts of development. This has given rise to what is called the Productionist paradigm, a system whose emphasis is on building the capacity of the food supply chain (particularly land and labour), and increasing the quantity and efficiency of output (Lang & Heasman, 2007).*

*Within the confines of the Productionist paradigm, growth (of yields, throughput and profitability) is understood to bring about inequality. But in keeping with the teachings of Arthur Lewis, inequality is not to be regretted, because it is inevitable (Lewis, 1955; Lang & Heasman, 2007; Isbister, 1995). In fact, inequality may actually be a reinforcing feature to growth (or so it is argued), as it concentrates more wealth into the hands of a select few, thereby amplifying its savings or investment potential.*

*Agriculturally, the paradigm tends to promote monoculture, the*

*practice of growing one crop over a large area (Lang and Heasman, 2007). This is a result of a 'quantity over quality' approach that seeks to maximise yields through the application of inputs (fertilisers, machinery and irrigation) with little consideration for costs that do not immediately impact net returns.*

*The effects of the paradigm upon policy and practice have been great. Lang and Heasman (2007) state that since the Second World War, it is increases in food due to improved yields that have kept millions of individuals from starvation. These sentiments are echoed in Holmén's (2006) assessment of the Green Revolution, a movement that provided the means to counter the growing imbalance between population growth and stagnating grain yields.*

*But because the issue of production is so closely linked with consumption, some argue that the paradigm has also had negative impacts upon society. In a world where consumption is rarely based on fairness and equality, supply becomes distorted according to willingness to pay (Lang & Heasman, 2007). In this climate of instant gratification, self-restraint and abstinence are not qualities to be admired - they are bad for business, and therefore bad for production (Daly, 1987).*

### ***Scientism***

*The success of Productionist technologies has given rise to what Daly (1987) calls the 'pseudo-religion of scientism'. There can be no denying that this deterministic, materialistic, mechanistic and reductionistic form of*



*science has led to great increases in our technological portfolio. But as scientific advancement becomes a goal in itself, purpose and practicality fall by the wayside.*

*If enquiries into our world are conducted according to the notion that there exists an objective external reality reinforced by immutable laws, then our real task is to discover, predict and control these natural phenomena (Pretty, 1995). This leads to the formulation of universal, over-arching laws that may be applied without regard for context. Complex, interconnected realities are dissected into discrete parts, and scrutinised in isolation. Consequently, research conducted with a level of control over individual components that verges on tyrannical is called 'good' science, and its output is called 'true' knowledge.*

*The upshot of this search for universal truth in agriculture has been the creation of numerous technologies, widely applied regardless of context. Pretty (1995) writes:*

*Where it has been possible to influence and control farmers, either directly or through economic incentives and markets, agricultural systems have been transformed. But where neither have the technologies fitted local systems nor have the farmers been controlled, then agricultural modernisation has passed rural people by.*

### ***Historical perspective***

*It may be argued that modern agriculture finds its genesis in the North American frontier. For 300 years, the West presented a seemingly limitless expanse of land, waiting to be broken. Agricultural practises and technology*

evolved to make maximum gains in labour productivity, rather than land productivity. Even as this vast frontier was closed, rapid urbanisation and industrialisation continued to prompt the substitution of capital for labour (Ruttan, Waldo & Houck, 1969). By 1880, non-agricultural employment in the United States exceeded agricultural employment, and by 1970, agricultural employment was approximately equal to total unemployment.

There is no error in developing systems to deal with labour constraints or surpluses of arable land. However, it cannot be assumed that because these systems were developed within the confines of modern science, that they may be applied universally (Pretty, 1995). Where labour is abundant, or land is scarce, new innovations must be sought.

### ***‘A hot meal for every Hottentot’<sup>1</sup>***

Contained within the Productionist paradigm is the implication that it is developed nations who possess the means (financial, technical and social) to lift the starving nations from their misery. This can be seen in foreign aid policies, development strategies, and United Nations programs such as the Millennium Development Goals (MDGs) (Mooney, 1996; Sachs, 2005). While some of the onus is placed upon the developing nation to expand its capabilities and embrace policies that lead to change, it is ultimately the outsider who provides the ‘means of escape’.

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<sup>1</sup>From Mooney, 1996; attributed to Dean Acheson, 1947.

***Exporting the paradigm: Altruism or revenues?***

*The desire to encourage foreign growth ought to be subjected to critical inspection. All too often, when the window dressing of public works has been torn away, what remains are market-oriented motives and commercial self-interest (Mooney, 1995; Becht & Belzung, 1975).*

*One of the most meaningful transitions in agriculture for the developing world is the rise of transnational agribusinesses. As farm production has become increasingly technical and reliant upon inputs, the power of these corporations to dictate the terms of development has also increased (Young, 1997; Lobe, 2007a).*

*It is clearly in the interests of transnational agribusiness that low-income nations adopt high-input agriculture (with its links to commodity markets), and align themselves with Western practices. For these agribusinesses, Third World development essentially acts as a means of expanding the market (Murphy, 2002; Pretty, 1995). And yet, there is evidence to suggest that the activities of these corporations actually serve to increase the divide between rich and poor countries, and to heighten class conflict within poor countries (Young, 1997). Some of the reasons for this are: the sensitivity of export-reliant nations to price changes in global commodity markets; shifts in political power from rural to urban areas; rapid urbanisation; and increasing rents and concentration of land ownership.*

*While it would be unjust to assume that all development efforts are a*

*result of carnivorous commercial instincts, as institutions and corporations intentionally limit the alternatives available to the Third World for development, the connection becomes increasingly clear.*

### ***Productionist shortcomings***

*A consequence of production- and market-oriented development is that regions presenting poor economic incentives to investors receive relatively little attention. This could be called a 'regional development bias'. For example, in India the vast majority of high-yielding rice varieties have been developed for irrigated zones. While this has amounted to increased yields in these select areas, other regions now produce up to 4.2 times less per hectare than their irrigated counterparts (FAO, 2000). Furthermore, since the introduction of the first MVs for rice in the mid-1960s, overall increases in supply have caused world prices to drop by 40% (Lang, 1996). While this may be more than offset by increases in yield for privileged farmers in irrigated areas, those in upland or rainfed zones do not enjoy the same increased yields, and simply receive less return for their crops.*

*An additional shortcoming of the paradigm is found in its potential to undermine dietary diversity. The emphasis on mass-producing relatively few staple foods has led to a global homogenisation of diets (Lang & Heasman, 2007; Fieldhouse, 1996). For example, changes in agriculture are causing a decline in the consumption of foods gathered or hunted from natural environments. These foods provide substantial nutritional value, and account for a large part of the traditional diets of many people groups in the*

*developing world (Mooney, 1996). But wild foods are being rejected in favour of simplified (and typically nutrient-poor) Western diets, a movement that has severe consequences for world health.*

*Finally, the paradigm replaces local, high-sensitivity self-determination with external, low-sensitivity decision-making. This is exemplified in the extremes of IMF structural adjustment policies that dictate the terms of development and level of government involvement in agriculture (Loxley, 1998; Buckland, 2004). Bilateral and multilateral organisations typically reflect northern interests and priorities, and use capital to manipulate southern development practices. Emphasis is placed upon diminishing the role of government in agriculture, and the liberalisation of markets. In consequence, governments are put in a position where they must justify support for publicly funded programs, even if these programs have strong regional benefits.*

## ***The Green Revolution***

*In the early postcolonial period, the US and the UN initiated national-level agrarian reforms in many of the fledgling nations of the developing world. Though initially successful, within a decade or so, these schemes had begun to lose their thrust. This was due, in part, to the perception that reforms had failed to achieve their purpose (Buckland, 2004). Isbister (1995) asserts that Western powers were not solely at fault; the blame also fell upon the shoulders of the newly established governments, who had promised prosperity, strength and economic freedom. Instead, they had ‘entrenched their positions of privilege’ and forgotten the masses.*

*This set the stage for a different approach to development - one that sought technical and scientific means to combat growing disparities between food output and population growth (Buckland, 2004). Inorganic fertilisers had been available for several decades<sup>2</sup>, but increased application to long-stemmed grains caused the head to swell to such an extent that the plant could not support its own weight. The result was a falling over, or *lodging* of the plant.*

*It was in Mexico, under the supervision of Norman Borlaug, that attempts to breed fertiliser-responsive, lodging-resistant wheat were first successful (Lang, 1996; Pretty, 2005). This was accomplished by breeding short-stemmed varieties, able to withstand the increased weight of the*

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<sup>2</sup> *Inorganic nitrogen, for example, had been available since the development of the Haber-Bosch process, shortly before the First World War (Smil, 2001).*

*enlarged head. An additional characteristic of the newly developed varieties was that they were photoperiod insensitive. This meant that they could be grown at different latitudes, where day length varies seasonally. This allowed the seeds to be planted across the globe, from Mexico to Bangladesh to China. Food security finally seemed achievable.*

### ***Success?***

*Similar programs were initiated for other staple grains: rice, maize, sorghum and millet. Partnered with the full ‘package’ of inputs (inorganic fertilisers and irrigation), annual world cereal production soared to 2 billion tonnes (Buckland, 2004; Naftzinger, 2006). Asian rice yields rose from about 200 million tonnes in 1960 to nearly 480 million in 1990 - an increase of 140% (Lang, 1996).*

*Historically, there is no comparison to the rapid increases in agricultural productivity that have been achieved in the sixty or so years since the first shots of the Green Revolution were fired in Mexico. It is generally recognised that without MVs and their incredible response to fertilisers, far more non-farmland would have been cleared for cultivation (Holmén, 2006; Buckland, 2004). This can, to some degree, be equated with preserving biodiversity.*

*Green Revolution technologies have been associated with a reduction in poverty. For example, in China, agriculture has been instrumental in reducing rural poverty rates from 53% in 1981 to 8% in 2001 (World Bank, 2008). Similarly, strong agricultural performance in Ghana has assisted a 24%*

*reduction in rural poverty since the early 1990s. Some of this is attributable to the increased incomes and employment generated by more agricultural activity. In South Asia and Latin America, 25% of rural males find employment in the agricultural sector, and any increases in employment opportunities or wages benefit this group directly.*

*One of the most important aspects of increased productivity is its downward affect on food prices. Because the urban poor rely almost entirely on food purchases, as well as over half of the rural poor (World Bank, 2008), lowered food prices can have a positive effect on food security.*

### ***Or failure?***

*World output of grains per person can, with limited accuracy, be used as a measure of global food security. With the advent of MVs, grain output grew significantly between the 1960s and the late 1980s (Naftzinger, 2006). Since then, however, there has been a marked decline in total output - a transition that has led some observers to claim that the era of 'technological fixes' to agriculture has come to an end. Others feel that the decline is simply a response to changing dynamics in the world market, such as reduced price supports and reduced subsidised overseas sales by the US. In short, after a thirty-year stint when increases in food production were ahead of population growth, food per capita is once more falling (FAO, 2008).*

*In practice, food security is far more complex than the mathematics of averages would suggest. Because of unequal entitlements, food may not actually get to the mouths of those that need it most (Conway, 1998). All too*



*often, crops produced using the Green Revolution 'package of inputs' are destined for export to wealthier nations in the 'global supermarket' (Browne & Hadwiger, 1986). Export earnings are assumed to trickle down to benefit the poorer sectors, directly impacting their employment opportunities and ability to purchase high-calorie food. The experience in much of the South, however, has shown this to be an unreliable assumption.*

*Studies conducted in fifteen countries in Latin America between 1965 and 1977 tested the relationship between Green Revolution inputs, food production and consumption, agricultural exports, and employment (Browne & Hadwiger, 1986). The results are surprising: there was no relationship between Green Revolution inputs and food production; no relationship between food exports and imports and food consumption; and a slight relationship between inputs and the decline of workers in agriculture. The study concluded:*

*There is no evidence to suppose that, in the Latin American case, a high-technology, export-oriented agriculture has in any way alleviated the food deficiencies of the peoples of Latin America.*

*Holt-Gimenez, Altieri and Rosset (2006) argue the case more strongly. The prohibitive cost of Green Revolution inputs places the majority of smallholders at a disadvantage, concentrates power in the hands of a privileged few, and makes food less available to the poor. By focusing primarily on high-technology solutions, policy makers fail to address structural inequities in the market and political systems.*

*Another area that remains largely unaddressed is that of post-harvest losses. It is interesting that although the introduction of MVs was conducted for the expressed purpose of increasing yields, planners and policy makers initially failed to build infrastructure that would accommodate these increases. Similarly, techniques were not developed or extended to farmers that would prevent significant losses. Consequently, it should come as no surprise that fully one third of the 1968 wheat harvest in India was lost to water, rodent and insect damage (Naftzinger 2006).*

*Post-harvest losses continue to afflict world agriculture. It is estimated that 25% of all food produced in Africa is lost to rotting and pests (Kwarteng, 1999). Moreover, it is argued that if these losses were prevented, Africa's food crises might be a thing of the past.*

*Proper storage methods and facilities are necessary to reduce post-harvest losses (FAO, 1982; FAO, 1985; Chakraverty & Singh, 2001). In the absence of farmer information or experience, it is the government's role to anticipate increases in yield due to new or improved technology, and to plan accordingly. Improved infrastructure such as roads and loading terminals facilitate rapid transportation and minimise damage to harvest (Naftzinger, 2006). Extension services can create links between farmers and government agencies or research institutions, relaying improved practices to farmers and providing agencies with critical firsthand information of the situation 'on the ground' (Bunch, 1982). Indigenous technologies can become incorporated into efforts to preserve harvests (Kwarteng, 1999; FAO 1984). Uniform*

*standards and grades can provide incentive to producers due to price expectation. National price information, planting forecasts, and other market information all empower the farmer and increase incentive to minimise postharvest losses.*

### ***Africa: Soil Fertility and Green Revolution 2.0***

*Recent efforts to advance the state of agriculture in Africa have resurrected the notion of a second Green Revolution. The MDGs and Sasakawa Global 2000 both promote the ‘package of inputs’ approach as the means to build productivity and fertility (Sachs, 2004; Lobe, 2007a). The Alliance for a Green Revolution in Africa (AGRA), a joint effort of the Rockefeller Foundation and the Bill and Melinda Gates Foundation, similarly campaigns for the ‘package’. AGRA maintains that the first Green Revolution bypassed Africa (Holt-Gimenez, Altieri & Rosset). But this claim meets strong criticism from supporters of farmer-led, sustainable agriculture, who argue that the Revolution did not bypass Africa; it simply failed.*

#### ***Modernisation and structural transformation***

*The duel between the conventional Green Revolution ‘package of inputs’ approach (spearheaded by transnational agribusinesses, privately funded institutions, multilateral organisations and major governments), and the sustainable agricultural systems approach (represented by farmer-researcher teams) is clearly exemplified in the issue of soil fertility.*

*Smil (2000) calls the use of increased inorganic fertiliser ‘the most urgent need of sub-Saharan Africa’, and declares that an insufficient supply of nutrients results in the continuing decline of soil fertility. This statement summarises the widely held view that soil fertility is a function of nutrient quantity. Soil, according to this view, acts as a ‘bank’ for nutrients that increase soil fertility and crop productivity (Bunch 2001). The overwhelming majority of scientific experimentation has been influenced by this limited view of soil fertility.*

*As the statement by Smil indicates, this perception has central importance in the debate over how best to improve the state of agriculture in Africa and the rest of the developing world. If improving yields is a simple matter of applying inorganic nitrogen, phosphorus and potassium (NPK), then what is needed is a massive push to promote the production and distribution of synthetic fertilisers globally (Browne & Hadwiger, 1986; Sachs, 2005). However, if soil fertility is, as Bunch claims, a much more complex issue, then perhaps these efforts would be wasted.*

*The principle protagonist of the ‘nutrient quantity’ viewpoint, Norman Borlaug (1994, as cited in Bunch, 2001), writes:*

*Some people say that Africa’s food problems can be solved without the application of chemical fertilizers. They’re dreaming.*

*And yet, extensive experimentation by these ‘dreamers’ has demonstrated that African yields can be increased without the use of inorganic fertilisers, and that this translates into more food at the household level (Lobe, 2007a).*

*The use of green manures and cover crops to increase soil fertility is by no means new. They have maintained a central role in traditional agriculture in many regions for millennia (Pretty, 1995; Lang, 1996; Bunch, 1981). But it is, in some instances, the very age of these techniques that is criticised. Borlaug expresses the belief that traditional agricultural systems have maximised their efficiency (by relying on labour-intensive processes and limited resources), leaving no room for improvement (Pretty, 1995). To expand production, the only recourse is to abandon traditional 'unproductive' agricultural practices. With this in mind, Borlaug (1992, as cited in Pretty, 1995) writes:*

*Development specialists... must stop 'romanticizing' the virtues of traditional agriculture in the Third World. Moreover, leaders in developing countries must not be duped into believing that future food requirements can be met through continuing reliance on... 'low-input, low-output' technologies that are impractical for farmers to adopt.*

*Thus, sustainable or ecological agriculture is dismissed in favour of pro-corporate alternatives, with the tidy assumption that 'low input agriculture is low output agriculture' (Bunch, 2001; Gimenez, Altieri & Rosset, 2006).*

*How does this compare to what occurs in natural ecosystems? Despite the presence of very low levels of soil nutrients, tropical rainforests produce vast amounts of biomass annually. This is due to the rapid recycling of nutrients as plant matter breaks down on the forest floor (Bunch, 2001). Alternately stated, low-input forests are high-output forests, a reality that places the 'nutrient quantity' concept on its head. Bunch writes:*

*The use of one rationale for proven rainforest productivity while refusing to admit to the possibility of the very same process in agriculture would seem to represent a serious lack of logical consistency.*

*What evidence is there that the use of organic fertilisers and traditional practices can compete with modern agriculture? Consider an example of rice farmers in Madagascar. Using a system of rice intensification that relies on only moderate amounts of compost and no synthetic fertilisers, farmers are able to achieve yields of up to 18 tonnes per hectare (t/ha) (Bunch, 2001). Contrast this with yields in the modern industrial sector: Japan, Asia's leading rice producer in terms of yield, and a consumer of high levels of inorganic fertiliser, produces approximately 6 t/ha. California, using an intensive system that involves aerial seeding and high amounts of inorganic fertiliser, produces 10 t/ha (Lang, 1996).*

*In this example, low-input farmers are seeing results that are at least as good, and sometimes significantly better than high-input farmers. It is easy to imagine the whirlwind of excitement that would surround the reporting of these kinds of figures in the manufacturing sector - increases of up to 300%, simply by altering technique. But in the din that surrounds pro-corporate agricultural development, these reports pass virtually unnoticed.*

*The issue is more than one of development strategy. At the heart of the fertiliser saga, as with other agricultural issues, is a contest for sovereignty. Who will control markets and livelihoods? By failing to include the farmer in any meaningful discussion of development, the historical*

*Green Revolution approach to agriculture has long usurped farmer independence, and transformed the complex issue of food security into a yields game (Lobe, 2007a). Whether per capita food production rises or falls, much like per capita GDP, this figure says nothing about food distribution and equity.*

*A second, equally important feature of stripping farmers of their sovereignty and reducing agriculture to a contest for yields is the way it plays into the hands of transnational agribusinesses. Becht and Belzung (1975) point to the logic that the multinational corporation is 'nothing more or less than a corporate form of colonialism', ultimately concerned with 'man's basic scramble for resources'.*

*In this context, some question the very foundation of the wholesale push for increasing the use of inorganic fertilisers in Africa. The primary source of information for all discussions concerning sub-Saharan soil fertility is a series of nutrient balance surveys conducted in the early 1990s, and the results have been used to provide strong rationale for the expanded use of inorganic fertilisers (Lobe, 2007a). Scepticism stems mainly from the assertion that soil fertility management is a far more complex issue than nutrient balances (Bunch, 2001; Burges, 1967), and has critical ecological and social components.*

*Furthermore, serious suspicions have been aroused by the spontaneous concern for African soil fertility, which comes at a time when global fertiliser sales have begun to slump after a 30-year boom (Lobe, 2007a). It is*

not surprising that the Africa Fertilizer Summit, held in Nigeria in 2006, was hosted by the International Fertilizer Development Center, a group heavily funded by the energy and agricultural inputs sectors. Neither is it surprising that the expressed purpose of the Summit was to devise a plan of action that would 'ensure that fertilizer use and supply would expand rapidly in Africa over the next five years'.

### ***Sustainable agricultural livelihoods: A farmer-centred approach***

*It is becoming increasingly evident that farmers ought to be included in dialogue about agriculture. Tautological as this statement may seem, farmers have long been mysteriously absent from the discussion table. But when farmers and individuals from across disciplines convene, decisions can be made that provide long-term solutions to issues in agriculture (Pretty, 1995; Conway, 1998; Lobe, 2007b). Placing the farmer at the centre of the agricultural development process builds human capital, and incorporates local realities and community assets in a way that is sustainable.*

*This implies a complete reversal of roles. Buckland (2004) states that instead of farmers and food conforming to fit corporate interests and consumer demand, corporations and consumers conform to the needs of healthy farms and food security.*

*This principle is seen in research conducted in conjunction with farmers. For example, projects in Malawi pair farmers and researchers to assess the impacts of different combinations of legumes and green manures on soil fertility (Lobe, 2007a; Lobe, 2007b). It is noteworthy that the*



*structure of the project is subjective, and recognises gaps in both farmer and researcher knowledge - a move away from the hubris of northern-dominated scientism.*

*A powerful feature of farmer-led development is its versatility. Pretty (1995) describes researchers' initial disappointment upon discovering that technologies or practices displayed at research stations were sometimes only partially adopted by farmers. However, it was understood that farmers had adopted (and adapted) the aspects of the technology that suited them, and ignored the parts that were extraneous. Furthermore, as farmers demonstrate the viability of proven technologies and techniques, other farmers will be more inclined to adopt new practices (Bunch, 1982).*

*A final feature to agricultural development necessary to empower farmers and farm communities is community-based resource management. Because many of the rural poor live in ecologically sensitive areas, they must be allowed to partner with governments and organisations to optimise management decisions (Marschke & Nong, 2003; World Bank, 2008).*

*Although the structure of this paper appears to pit practices that incorporate inorganic fertilisers into agricultural development *against* those that are 'sustainable', it should be understood that the two methods are not mutually exclusive. A third school of thought exists that gives farmers and developers the freedom to pick and choose what elements from both methods best fit their particular needs (Bunch, 1982). But it is clear that this system is more closely aligned with the farmer-led approach, as the 'package'*

*approach makes very few allowances for alterations.*

## ***Conclusion***

*There are significant challenges confronting the issue of food security: population exerts pressure upon food supply; the debilitating forces of hunger and disease diminish society's capabilities; and wanton growth erodes biological diversity and the environment (Young, 1997; Shils, et al, 2006; Mooney, 1996).*

*Agricultural development has the power to strengthen the overall economy through export earnings, job creation, lowered food prices, and food production (World Bank, 2008). And yet, the capacity of agriculture to accomplish these objectives is heavily dependent upon the mode of development employed. Current trends emphasise the Green Revolution: high-input, capital-intensive, corporation-oriented technologies that find their origin in the North (Lobe, 2007a). A second approach emphasises farmer-centred discussion and community-based management decisions (Buckland, 2004; Marschke & Nong, 2003).*

*These two approaches are not incompatible, and it is becoming evident that much can be accomplished when top-down policies are joined with bottom-up decisions. Government and institutional support can give farmer-made, farmer-oriented decisions the thrust they need to overcome the challenge of world food security.*

## Appendix

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### *Inefficiencies in food production*

*The solution to food security is seen by many to lie in increasing grain output. But global yields have been decreasing for the first time in 30 years. Dennis Avery (as cited by Naftzinger, 2006) argues that the fall in per capita grain output since the 1990s is an indicator of changing global diets, from staples to foods such as meat, eggs and milk. While there have been striking increases in per capita consumption of these 'luxury' foods, there is strong reason to believe that Avery's interpretation is flawed. Far from causing a downward trend in grain output, increased meat production necessitates greater levels of grain as feeds. Although dietary efficiencies vary from animal to animal, feed-to-weight-gain ratios (kg feed/kg gain) are generally significantly higher than 1:1. This is especially true when a distinction is made between an animal's live and edible weight.*

*Energy conversion efficiency for edible weight of chicken averages at 4.5:1, whereas for pork and beef, the figure jumps to 7.3 and 20.0 respectively (Smil, 2000). Fish boast the highest energy conversion efficiency, with edible weight averages at 2.3 for carp and 1.4 for salmon. Milk and eggs offer better efficiencies than most meats, with conversion ratios of 1.1 and 2.8, respectively.*

*Interpreted in isolation, these figures would seem to suggest that meat production is a highly wasteful activity - one that channels valuable*

*resources into a system with diminished returns. However, meat (along with milk and eggs) contains complete proteins at ratios required by human beings, and is more bioavailable for human beings than plant protein (Shils, et al., 2006). Furthermore, vast portions of the earth's surface are not well-suited for intense cultivation (such as semiarid grasslands, steep slopes, and mountain meadows), and grazing of livestock in these areas does not present any competition to human food production (Smil, 2000). To illustrate that meat production cannot categorically be said to exacerbate world hunger, the International Food Policy Research Institute states that even if global consumption were to fall by 50%, rates of child malnutrition would decline by only 1-2% (Lang and Heasman, 2007).*

*Nevertheless, increasing demand for meat and animal products has prompted producers to divert increasing amounts of cereals to animal rather than human consumption. Smil (2000) states that the proportion of grain fed to livestock has increased globally, from approximately 20% in 1950 to 45% in 2000. By 2020, the global demand for meat and milk is expected to increase by an additional 118 and 231 million metric tonnes respectively, primarily driven by urbanisation, population growth and rising incomes in the developing world. This will not only have a pronounced effect upon the demand for cereals, but has tremendous implications for public health and the environment (Lang and Heasman, 2007).*

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