THE AGRICULTURE, NUTRITION, AND HIV/AIDS CONNECTIONS IN DEVELOPING COUNTRIES

A resource paper prepared

for

The U.S. Agency for International Development

by

The Association for International Agriculture and Rural Development

December 2003

TABLE OF CONTENTS

List of Acronyms

Acronym	Term
AED	Academy for Educational Development
AIARD	Association for International Agriculture and Rural Development
AVRDC	Asian Vegetable Research Development Center
CABI	CAB International, formerly the Commonwealth Agricultural Bureaux
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIP	International Potato Center
CRSP	Collaborative Research Support Program
DNA	Deoxyribonucleic acid
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HLCP	FAO High Level Committee on Programmes
IARC	International Agricultural Research Center
ICRW	International Center for Research on Women
IDS	Institute of Development Studies, Sussex, England
IFPRI	International Food Policy Research Institute
INTSORMIL	The Sorghum Millet CRSP
IQ	Intelligence Quotient
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
NGO	Non-government organization
PAHO	Pan-American Health Organization
PEM	Protein Energy Malnutrition
RENEWAL	Regional Network on HIV/AIDS, Rural Livelihoods and Food Security
UN ACC/SCN	United Nations Administrative Committee on Coordination, Sub-Committee on Nutrition
UNAIDS	United Nations AIDS
UNDP	United Nations Development Program
USAID	U.S. Agency for International Development
WHO	World Health Organization

Executive Summary

This essay was invited by USAID, and is intended to inform its strategic planning in agriculture. It seeks to create an awareness of the connections between rural poverty, undernutrition, and HIV/AIDS in developing nations and to then suggest specific cross-sector investment strategies that can be used more effectively to combat these three deplorable human conditions. Striking is the finding that the integration of work in the agricultural, nutrition, and health sectors has not been pursued systematically to date. The exceptions have been termed "isolated and small scale."

The ten principal conclusions of this paper concerning the connections between rural poverty, undernutrition, and HIV/AIDS in the developing world are:

- poverty is principally a rural problem;
- undernutrition and HIV/AIDS are closely associated with rural poverty;
- rural poverty is a problem of the poverty of agriculture in developing nations;
- therefore, improvements in agriculture have a strategic role to play in combating poverty, undernutrition, and HIV/AIDS;
- yet, agriculture is not being used as a primary tool to combat undernutrition and HIV/AIDS—and it must be;
- the social costs of undernutrition are immense: they are a consequence of nutrition's impacts on a country's productivity, growth, work force, the cognitive development of children, and the overall health status of the population;
- existing micronutrient deficiencies reflect ironic past trends in agriculture, but promise to be dealt with most cheaply and sustainably through the biofortification of plant and animal species found in the agricultural sectors of developing countries;
- convincing evidence also exists which shows that poor nutrition affects adversely the sexual and mother-to-child transmission of HIV/AIDS, as well as the progression and the mortality rates of the disease; furthermore, immune system impairment from HIV/AIDS leads to undernutrition which leads to the worsening of HIV;
- the sensitivity of agrarian societies to shocks of all kinds, including droughts and poor rainfall distributions that spark famines, appears to have been increased as a result of HIV/AIDS in the developing world; and
- the pandemic has moved faster than expected and Africa is carrying the burden of the disease worldwide, as are the poor, rural areas, and agriculture (principally through the shrinkage of the agricultural labor pool); these losses in agriculture will only further diminish the prospects of arresting and eliminating HIV/AIDS.

Two main recommendations are derived from the analysis of the paper, which responds to the preceding conclusions. First, cross-sector investments should be promoted by the State Department and USAID policy makers at the highest levels in Washington.

Second, a "Fund for Agriculture, Nutrition, and Health Collaboration" should be established to facilitate the financing of projects that integrate agricultural, nutrition, and HIV/AIDS components, empower women, and are sustainable. It will be a competitive grants mechanism, with proposals being encouraged at the mission level for results-based projects that capitalize on the agriculture/nutrition/health connections. Examples of priorities of the Fund will be to stimulate synergies between existing projects; to encourage nutrition-health buy-ins to existing or proposed agricultural projects; to add resources to the promising research undertakings involving the biofortification of agricultural commodities in the

developing world that ensure transfer and applications to human health and nutrition betterment; to assess how public policies in developing nations are currently improving nutrition and helping rural families cope with the HIV/AIDS pandemic; to revitalize rural support services through institutional strengthening projects; and to address the shrinkage in agriculture's labor pool due to HIV/AIDS through studies and the commercial development of animal and mechanical sources of power.

Part I – Introduction

Purposes and organization

For many reasons, some of which relate to the advocacy structure of U.S. international development efforts, programs that should ultimately improve the health and nutrition of people in developing countries can be disjointed, competitive, and unsustainable. It is argued here that a strategic partnership between agricultural and rural development, nutrition, and HIV/AIDS initiatives could add net program benefits and combat more effectively three deplorable human conditions—rural poverty, undernutrition, and HIV/AIDS.

This resource paper, intended to inform the agricultural strategic planning exercise of USAID, seeks to

- highlight and explain the connections between agriculture, nutrition, and HIV/AIDS in low income, developing countries; and
- suggest a set of program proposals for USAID that could more effectively capitalize on those connections to reduce hunger and undernutrition[1], raise child survival, and reduce mortality and morbidity from infectious diseases.

The factors that drive the connections that are identified in developing countries cannot be considered a "fresh discovery". For example, it has been observed:

"It is no coincidence that the maps of HIV prevalence and malnutrition overlap. The HIV epidemic is increasingly driven by the very factors that cause malnutrition: poverty, conflict, and inequality" [Piot, et. al., 2002].

Closer to new discovery are the linkages this paper draws between poverty and rural areas and the connections it makes between rural poverty and the poverty of agriculture. For it is that set of linkages which leads to the conclusion that agriculture has a potentially central and strategic development role to play in helping to combat poverty, undernutrition, and HIV/AIDS. Yet, agriculture has not been used as a primary tool to alleviate poor nutrition and health globally. The exceptions are "isolated and small scale".

Following this Part I, Part II of the essay deals with agriculture's connections to poverty. Parts III and IV cover the nutrition/agriculture connections and the HIV/AIDS and agricultural connections respectively. Part V sums up and presents specific proposals for future action, which illustrate ideas meriting additional investigation and discussion.

[1] The term undernutrition is used here to signify stunting, underweight, wasting, low body mass index, and foetal growth retardation—conditions of inadequate nutrition. The term malnutrition is taken to signify both undernutrition and overnutrition, or deprivation and excess [UN ACC/SCN, 2000]. Measurements of undernutrition can differ from 10 to 85 percent for some age groups because of the differing methods in use to estimate the condition [Chen, et.al., 2001]. FAO discusses indicators it uses in FAO, 2001. The Malnutrition Advisory Group (MAG) of the British Association of Enternal and Parental Nutrition has recently adopted detection guidelines using the Body Mass Index and unintentional weight loss, which recommend themselves by reason of their precision and dependence on just two indicators.

Were further work conducted on the agriculture, nutrition, and health connections, AIARD believes that highest priority should be assigned to:

- other important health issues, including those related to tuberculosis and malaria;
- the plans and strategies of major assistance organizations of greatest relevance to agriculture, nutrition, and health;
- the programmatic suggestions that are made here; and
- assessing further the biofortification approach against the current availability of micronutrients in some rural settings.

Acknowledgements

This paper was prepared at the request of USAID. Tom Crawford (INTSORMIL and AIARD's President Elect), Montague W. Demment (Global Livestock CRSP, the University of California/Davis, and AIARD past-president), Sue Schram (ACDI/VOCA and AIARD past-president), and John Yohe (INTSORMIL and AIARD's current President) all generously provided materials that launched the effort. The paper was assembled by Reed Hertford, also a past-president of the Association, with the help of many others. Particular mention should be made of Cheryl Jackson (USAID/EGAT) who provided a most helpful summary of relevant USAID actions. Special thanks go to Dr. Schram for her thorough review and editing of the final draft of this manuscript.

In addition, the paper benefited greatly from the supporting literature and constructive comments on earlier drafts received from John Becker (USAID/PPC), Andrew Bennett (Syngenta), Patricia Bonnard (FANTA Project/AED), Howarth Bouis (IFPRI), M.L. Chadha (AVRDC Regional Center for Africa), Montague W. Demment (University of California/Davis), Don Ferguson (formerly of USDA/FAS/ICD), Russ Freed (Michigan State University), Stuart Gillespie (IFPRI), Ray Glahn (Cornell University), Larry Haddad (IFPRI), Charlotte Johnson-Welch (ICRW), Audrey Maretzki (Penn State University), Malcolm McPherson (USAID/Washington and the JFK School of Government), Anthony R. Measham (formerly, the World Bank), Richard L. Sawyer (formerly of the International Potato Center), Anita Singh (USDA/Food and Nutrition Service), Marcela Villareal (FAO/SDWP), and J. H. "Tim" Williams (University of Georgia/Peanut CRSP).

Identifying payoffs to cross-sector investments

When is it that the connections between agriculture, nutrition, and health are so strong that integrated investment projects, bridging the three sectors, are most effective and provide largest returns?

Assume that three projects are now operating in the same region—one each for agriculture, nutrition, and health. Integration of the three into a single undertaking could be beneficial, if their collection of costs were reduced and/or their collection of benefits were augmented by integrating the three in a single enterprise[2].

Costs might be reduced, if some activities did not need to be replicated because they are common to the three projects. Outreach or delivery personnel, for example, might be able to make one trip to the field instead of three, if activities were integrated. Or, perhaps, only one set of some supplies and equipment (e.g., project vehicles) might be all that is required for the integrated project, while three sets are now in use.

For cost reductions to be possible and significant, the target population of beneficiaries should be common to the three projects. If the costs of outreach are currently high because of the inaccessibility of the target population by reason of geography, topography, or particular attributes (e.g., low levels of literacy), opportunities for cost-cutting through project integration may be especially good.

On the side of benefits, the case for integration is most easily made, if the chief products of each project promote those of the other projects. Some automakers are in the banking business and the car rental business because additional resources devoted to one of these enterprises will increase the productivity of the others. This paper explores the potential to improve health and nutrition through agricultural production and productivity improvements which will, in turn, increase family incomes and food security—and vice versa. It is also pointed out that HIV/AIDS is a disaster for agriculture; and, in turn, an agriculture "on the ropes" will not provide the income and food security that can have an important role in mitigating the HIV/AIDS epidemic through its prevention, care, and treatment.

The main cautionary note relating to this kind of integration is that the transactions costs of bringing together the three projects into one can significantly erode the increased net benefits. Examples abound: of "integrated rural development projects" which were too complex, consortia that have come apart, marketing and trade agreements among nations that have never effectively been implemented, and multinational organizations that appear to be ponderous and costly bureaucracies. A practical approach to handling this is to limit integration efforts to situations in which the payoffs are truly significant.

By addressing the first objective of this paper—that is, by highlighting and explaining the connections between agriculture, nutrition, and HIV/AIDS--it is hoped that the reader can come to appreciate not only where it is that the payoffs to cross-sector, integrated investment projects are truly significant, but why it is that the specific program proposals presented in Part V are believed to promise major returns to rural poverty, undernutrition, and HIV/AIDS alleviation.

[2] The argument is kept simple by comparing the costs and benefits of the integrated project against those of the three individual projects. Technically it would also be necessary to compare the costs and benefits of the fully integrated agriculture-nutrition-health project against the three projects which integrate just two project components, i.e., agriculture-nutrition, agriculture-health, and nutrition-health.

Part II – Poverty, its Connections to Agriculture

A complex human condition

Because of the ease with which income levels can be taken as descriptors of poverty, it is important to stress the point that poverty is a complex human condition:

> *"The poor experience economically deprived lives which are without the multiple opportunities, and freedoms of action and capacity to access those opportunities, that are enjoyed by other members of society. They confront vulnerabilities to disease, disasters of all kinds, and violence in their surroundings, in addition to indifference and abuse by the non-poor and by the institutions of society. They lack abilities to influence the institutional decisions and policies that affect them most, or that could affect them [Hertford, 2001]."*

In short, low income people—men, women, young and old—generally lack tangible and non-tangible assets that generate well-being (financial, human, natural, physical, and social); they are highly vulnerable to adversity, including hunger and poor health; and opportunities which could improve their lives are simply unavailable. Where people are poor in these terms, gender asymmetries are more pronounced: women have fewer assets, appear more vulnerable, and experience greater restrictions on opportunity than men.

Poverty, its rural prevalence, and undernutrition and HIV/AIDS

In developing regions of the world, poverty is--first and foremost--a rural problem. Approximately 70 percent of the poor reside in rural areas and the incidence of poverty is greater in rural than in urban areas of countries where data are available [World Bank, 2001].

As the above definition of poverty suggests, undernutrition, particularly micronutrient undernutrition, is closely associated with poverty [Demment, et.al., 2002; WHO, 2002][3], yet not always synonymous with it; and it is most readily found in the poorest nations of the world, which are predominantly rural. Similarly, it is now considered that HIV/AIDS is becoming a problem of poverty [World Bank, 2001][4]. And because Sub-Saharan Africa, predominantly rural, has become the epicenter of the HIV/AIDS pandemic, rural poverty has become an important fuel for its spread. This is a recent phenomenon since HIV/AIDS spread rapidly at first as a result of "men, movement, and money", or as a result of factors associated with more upscale, urban populations.

The rising vulnerability of the rural poor can be explained by the fact that they are often among the landless class who migrate as temporary laborers to urban areas and contract HIV there; family cohesion is less, leading to multiple casual partners; and many rural poor are completely homeless, finding themselves changing shelter arrangements with some frequency. Furthermore, the rural poor are undernourished and subjected to repeated infections with less access to health services, factors that increase their vulnerability to HIV-infection. Poor rural women are also generally less informed about health matters and not empowered[5] to control their sexual relations [FAO/UNAIDS, 2000].

Some etiologic purists have difficulty accepting rural poverty as an important cause of undernutrition and disease. But it is a widely presumed, if not accepted, "distal cause", distinct from a proximal cause. On moving from the direct, proximal causes of disease, causal certainty and consistency decrease and complexity certainly increases. But distal causes like poverty can impact many different proximal causes and, thus, have amplifying effects. Therefore, they can make very large differences. Rural poverty has precisely those broad and large impacts, which gives it special value for an essay that explores the connections between agriculture, nutrition, and health[6].

---

[3] One of the most recent and exhaustive examinations of poverty and undernutrition concluded that, "for all subregions, there was a strong gradient of increasing child underweight with increasing absolute poverty. . . The strength of the association varies little across regions" [WHO, 2002].

[4] In the source cited, it is said: "Although HIV/AIDS initially affected the poor and the rich almost equally, recent evidence indicates that new infections occur disproportionately among poor people."

[5] Empowerment, empower, and empowered are used throughout this manuscript, chiefly with reference to women. Empowerment refers generally to the conditions of women that permit their having equitable access to—and control over—assets and resources, decision-making, and the benefits deriving from those assets, resources, and decisions.

[6] The World Health Report 2002 contains an excellent discussion of the issues involved, and illustrates many of them elegantly in its discussion of "health risks" [WHO, 2002].

Rural poverty, an agricultural problem

Available analyses of rural poverty by occupational class indicate that its incidence (the number of rural poor divided by the total rural population) is highest among agricultural producers and agricultural laborers. This is illustrated by Table 1 for Central America, one of the poorest regions of the world. Regrettably, comparable cross-country data are unavailable for other regions, particularly for Africa[7]. Nonetheless, because agriculture dominates the rural economies of poor nations, it is recognized that it would simply be difficult to encounter a high incidence of rural poverty were agriculture not generally poor. The rural poverty-agriculture connection does pervade writings on the subject[8].

This argument and the available data point to the primary location of poverty, undernutrition, and HIV-positive individuals being in the agricultural sector. Therefore, agriculture has a potentially central and strategic development role to play in combating these three deplorable human conditions--poverty, undernutrition, and HIV/AIDS.

Combating undernutrition and HIV/AIDS through agriculture

In view of the preceding statement, it is surprising to learn from Welch and Graham [1999] that the nutrition and health communities have not considered using agriculture as a primary tool in their programs directed at alleviating poor nutrition and health globally[9]. That their statement still largely holds, is reflected in IFPRI's asking, as recently as this year, why is it that strategies combining care, improved nutrition, health, and agriculture have been so "isolated and small-scale" [Levin, Carol E., et. al., 2003]. Could this explain why the eradication of hunger has progressed slowly in relation to the millennium goals that were set by the United Nations, and why HIV/AIDS has spread as an epidemic at a rate that has far exceeded earlier projections?

[7] The data that are available indicate that the incidence of poverty in Kenya, Namibia, Senegal, and Tanzania is comparable to (in the range of) that for Guatemala, Honduras, El Salvador, and Nicaragua in Central America. Poverty in Africa is more intense in Mali, Niger, Nigeria, Rwanda, Sierra Leone, and Uganda. Cf. World Bank, 2001.

[8] One of many examples can be found in World Bank, 2001.

[9] There are certainly some exceptions. One recent example (December 2001) involved USAID's financing a four-year project in five African countries of ICRW and IFPRI, which is called "The Agriculture-Nutrition Advantage". It seeks to investigate and promote greater linkages between agriculture and nutrition, as well as gender approaches and methods. There is also ICRW's projects in Ethiopia, Kenya, Tanzania, and Uganda (related publications can be accessed at the project website, www.agnutritionadvantage.org). In addition, there is a new ICRW project in Urganda, bringing together agriculture-nutrition-HIV/AIDS folks with community members to address food security in HIV-AIDS-affected areas. A related information bulletin is available at www.icrw.org. Another example involved a UN initiative which reached across the agriculture-nutrition-health connection and took place in April 2001. In this instance, the UN International Coordinating Committee's SubCommittee on Nutrition focused sharply on HIV/AIDS.

Table 1 -- Central America: Poverty and extreme poverty by occupational class for the total population and the rural population, 1998

Occupational class	Total population		Rural population		Rural population	
	Incidence of poverty (percent)	Percent of population	Inci-dence of poverty (per cent)	Percent of rural population	Inci-dence of extreme poverty (per-cent)	Percent of rural popula-tion
1. Farmer	85	10	87	18	69	18
2. Farm laborer	80	9	82	17	67	17
3. Laborer Farm/Non-farm	-	-	73	6	46	6
4. Non-farm producer	45	20	63	14	33	14
5. Non-farm laborer	36	30	52	19	27	19
6. Non-farm producer/ Laborer	29	15	43	9	18	9
7.Total or Average	50	84	69	83	45	83

Source: Hertford and Echeverri, 2003. Note: Central America excludes Belize, in this instance. The rural population was reclassified in the study to include individuals living in cities and villages of less than 100,000 people. The conventional definition of rural is that of individuals in villages of 2,500 people or less. The effects of these different definitions are discussed in the source. The poor are individuals with US$2.00 of income per day; the extremely poor received incomes of US$1.00 per day.

Part III – Nutrition and its Connections to Agriculture and HIV/AIDS

Undernutrition—micronutrient undernutrition, or generalized, protein-energy undernutrition, PEM--directly impacts a country's productivity, growth, work force, cognitive development of children, and the overall health status of the population, including the incidence of HIV/AIDS.

USAID considers food security to include:

- availability (or the supply of food),
- access (or the means to obtain food, e.g., through home production), and
- utilization (or the biophysical conditions necessary for the human body to assimilate food effectively, e.g., the health of the individual).

Historically, interventions to improve nutrition at the household level through improved food security have involved four approaches:

- dietary diversification via nutrition education, feeding programs, and market programs that make nutrient-rich foods less expensive, or through other consumption inducements that improve diet quality (e.g., successful cases of dietary diversification in developing countries have been described by the Global Livestock CRSP's involvement with feeding rural school age populations meat and milk [Daley, Tamara C., et. al., 2002, plus the publications at the Web site www.glcrsp@ucdavis.edu]);
- food fortification by biological, plant breeding approaches, which probably has the shortest history of these four interventions (e.g., the breeding of bioavailable beta carotene-rich tomatoes);
- food fortification[10] by industrial processes (e.g., the iodization of salt); and
- nutrient supplementation (e.g., consumption of vitamin A capsules).

All contribute to raising the availability and access to food, the nutrient balance of the diet, and even the utilization of food.

Experience has shown that these approaches are most likely to succeed,

- if women are included and empowered with the necessary time, information, training, and authority to control the program,
- if the approach is sustainable and long-lasting, and
- if complemented by health and nutrition training [AED, 2001].

Women are the linch pin: as farm laborers and in numerous other capacities, they earn income for food and health; they process and prepare family food; they care for themselves, their children, and others and watch over sick family members; and they educate their household about what to eat and about so much else. They are most important to better nutrition, health, and family well-being[11].

---

[10] It is common to use the term "commercial" or "industrial" fortification for what is termed here fortification by industrial processes and "biofortification" for what is termed here as fortification by biological approaches. Biofortification is also sometimes referred to as "self fortification". The reason is that the plant self-fortifies and does not require a deliberate action from cultivators. The terms used most commonly in this paper will preclude, it is hoped, any confusion about the kind of fortification being referenced.

[11] This point is elegantly made by the numerous publications of the ICRW. As an example in the nutrition field, see Charlotte Johnson-Welch, 1999. In this instance, USAID-funded studies were conducted in five

Mainly through activities and services leading to increased farm productivity and production and increased rural employment can poverty and hunger ultimately be overcome and can rural health improve. As the economic growth process proceeds, food purchases generally become more diverse and shift to higher quality foods like meat and fruit which (in turn) lead to improved nutrition. This creates new opportunities for farmers to produce for new, higher return cash markets. But without directing resources to limited resource rural areas and farm families, there is the risk that growth could take place mainly in commercial agriculture as a result of the application of labor-saving technologies. The benefits of growth to households most in need of nutrition and health improvements might, then, not be fully realized.

Undernourished children and adults: the social costs

Undernutrition in children is a significant problem worldwide, leading to approximately 6.0 million deaths each year [Pelletier, 1994]. Many more
children become stunted as a result of prolonged undernutrition, which is associated with deficits in cognitive ability and learning productivity[12]. Frequent bouts of illness; poor eyesight; and increased maternal, infant, and child mortality constitute other tragic consequences of undernutrition in children. In the case of adults, undernutrition reduces the length of the periods of work and the intensity of the effort on the job.

Science-based improvements in staple food yields in the past four decades were most successful in arresting the South Asian famines of the 1960s, in igniting and sustaining the "Green Revolution", and—even in the face of population expansion--in reducing modestly the number of undernourished people in the 1990s (by 2.5 million persons by 1998/2000 from a base of about 840 million people in 1990/92 [FAO, 2002b]).

But rising global grain production contributed to a 40 percent real decline in cereal prices since the early 1970s [CIAT and IFPRI, 2003]. This probably resulted in cereals edging out from human diets some more micronutrient-rich foods that experienced lesser price declines, for example, fish, meat, and milk [Ranum, 2001]. Nonetheless, by freeing up cash of consumers, declining cereal prices might also have permitted greater purchases of nonstaples. Uncertainty surrounds the "net result".

Both in communities with adequate and less than adequate calorie consumption, diet quality improvements are the challenge ahead—reducing iron, iodine, Vitamin A, and zinc deficiencies. However, efforts to sustain the growth of cereal production, and its significant contributions to the reduction of protein-energy undernutrition, must not be neglected.

---

countries where women had been provided the resources and opportunities to enhance their contributions to nutrition. The results indicate that the effectiveness of micronutrient programs can be increased significantly by raising the levels of active participation by women. ICRW's web site is www.icrw.org.

[12] In 2000, it was estimated that the prevalence of stunting among children under five in developing countries was 32.5 percent, or 182 million children, with 70 percent of these children living in Asia and 24 percent in Sub-Saharan Africa [UN ACC/SCN, 2000].

Nourishment and cognition

Undernutrition over a period of years among children leads to stunting and reduced anthropometric measurements, including height-for-age and weight-for-height. In 2000, the prevalence of stunting in developing countries was 33 percent of the population of children under five years, representing 165 million children. Most were in South Asia and Eastern Africa [UN ACC/SCN, 2000], and the prevalence of stunting was consistently higher in rural than in urban areas [Ruel, 2001]. The effects of undernutrition itself are sometimes difficult to discern, but associations between stunting, cognitive development, and productivity can be demonstrated, using stunting, in these instances, as an "indicator" of prolonged undernutrition.

Children stunted between birth and age two have been shown to have significantly lower test and IQ scores than non-stunted children, especially when stunting was severe, as well as later deficits in cognitive ability [Mendez and Adair, 1999]. Stunted children are less likely to attend school, or more likely to enter school later than other children. Absenteeism and the repetition of school years are also higher among stunted children, even when account is taken of other variables in a multivariate format. In Zimbabwe, absenteeism and repetition are estimated to lead to losses in lifetime earnings of about 10 percent [Alderman, Hoddinott, and Kinsey, 2002].

A study in Nepal found that the probability of attending school was 5.0 percent for stunted children and 27 percent for children of normal nutritional status [Del Russo and Marek, 1996]. In Ghana undernourished children entered school at a later age and completed fewer years of schooling than better nourished children [Del Rosso and Marek, 1996]. In Honduras, stunted children who came from the poorest homes were twice as likely to repeat a grade as non-stunted children from such homes [Del Rosso and Marek, 1996]. And in the Philippines, looking at children from birth to the end of their primary education, it was found that well nourished children entered school earlier and, thus, had more time to learn. They also demonstrated greater learning productivity per year of schooling, after taking account of greater learning effort in the form of homework time and school attendance [Glewwe, et. al., 1999].

In short, reduced mental capacity and poor school performance are clearly associated with undernourished children. Such undernutrition can also lead to severe bouts of illness; poor eyesight; and increased maternal, infant, and child mortality.

Major effects on adults

Underweight adults appear to be less prevalent in their population than underweight children in their population. In Africa, women who are underweight in the 20-49 age group represent between 6.3 and 15.8 percent of all women, between 3.0 and 13.0 percent in Latin America and the Caribbean, and between 8.5 and 28.9 percent in Asia [UN ACC/SCN, 2000][13].

The systematic undernutrition of adults results in a loss of output and productivity due to the reduced sustainability of effort and/or intensity of the effort while on the job. These are clear costs, with social and economic implications. Additional costs are associated with a shortened life expectancy and the added burden of undernourished residents on a nation's social services.

Most interesting, in this regard, is the study by a Nobel Laureate of total factor productivity in the British economy [Fogel, 2002]. He concluded that the combined effect of the increase in dietary energy available for work, and of the increased human efficiency in transforming dietary energy into work output, accounted for about half of British economic growth after 1800.

[13] Data for Egypt, Bolivia, and Peru are not included in these ranges, although they were reported in the source.

The Green Revolution and a related irony

The science-based agricultural production paradigm of the past half century (the Green Revolution) prevented more horrific famines from occurring than those that reared their ugly heads in the 1960s in South Asia. The cereals that fueled this Green Revolution now account for more calories and protein per capita in the developing world than any other class of food. But challenges remain. While food security at the national level has shown improvement, at the household level chronic undernutrition is still prevalent in South Asia and Sub-Saharan Africa. And while between 1990/92 and 1998/2000 the number of undernourished people (those underweight for their age) decreased by 2.5 million persons worldwide, about 800 million undernourished people remain [FAO, 2002b]. Fully 170 million children in poor countries are said to be underweight for their ages, and especially tragic are the three million children under the age of five who die annually in developing countries from underweight [WHO, 2002][14].

Ironically, the success of the production paradigm and the Green Revolution led cereals, in some instances, to replace more traditional crops rich in protein and micronutrients. For the increased production of cereals--owing to productivity gains, new defenses against pests and diseases, changed cultivation practices and the like--reduced their relative prices and/or lessened price increases that would have otherwise occurred. Cereal prices in real terms (inflation-adjusted) have fallen by 40 percent since the early 1970s [CIAT and IFPRI, 2003]. Reinforced by this strong economic incentive on the consumption side of the equation, cereals and grains have substituted other commodities in the diet with more abundant quantities of micronutrients [MacDonald, et. al., 2000]. Said otherwise: micronutrient-rich foods have become relatively expensive. However, casting doubt on the net result is the fact that the fall in cereal prices should have permitted consumers to purchase nonstaples with the savings they realized.

In South Asia, where cereal production has increased more than four times since 1970, the production of pulses declined by 20 percent. The National Pilot Program Study of India found rural families having diets that were adequate only in the cereal food category. Variety was lacking—particularly, fruits and nuts, animal food, and milk and milk products. All but one region was lacking in green leafy vegetable consumption, and up to 30 percent of all families were found to be deficient in their consumption of Vitamin A. In Sub-Saharan Africa, 60 percent of all children may suffer from one or more deficiencies in the consumption of micronutrients. Chinese children between 12 and 47 months of age had higher height-for-age scores when eating three or more food groups. And among Kenyan children, "dietary diversity was the strongest and most consistent predictor of anthropometric status" [Chakravarty and Sinha, 2002; Onyango, et. al, 1998].

It should also be noted that the additional current and pressing nutrition challenge—improving diet quality, and specifically, the consumption of micronutrients by children under five years of age—arises partly as a result of increasing the survival rates of children through vaccination programs and the availability of more calories and protein.

> *"As greater numbers of children survive, it becomes critical to pay closer attention to the strong relationship between nutritional status and children's*

[14] The total number of children worldwide under the age of five who die each year has been reported to be 11 million [Natsios, 2003].

ability to achieve optimal physical growth and psychological development." [de Onis, et. al., 2000]

Major micronutrient deficiencies

The "Big 3" micronutrients are Vitamin A, iodine, and iron, although more attention is being devoted to the importance of folate, zinc, and multiple micronutrient deficiencies because of the synergies and interactions between nutrients [Ramakrishnan, 2002]. The World Bank estimated in 1994 that, in South Asia alone, 5.0 percent of GDP is lost annually due to deficiencies in the consumption of just these three micronutrients[15]. This is sometimes termed the "hidden hunger problem" because people are generally unaware that their diets are deficient in these nutrients.

Iron deficiency anemia[16]

Iron is the biggest micronutrient problem which may affect up to 2.1 billion people globally and account for anemia among an estimated 1.2 to 1.5 billion people [Glahn, R.P., et. al., 2002; WHO, 2002]. Young children and pregnant and postpartum women are most commonly and severely affected because of the spike in iron demands with infancy and pregnancy. Low meat intake and infections causing blood loss place populations at particular risk for anemia. About 90 percent of the affected people live in the developing world. There is some evidence that the prevalence of iron deficiency has increased in South Asia and Sub-Saharan Africa, possibly as a result of the expansion of cereal cropping systems and decreases in the farm production of micronutrient-dense staple foods such as beans, lentils, and chickpeas [Glahn, R.P., et. al, 2002].

Iron is required in the body for basic cellular functions, and is critically important in muscle, brain, and red blood cells. Anemia delays psychomotor development and impairs cognitive performance of infants. Iron deficiency also leads to childbirth complications and reduced physical capacity and productivity among adults. It can also lead to DNA oxidation which has important roles in causing some cancers.

Although iron therapy often cannot reverse impaired performance on language tests, motor skills, coordination, and IQ tests, it has been shown that iron supplementation can increase work output among road workers and rubber tappers in Indonesia; tea pickers in Indonesia and Sri Lanka; agricultural workers in India, Guatemala, and Colombia; and industrial workers in Kenya, China, and other countries. Gains in productivity and take home pay ranged from 10 to 30 percent of previous levels [WHO, 2001].

Iron deficiency is a major problem in India [Welch and Graham, 1999]. In that country, 60 to 70 percent of children are anemic and half of all women are also anemic. More generally, in non-industrialized nations, 40 percent of children under four, and almost half of all children between five and 14 years of age, are thought to be anemic [Bouis, et. al., 1999].

Iodine deficiency.

Iodine deficiency is likely to be the single most common preventable cause of mental retardation and brain damage [WHO, 2002]. Iodine deficiency has also been associated

[15] Cited by Bouis, et. al., 1999.

[16] Anemia can be brought on by infections, illnesses, and genetic factors. But the most important cause of anemia is probably iron deficiency.

with lower mean birth weight and increased infant mortality, hearing impairment, impaired motor skills, and neurological dysfunction. One third of the world's population is thought to be exposed to a health risk from iodine deficiency[17]. Globally, between 740 million and 1.0 billion people and over 5.0 percent of school age children are affected with goiter. Visible goiter rates average 20 percent in Africa and 12 percent in Southeast Asia [Ramakrishnan, 2002]. This deficiency is controlled through supplementation with iodized oil, applying iodine to some vehicle like irrigation water, and (most frequently) through the iodization of salt.

Vitamin A deficiency.

This is a serious problem in some 60 developing nations. WHO reported in 1994 that 3.1 million pre-school age children had eye damage due to Vitamin A deficiency, 29 million under five years had clinical signs of Vitamin A deficiency (involving a dry, thickened, lusterless eyeball), and another 251 million children had signs of sub-clinical deficiencies of Vitamin A[18]. It is estimated that each year between 250,000 and 500,000 pre-school children acquire blindness due to the deficiency and that about two thirds of these children die within months of going blind [Bouis, et. al., 1999]. Vitamin A deficiency is believed to be responsible for up to one quarter of all deaths of children where Vitamin A deficiency occurs. Vitamin A deficiency is also attributed with over 15 percent of the worldwide burden of malaria and slightly more of the burden of diarrhoeal diseases [WHO, 2002].

Vitamin A supplementation may be at least as effective as immunization and oral rehydration in preventing measles and diarrhea. Vitamin A also prevents night blindness, corneal destruction, birth defects, numerous infections, and possibly some types of cancer. And it mitigates the adverse effects of HIV infection and malaria [Mac Donald, et. al., 2000].

Vitamin A is available in dark orange fleshy fruits and vegetables (e.g., papaya, or sweet potato) and dark leafy greens, although the vitamin appears to be less available for human consumption in the latter source[19]. Animal sources—liver, milk, eggs, and butter—are most easily assimilated by the body.

Zinc deficiency

Zinc deficiency has equally serious consequences for health. In view of this fact, it is regrettable that there is no widely accepted method for measuring zinc deficiency[20]. Nonetheless, worldwide the risk of zinc deficiency is thought to apply to between one third and one half of the global population of 5.9 billion people [CIAT and IFPRI, 2003; WHO, 2002], with highest rates of prevalence being found in South Asia, Southeast Asia, and in Africa.

---

[17] The "at risk" population worldwide may be 2.2 billion people, or 38 percent of the world's total population, with highest prevalence figures being for the Eastern Mediterranean countries (74 percent) and for Africa (48 percent) [UN ACC/SCN, 2000].

[18] Cited in Ramakrishnan, 2002.

[19] Personal communication from M.W. Demment, 2003.

[20] Ray Glahn and his colleagues at Cornell University claim that they are adapting their *in vitro* model to measure zinc availability, and early results appear promising. Some validation experiments are needed; this could be a target of opportunity for USAID.

Zinc supplementation can reduce by one third the morbidity from a number of common childhood infections, especially diarrhea, pneumonia, and possibly malaria [Ruel and Bouis, 1998]. Furthermore, approximately 16 percent of lower respiratory tract infections, 18 percent of all malaria, and 10 percent of diarrhoeal disease have been attributed to zinc deficiency [WHO, 2002].

****

Will all the micronutrient deficiencies just described simply go away, if income and consumption levels can be raised among the poor? The presumption of this paper is that making agriculture, the primary productive sector, more productive—especially while working in collaboration with other sectors--will improve nutrition and health in rural areas.

But the cost of failing is just too great. Therefore, significant interest lies in how to deal with micronutrient deficiencies in the most cost-effective manner.

Dealing with micronutrient deficiencies through fortification and supplementation

Biofortification

There is a two-part challenge for the fortification of foods using biological, plant breeding approaches: not only must the absolute amounts of micronutrients be increased in the edible portions of food commodities, but also these nutrients must be in forms that are bioavailable to people consuming them in typical meals. Over the past few decades, the high costs of performing animal and human trials on bioavailability have limited progress. However, an *in vitro* bioavailability model that mimics the gastric and intestinal digestion of humans, coupled with culture of human intestinal cells, now shows great promise in addressing bioavailability [Glahn, R.P., et. al., 2002; Oikeh, et. al., 2003]. In addition, there is the challenge of ensuring that foods with micronutrients produce for farmers as well as, or better than, the traditional forms of those commodities[21]. These matters have been dealt with by Welch 2002a and 2002b.

Fortification of foods using biological, plant breeding approaches is to constitute an inexpensive, sustainable means of delivering micronutrients to the poor [CGIAR, 2001]. Recurrent costs of this approach are low, it is highly sustainable, nutrients can more readily get into remote rural areas, and a yield penalty is not anticipated as some of the micronutrients being bred for have been shown to help host plants resist disease and other environmental stresses[22]. The CGIAR has cast the related efforts of its centers in a new Challenge Program, "Improving Human Health through Crop Biofortification", involving nine disciplines and nearly 50 partner organizations. The Program began with the common bean, cassava, maize, rice, and wheat; and it targeted three nutrients, iron, zinc, and beta-carotene. There is evidence to date that the micronutrient densities can be increased by a multiple of two for trace minerals and by higher multiples for beta-carotene (additional details are provided below) [CIAT and IFPRI, 2003]. The *in vitro* and animal tests of bioavailability are promising, and tests on human populations are now an important hurdle. At CIAT headquarters on June 2-6, 2003, the group involved in the challenge program made solid progress in determining how it will work to boost the vitamin and mineral contents of the world's staple foods in the period ahead[23].

Available estimates of the reduction in iron deficiency prevalence is that rates could fall from levels of 40 percent to 20 to 30 percent among consuming populations. The International Rice Research Institute, IRRI, already has available a rice variety with

[21] Some reviewers of this paper pointed out that the world's poorest farmers may not have benefited from Green Revolution technologies, if they did not have access to new, non-traditional inputs by reason of resource constraints; yet, they were confronted by falling prices for cereal crops caused by technical change and production expansion on adopting farms. They then asked, "Might this happen again in the case of the biofortified crops that are now beginning to emerge?"

[22] Breeders have found that higher quality protein content is generally associated with lower yields. Hence, the positive association between micronutrient density and yields is promising. In a personal communication, Ray Glahn said, "data exist to show that increasing the trace mineral content of seeds actually increases seedling vigor and yield, a win-win situation agriculturally and nutritionally." More about that is in Horwood, 2002. In another personal communication, Russ Freed, an AIARD ex-President and plant breeder, points to the fact that this is still a debated point, with the comment: "We breeders are usually breeding for high yield which will many times reduce the nutrient content of the grain. Poverty reduction, mixed diets, fortification are better than breeding." Feeding trials for humans are on-going in the Philippines, but the results are not in as yet for that population and others.

[23] Additional information is available on CIAT's Web site, www.ciat.cgiar.org.

double the iron (after milling) of standard IRRI releases; the variety is also early maturing, high yielding, and disease resistant, all highly desirable qualities. It could be ready for release to farmers in a few years.

Because it appears that fortification through biological approaches and plant breeding can raise zinc densities in plants by more than in the case of iron, there is some optimism that the prevalence of zinc deficiency can be reduced by even more than that of iron deficiency. It has been reported that zinc content, for example, varies substantially in corn, as well as does the degree to which zinc is translocated from the stalk and leaves to the seed during seed formation, meaning that in this crop there would appear to be a basis for breeding for zinc fortification[24].

Vitamin A deficiencies might also be made to fall rather significantly through the biofortification approach. The AVRDC has succeeded recently in developing a Vitamin A-rich, golden-colored tomato that contains three to six times more beta-carotene than red tomatoes [AVRDC, 2003]. Besides being nutritious, the flavorful golden tomatoes are lower in acid and similar in sweetness to standard red tomatoes. Bioavailability tests will need to assess these new products, and marketing tests will need to be performed of their profitability. AVRDC is also utilizing vegetable legumes to overcome PEM, okra and onion to help reduce iodine deficiencies, and different combinations of vegetables cooked together to enhance the bioavailability of iron. In the specific case of Vitamin A fortification, successes are also being reported for maize in Zimbabwe and for sugar in Zambia [UN ACC/SCN, 2000].

The plant breeding option is acceptable to the consuming public and avoids long-term commitments to centralized processing facilities which are necessary for fortification using industrial processes. Biotech fixes (e.g., Golden Rice with a gene added to increase beta-carotene content) remain controversial in many countries and require significant investment [Cohen, 1999; Persley and Lantin, eds., 2000; and Trigo, et. al., 2002]. The biofortification work reported above has involved (and will involve) conventional breeding approaches, as well as biotech fixes.

[24] This information on corn was contained in a personal communication from Dr. Herb Massey of the University of Kentucky. See also Maziya-Dixon, et.al., 2001.

Fortification with industrial processes and supplementation

Iodine fortification of salt has been one of the most successful fortification efforts using industrial processes. Folic acid fortification of cereals also testifies to the success of this approach, although this form of fortification is really only an option where the food industry is developed and there is a structure in place which can provide quality assurance. It is also commonly an expensive and technologically challenging approach. It works well with corn meal and wheat flour, but less well with rice and other staple food commodities most consumed in the developing world.

It goes without saying that supplementation (generally involving the distribution of capsules) treats the symptoms of vitamin and mineral deficiencies rather than the underlying causes. Furthermore, in many countries with poorly developed health and road infrastructure, supplementation can be expensive and difficult to sustain through time. If supplementation is to be carefully targeted, there can be significant additional costs associated with identifying beneficiaries. Recurrent programs of supplementation are also large since there is technically no end to a supplementation program. Nonetheless, efforts like those of Helen Keller International, which deliver Vitamin A to vulnerable populations, should be supported to bridge adults and particularly children to the point that a sustainable supply of the vitamin is available locally in the food they eat.

One more targeted, fortification/supplementation approach, involving the development of new agricultural enterprises, has been suggested which appears to offer some promise, and is certainly worthy of mention at this juncture:

> *. . .affordable packaged/processed foods that are nutritious, safe, tasty, culturally appropriate and relatively quick to prepare should [come in for attention]. . .Cooked foods are quickly contaminated in tropical climates and, when eaten without proper reheating by individuals with compromised immune systems, they can pose a serious health problem. Impaired appetites and ulcerated mouths and gastrointestinal tracts call for tasty foods. . .as well as easily masticated and digested foods. In some areas, families caring for HIV-affected individuals are spending large amounts of money for special foods they can ill afford that they believe will cure or treat the sick individual. [This suggests] an opportunity for small scale, value added agro-enterprises to be created in rural areas by women entrepreneurs*[25].

[25] Stated in a personal communication by Dr. Audrey Maretzki, Professor of Food Science and Nutrition, The Pennsylvania State University.

The nutrition-HIV/AIDS linkages

Some of the direct evidence

There is convincing evidence that poor nutrition is an important factor in adults and children through its effects on the sexual and mother-to-child transmission of HIV/AIDS, the progression of HIV to AIDS, and the mortality rates of AIDS [Friis and Michaelsen, 1998; Tomkins, 2002; Stillwaggon, 2002][26].

HIV infection reduces the intake, absorption, excretion, and utilization of micronutrients. HIV infected persons have been found deficient in Vitamins A, B6 and B12, Vitamin C, and Vitamin E; and zinc, magnesium, and selenium. But beyond micronutrients, macronutrients and a healthy calorie-protein diet is a crucial requirement as well that cannot be met by pills alone.

> "*Food is often the first priority of people affected by the pandemic"*
> [Loevinsohn and Gillespie, 2003a].

After sexual transmission, mother-to-child transmission of HIV is the second most common route of infections in sub-Saharan Africa. Mothers with a good immune status are far less likely to transmit the virus to their infants, and the immune status is positively related to nutritional status. There is also evidence that exclusive breastfeeding might be more protective against HIV/AIDS than partial breastfeeding [UN ACC/SCN, 2000].

What seems clear is that immune system impairment from HIV/AIDS leads to undernutrition which leads to the worsening of HIV—a downward spiraling, vicious circle [de Waal and Tumushabe, 2003].

The New Variant Famine

Southern Africa is currently in the midst of a humanitarian crisis, and access to food for the rural poor seems to be at its heart. The most severely affected five countries experienced flooding and poorly distributed rainfall which led to reduced food production. However, it was striking that the climatic anomalies in recent years were less extreme than the drought period that ravaged the region in 1992. Yet, the latter event did not result in widespread famine or deaths [Eldridge, C., 2002].

How is this to be explained? One important hypothesis to emerge recently is that the spread of HIV/AIDS has increased the sensitivity of agrarian societies to shocks of all kinds, but especially droughts and poor rainfall distributions. The term applied to this phenomenon is "new variant famine" [de Waal and Whiteside, 2003].

Aflatoxicosis

Aflatoxicosis in humans straddles agriculture and health because aflatoxin (AF) is a hepatoxic, anti-nutritional contaminant in many food commodities, which can develop before harvest, or during storage. Exposure in developed countries is limited by capital intensive, large scale grain drying and storage practices which are not generally used in developing countries. Therefore, developing country populations are more frequently exposed to AF which produces liver damage, may increase the risk of liver cancer, and

[26] There are the broader effects of nutrition on reproductive health generally [Mackey, 2000].

produces immunosuppresion, edema in the lower extremities, abdominal pain, and vomiting[27].

A small body of literature is emerging which also connects the rate of progression of HIV with AF exposure [Williams, J. H., et. al., 2002]. Given the fact that AF is a factor that influences nutritional status, it is seen to be of particular importance for HIV/AIDS sufferers and the human immune system.

An inexpensive food additive is available which might be able to prevent biological exposure. But research is needed to determine the economic and human costs of AF contamination in selected populations, especially in developing nations, and then to test for the safety, efficacy, and dosimetry of the food additive.

[27] This information and additional details concerning aflatoxicosis are available through fact sheets of the Food Safety Research Information Office of the Agricultural Research Service of the U.S. Department of Agriculture. See, for example, www.nal.usda.gove/fsrio/research/fsheets/fsheet.htm.

Part IV – The HIV/AIDS and Agricultural Connections

The status of the epidemic, its regional distribution, poverty linkages, ruralness, and prevalence in agriculture

The reader who is unfamiliar with HIV/AIDS can be brought up to date by reviewing the large body of literature now available [Barnett and Whiteside, 2002; Bollinger and Stover, 1999]. Only a few facts are underscored here, namely, that the pandemic

- has moved faster than expected and
- Africa is carrying most of the burden of the disease worldwide,
- as are the poor, rural areas, and (probably) agriculture.

Status of the epidemic

The data of Table 2 present a global summary of the status of HIV/AIDS and lead to the following inferences:

- because adults are disproportionately represented among people living with the disease, their share of deaths, now at 93 percent, may be rising in the future;

- because women are under-represented among people living with the disease, their share of deaths, now at 37 percent, may be falling in the future while that of men may be rising;

- because children are under-represented among people living with HIV/AIDS, and children contracting the disease about equal the number dying in the same year, HIV/AIDS can be said to present a more certain and quick death to children than to adults;

- WHO's Global Programme on AIDS projected in 1991 about half as many people living with HIV/AIDS than is presently the case (40.0 million) [UNAIDS and WHO, 2001]; hence, the rapid spread of the disease has been surprising—in fact, already more people have died from HIV/AIDS than from the Black Plague of the Middle Ages which took 20 million lives; and

- men are the primary casualty of the disease; only in Sub-Sahara Africa are there more HIV-positive adults who are females [UNAIDS and WHO, 2001; WHO, 2002] [28].

The data of the Table have their weaknesses. For many countries, no information on the prevalence of HIV is published; for many others, studies are unevenly distributed, depending on the convenience of their being performed under prevailing ethical, financial, and logistical constraints. There is a tendency for prevalence to be monitored in large urban centers, even though they often comprise a minority of a nation's population. The true extent of HIV needs to be examined with both urban and rural samples. Any effort to expand the quantity and quality of HIV/AIDS data should be encouraged and supported.

[28] This statement refers only to the incidence and the direct effect of the disease on men and women. If the many indirect effects of the disease on women are taken into account, for example, the amount of time women spend caring for HIV-infected family members, or the need for them to dedicate more labor time to activities in the field to support family agricultural production, this casualty statement would be quite different. More is said about this further on.

Table 2 -- GLOBAL SUMMARY OF THE HIV/AIDS EPIDEMIC, 2001

CONCEPT	TOTAL (million)	PERCENT ADULTS	PERCENT WOMEN	PERCENT CHILDREN <15 YEARS
People infected with HIV	5.0	84	40	16
People living with HIV/AIDS	40.0	93	46	4
AIDS deaths	3.0	83	37	19
Cumulative AIDS deaths	24.8	80	41	20

Source: UNAIDS and WHO, 2002. These are the most recently available global data.

The concentrated regional distribution of the disease

At present, over 90 percent of the people living with HIV/AIDS are in developing countries. Africa (primarily, Sub-Sahara Africa) is the global epicenter, currently harboring 70 percent of the 40 million people with HIV infection [UNAIDS and WHO, 2001; WHO, 2002], even though the Continent accounts for only about 10 percent of the world's population. South and Southeast Asia stand in second position, and Latin America is third ranked by the number of adults and children living with HIV/AIDS [UNAIDS and WHO, 2001]. India is the country with the largest number of infected people--around four million. Some Caribbean countries have high incidences of the disease, and that region as a whole has the highest HIV rates per unit of total population in the world outside Africa.

Links with poverty

Impact mitigation strategies need to be carefully targeted and differentiated by income and wealth levels[29]. In rural areas, poverty definitely makes people more vulnerable to the disease since the poor are more frequently landless migrant laborers, subject to family break ups (leading to multiple casual partners), overcrowded in their housing, or without homes at all. The poor are also more likely to be undernourished and subjected to repeated infections. Undernourishment and infections tend to shorten the latency period of HIV.

Striking is the finding that in poor households spending on food fell by nearly a third in the six months following the death of a young, productive, male adult, while both food spending and food consumption rose in non-poor households, possibly because of funeral feasting. Furthermore, following death, poor households received little from family, friends, and other private sources, while the non-poor received significant amounts of cash and non-cash gifts [UNAIDS and WHO, 2001]. Similar conclusions emerged from a study of AIDS-affected households in Zambia.

[29] Mitigation activities should probably not be focused exclusively on the poor. Half of the deceased prime age men in a recent study of Kenya found that men were in the highest per capita income quartile and that they are likely to be household heads. Thus, there may be a need to look at high income men in some settings.

Its ruralness and prevalence in agriculture

Over two thirds of the population of the 25 most affected African countries live in rural areas [du Guerny, 2002b]. Because of their importance in the pandemic, this makes HIV/AIDS predominantly a rural problem. Two reasons for this stand out: health services are less available in rural areas; and mobile and migratory workers, prevalent in the farming sector and in mining, evidence higher incidences of the disease. Educational services are also less prevalent in rural areas; and rural women are generally ill informed about health matters and are not empowered to control their sexual relations. Furthermore, rural areas, not urban ones, are being burdened now with more of the new cases of HIV/AIDS in Africa [UNAIDS, 2003]. IFPRI has lamented that:

> *"This list of the most affected countries is depressingly familiar to those who have worked on food security and nutrition for many years. It is no coincidence that the maps of HIV prevalence and malnutrition overlap. The HIV epidemic is increasingly driven by the very factors that cause malnutrition: poverty, conflict, and inequality"* [Piot, et. al., 2002]

It has been shown by FAO that the vulnerability to HIV in rural areas—where vulnerability is of two kinds, vulnerability to contracting the disease and to being impacted by the disease--is greatest along truck routes and in areas sending migrant labor temporarily to urban areas. Similarly, nomadic pastoralists are at increased risk of contracting HIV due to their mobility and limited access to social services [du Guerny, 2002b].

And there are reasons to believe that most HIV/AIDS cases are arising in agriculture. First, although the disease can be transmitted in any of three ways (unprotected sexual intercourse, through blood products and semen, and through an infected mother to an infant during pregnancy or delivery), the risks of transmission are heightened by:

- asymmetric sexual relations—for example, when a small number of women have unprotected sex with a larger number of men;
- through the movement of people, as there would not be a generalized epidemic were people not to move; and
- as a result of inequalities in social, economic, and gender relationships [Loevinsohn and Gillespie, 2003a].

Second, agriculture has numerous examples of these transmission risks: the larger labor forces prevalent in plantation agriculture can be associated with smaller numbers of women than men; the migrant labor in agriculture clearly results in more movement of people (and in the absence of their families) than is the case of other industries; and gender inequalities are prevalent, in part simply because of the heavy work requirements of agriculture. Hence, the risks of HIV/AIDS are probably greatest in the agricultural sector of the rural economy.

Suggestions to the effect that HIV/AIDS is less prevalent in rural areas can be found. Nonetheless, they appear to be restricted principally to some recent work in Zambia, which showed that rural prevalence rates are at around 11 percent compared to 23 percent in urban areas [Harvey, 2003].

The impact on women is especially severe

Female-headed households afflicted by AIDS become entrenched in poverty. In addition to losing cash income on the death of the spouse, women have fewer legal rights, are less literate, and have restricted access to support services. In parts of West Africa, women have no rights to the land of a deceased spouse, which must pass to a male relative, and they commonly lose other possessions as well. These various problems have contributed to the "feminization" of rural poverty[30].

Furthermore, the AIDS stigma can sever the access widows would otherwise have to assistance from the extended family and the community. Often a widow is blamed for transmitting the disease and is accused of promiscuity and immorality. Some widows are harassed and forced to leave their village. They migrate to the towns where they can escape from the stigma, earn their living as petty traders, engage in transactional sex, or remarry in anonymity. There is, of course, a countervailing flow of migrants. It involves urban residents who seek to "return home" when infected by the disease to be among long-time friends, avoid harassment, and enjoy the lower living costs of rural areas. Because the new cases of HIV are occurring mainly in rural areas, the larger of these migrant flows is probably the urban-to-rural one.

In short, it may be highly unlikely that the HIV/AIDS epidemic can be controlled without the effective support of agriculture, the rural economy, and rural people[31]. It is encouraging to learn that FAO has been evolving an agricultural sector strategy for HIV/AIDS.

[30] Marcela Villareal of FAO notes that the Organization's High Level Committee on Programmes (HLCP) can be attributed with the comments that "Women and girls bear a disproportionate burden of the AIDS crisis. Women are more easily infected. . . Girls are also care-givers, and are more likely to lose development opportunities—such as being pulled from school as households cope. Women comprise the majority of African farmers, are the backbone of agricultural systems, and are key drivers of both rural and urban economies."

[31] In recognition of this fact, a Regional Network on HIV/AIDS, RENEWAL has been launched in Africa, co-facilitated by ISNAR and IFPRI. The challenge RENEWAL confronts is to enhance understanding of the links between rural livelihoods and food security on one side and HIV infection and AID-linked illness and death on the other so that actions can be more conscious and targeted and their effects felt in years, not decades [Loevinsohn and Gillespie, 2003b]. It is working actively in Uganda and Malawi.

The losses in agriculture from HIV/AIDS

The 18 specific impacts of HIV/AIDS on agriculture that follow have been largely derived from the available literature [Bonnard, 2002; FAO, 2002a; Gillespie, 1989; Gillespie, et. al., 2001; White and Robinson, 2000]. This paper tries to make an additional contribution, however: to highlight the main consequences in each case and to suggest a highest priority mitigating action. Because the impacts are on agriculture, the suggested remedies are led principally by on-farm actions. In all cases, these will require the company of nutrition and health interventions.

The reader will note that the vast majority of the impacts described affect the supply and productivity of labor and human capital in the rural economy. For these reasons, the prevention, care, and mitigation of the pandemic in rural areas must involve schemes which replace the lost labor and increase the productivity of remaining members of the labor force.

An important cautionary note: the actual effects of a death in the family due to HIV/AIDS are sensitive to the gender, the position, and the age of the deceased member [Yamano and Jayne, 2002][32]. Too, it needs to be recognized that these impacts of HIV/AIDS on agriculture are far better understood than are the effects running from agriculture to the spread of HIV--how it is that agricultural systems, policies, and practices may contribute to the pandemic [Loevinsohn and Gillespie, 2003b].

Food requirements rise for the HIV/AIDS-infected

- ***** Main consequence – Falling labor productivity
- * Priority remedial action – Nutritional supplementation

Persons with HIV have higher than normal nutritional requirements: up to 50 percent more protein and up to 15 percent more calories are required [Piwoz and Prebel, 2000]. Jacques du Guerny [2002a] has estimated that the additional calorie requirement is 400 kcal/day for adult males and 300 kcal/day for adult females, representing one third or more of the total energy available. Recently, it has also been recommended that micronutrient intakes of HIV-positive individuals be increased by 100 percent [www.fantaproject.org]. Yet, unfortunately, HIV-positive people are likely to suffer loss of appetite and anorexia. Undernutrition is the consequence.

Undernutrition shortens the latency period of HIV infection, hastens the onset of AIDS and (ultimately) death, and increases the risk of HIV transmission from mothers to babies. Diets rich in protein, energy, and micronutrients can delay the onset of AIDS (even death) and prevent opportunistic infections. Because of immune system-nutrition interactions, good nutrition is also important to the disease's prevention. Thus, nutritional supplementation must be a core component of HIV prevention, care, and mitigation efforts in vulnerable, poor, rural areas, if the productivity of labor in all its forms is to be sustained [Gari, J.A., 2003; FAO, 2002c] This, however, should certainly not be construed to mean that the nutrition buffer against HIV/AIDS is perfect.

[32] It needs to be pointed out that these results have been derived from a large number of studies, but very few are based on micro-level information on how households actually respond to HIV/AIDS and the subsequent effects on production, income, and other indicators. One of the best examples of the studies that are needed is the Yamano and Jayne, 2002 reference.

Land is fallowed, or abandoned

* Main consequence -- Farm output falls
* Priority remedial action – Increased land and labor productivity

Especially among disadvantaged agricultural producers, the land parcels being cultivated tend to be widely separated and some are remote. Getting to these fields can be restricted by the disease, with the result that some land may be left fallow and farm output may decline. For example, labor time for cultivation may have to be diverted to the care of sick household members. Actions that raise the productivity of the land remaining under cultivation and increase the productivity of labor so time in farming can be economized are most desirable.

The work day lengthens

* Main consequence -- The productivity of labor may fall further
* Priority remedial action – Increased use of equipment, tools, and mechanical and animal power

When a young adult in the labor force dies from AIDS, the work day of uninfected survivors is lengthened, especially that of widows. One consequence of this coping mechanism is that children are left unattended, meals are poorly and hastily prepared (there is less time available, for example, to collect fuel wood), and the health and diet of survivors may deteriorate from exhaustion and less food intake. If family members become HIV-positive, they may be unable to grow food because they are not getting enough to eat and are, therefore, not strong enough to work. This is a vicious circle.

New and different types of farm power and equipment may respond to this situation [IFAD/FAO, 2003; Lieberum, 2002]. Some writers have suggested developing lightweight plows for use by women and youth, when an area is attacked by HIV/AIDS [Gillespie and Haddad, 2002]; Zimbabwean farmers developed a lightweight cotton planter that could be drawn by a donkey [Ncube, 1999]. The financial requirements for such options must be modest.

Off-farm rural incomes fall

* Main consequence – Reduced family income
* Priority remedial action – Raise labor productivity on- and off-farm

Especially when a prime age male head-of-household is lost to AIDS, the family can suffer a significant loss of off-farm rural income. This reflects the "pluri-active"[33] nature of occupations held by rural dwellers and the importance to them of non-farm rural income. Raising on-farm labor productivity should free time for off-farm employment, or compensate some of the reduced off-farm income; raising off-farm labor productivity should raise earnings for employment time in that sector.

[33] This term was less commonly used in the U.S. before de Janvry, Alain and E. Sadoulet, 2000. Marcela Villarreal of FAO called AIARD's attention to the fact that it was in common use in the European Union well before 2000 to describe the multiple livelihood strategies of (part time) farmers.

The labor pool for commercial agriculture shrinks

* Main consequence – Commercial farm output falls
* Priority remedial action – Increased use of equipment, tools, and chemical and animal power and increased on-farm labor productivity

This is a result of the fact that commercial agriculture depends on hired labor, sometimes migrant labor, which is a group of individuals at generally high risk of infection by HIV. Migrant laborers also generally live apart from their families for parts of the year. Hence, the migrant labor pool diminishes as HIV/AIDS spreads. This could be offset by mechanization and/or increased labor productivity

Soil fertility declines

* Main consequence – Falling land productivity
* Priority remedial action – Introduce land conservation practices that are labor-saving

FAO claims to have detected falling soil fertility as a result of HIV-infected farmers being reluctant and unable to carry out long-term soil conservation measures because such measures either do not yield immediate income [FAO, 1994], or require energy that is not available. Too, soil conservation measures, FAO notes, are frequently labor-demanding. Thus, in an environment where human resources have become scarce, declining soil fertility can be expected *ceteris paribus*.

Pests and diseases mount

* Main consequence – Lower, more variable, and inferior quality production
* Priority remedial action – Increased environmentally friendly biological and chemical controls

The incidence of pests and plant diseases increases where labor had been previously used for its control. This is the case among poorer producers of bananas in their control of the banana weevil and among poorer coffee producers in their control of stinging ants. Although not always available, environmentally friendly biological and/or chemical controls are the most direct remedy for this problem. The challenge is to keep down their costs which had made control by labor cheaper.

Essential cultivation practices are neglected

* Main consequence – Falling and less certain yields
* Priority remedial action – Increased labor productivity

Tillage, mulching, planting, weeding, and pruning may be neglected, or not conducted with the care required for yields that prevailed before HIV/AIDS. Activities may also be delayed, and the most appropriate timing for operations can be missed as a consequence of HIV/AIDS.

Production declines and shifts

* Main consequence – Returns to existing enterprises fall
* Priority remedial action – New enterprises and markets

This is the inevitable result of the outcomes just described and others [Harvey, 2003]. Several studies have now documented the decline in agricultural production of existing enterprises caused by adult mortality affecting adversely yields, soil fertility, the pool of available labor, land area cultivated, and the buildup of pests and diseases. In Kenya, net household production dropped 68 percent; in Zimbabwe, output declines of 37 to 61 percent were found for different crops; and in Swaziland, maize production fell 54 percent following the death of the household head[34].

To avoid this loss, or recoup it completely or in part, remaining family members tend to shift commodity production patterns to more labor-extensive items to conserve on the labor input, e.g., to bee-keeping, or from rice and millet to maize and cassava, or to fishing and trading because of their "quicker returns" [Yamano and Jayne, 2002]. This also occurs in animal agriculture where producers have been observed to shift from bovine animals to pigs and poultry. As an alternative to a shift in commodity production patterns that can impact household nutrition adversely, new markets with better returns should certainly be investigated and developed.

A short-term outlook prevails

* Main consequence – Investment diminishes
* Priority remedial action – Introduction of subsidies and special facilities for rural investment

Most detrimental to investing in rural areas is the fact that many people affected or afflicted by HIV/AIDS develop a short-term outlook. Investing in perennial commodities declines, and even annual crops come to appear to be more risky. People affected by HIV/AIDS prefer to invest in petty trading, for example, because the payoff is more immediate.

"**Predial larceny" increases**[35]

* Main consequence – Investment is stifled
* Priority remedial action – Introduction of subsidies and special facilities for rural investment, accompanied by community policing and theft controls

Particularly in the Caribbean, there is a tendency for rural areas to become more insecure. As HIV/AIDS enters an area, the need for food rises; and fields are left less closely guarded by operators who must leave to nurse sick relatives in distant locations, or perform other functions that are abandoned by the death of adult family members. Robberies of farm produce are the result, termed predial larceny in the Caribbean. While community policing and theft controls would seem required parts of any solution to the problem, it can be easily understood that discipline (or its threat) is not effective when death by AIDS is on the horizon!

[34] Cited in Loevinsohn and Gillespie, 2003a.

[35] One of the best descriptions of predial larceny is in World Bank, 1997b.

The inter-generational transfer of knowledge and skills

***** Main consequence – Investment in human capital is truncated

* Priority remedial action – Policies encouraging school attendance, plus curriculum reform

Parents affected by HIV/AIDS have less time to instruct their children in a variety of areas, including how to farm. Owing to the gender division of labor and knowledge, the surviving parent is most often not able to transfer the skills of the deceased one. Sometimes children are left completely orphaned, and in those situations schooling of any kind is practically out of the question[36].

As with so many of these impacts which are labor-related, this one could be anticipated and mitigated were the labor productivity of surviving adults in the household to increase. Failing that, policies would need to be devised to encourage school attendance and modify appropriately curricula to incorporate the inter-generational training no longer available in the home.

Absenteeism rises

***** Main consequence – Wage earnings fall and institutional performance declines

* Priority remedial action – Employee income maintenance and substitute labor schemes

This constitutes a serious consequence of HIV/AIDS, caused by mortality and morbidity, attendance at funerals, and various other exigencies of daily life that result from the disease. Discrimination at the workplace against HIV-positives further interferes with work performance. Provisions for absenteeism must be made, which provide for some income maintenance and assist with the acquisition of substitute labor on a temporary basis.

Rural support services become frail

***** Main consequence – Wage earnings fall and institutional performance declines

* Priority remedial action – Review and modification of human resources policies

There is a developing literature that shows that HIV/AIDS is eroding the capacity of governments to deliver social services such as health and education, especially in rural areas [FAO/UNAIDS, 2003; Harvey, 2003][37].

---

[36] There are 13 million orphans in Africa alone, mainly the product of HIV/AIDS. It is believed that the number of orphans in Africa will equal the number of children in public schools in the U.S. by the year 2010 according to a statement by Rep. Barbara Lee (D-Calif.) made in March of this year, when the House moved to "set up a 'Marshall Plan' for AIDS-devastated Africa".

[37] In Namibia and Zimbabwe, extension personnel were reported to spend 10 percent of their time attending funerals, resulting from deaths of AIDS victims. In Uganda, every time there is a burial, the work week is reduced from six to three days as people have to take Saturday, Sunday, and Monday off to travel to the village and attend the burials. In Malawi, employee deaths at the Ministry of Agriculture and

Recruitment practices, personnel replacement, training strategies, and employment benefits of rural support services agencies may all have to be reviewed and revised radically in these settings.

Divisible assets are sold; others obsolesce

* Main consequence – Household income generating potential is truncated
* Priority remedial action – Provision of resources on "soft terms" for a financial reserve and/or for asset conservation and maintenance

Land and other valuable assets may be sold for lack of use as a result of the changes identified above. Too, such stores of value as livestock are frequently sold, gifted, or sacrificed in payment of necessary medical services, or other treatments, and funeral services. To pay for the escalating costs of hospital fees, traditional healers' fees, transportation, special food, and funeral expenses, affected livestock households in Namibia sold their livestock, then their crops, and (where still in need) entered into borrowing arrangements [Engh, Stloukal, and du Guerny, 2000].

In several African societies, the death of the male head-of-household does not result in land passing automatically to his spouse as only males can inherit the land. This is especially prejudicial to widowed females in rural areas [Drimie, S., 2002]. HIV-infected producers may become so weak that they do not have the labor time or labor force to maintain their assets. One individual's house collapsed, and he was too weak to repair it.

Dependency increases

* Main consequence – Household food and financial security are jeopardized
* Priority remedial action – Foster care by institutions and families should be provided for in whole or part

Sometimes the number of unproductive family members increases as a result of fostering children, or hosting and caring for sick HIV-infected relatives who typically return to rural areas to avoid the social biases to which they are subjected in more heavily populated urban areas. These realities endanger both short- and long-term household food security and financial solvency. Communities are reported to be arranging successfully for the lower cost, non-institutional care of orphans in Kenya, Malawai, Zambabwe, and Zambia [UNAIDS and WHO, 2001].

Irrigation doubled from five to ten per 1,000 in the 1996-98 period, largely due to AIDS. In Namibia, where livestock is an important product of the rural economy, HIV/AIDS has had important effects on the delivery of veterinary services and on inspection services for exports [AED, 2001]. In this regard, it has been pointed out that there are consequential risks of losing markets, if countries cannot monitor, control, and eliminate trade-threatening diseases [Engh, Stloukal, and du Guerny, 2000].

Risk pooling and collective management diminishes

* Main consequence -- Some livestock, forestry, and fisheries enterprises exit production
* Priority remedial action – Support and facilitation of institution building for social capital

Incentives for coordinated group action may be diminished because people largely discount the future benefits of such action. Reference is made particularly to the collective and sustainable management of common property, such as rangeland and river basins. Formal institutions that also constitute important social capital (e.g., church groups, sports clubs, and community associations) will be weakened as members die, and the benefits of rebuilding them are likely to be discounted because they only begin to flow in the distant future. Existing networks and social capital may also be weakened as they become stigmatized by the presence of HIV/AIDS among some members. An attitude of "each unto his own" begins to dominate.

Fewer children reach school age, and opportunity costs and perceived out-of-pocket costs of schooling rise precipitously

* Main consequence – Human capital formation falls significantly
* Priority remedial action – New incentives encouraging schooling attendance

HIV is reducing the number of children in school, especially in rural areas, chiefly because both the opportunity costs of schooling and the perceived out-of-pocket costs rise precipitously. Too, children are infected and die before reaching school age. HIV-positive women have fewer babies, as they may die during their childbearing years; and a third of their children are infected and die before school age. Other children drop out of school to assume duties of sick relatives, or of others that have died, further raising the opportunity costs of the time spent in school. The stigma of coming from a family infected with HIV/AIDS also drives some children from attending school. For these and other related reasons, the opportunity costs of schooling rise. School attendance costs may also come to be perceived as prohibitive in a family, if it has lost the income of adults who were formerly in the labor force[38].

[38] IFPRI has described a "food for education" program which may merit scaling up under the circumstances just described: children are fed in school (through school feeding programs of the more traditional variety) and families are given food, if their children attend school (a food for schooling program). Both programs combine educational opportunities with food-based incentives. And both motivate parents to send their children to school, empowering future generations by educating today's children [IFPRI, 2003]. A similar program, the McGovern-Dole International Food for Education and Child Nutrition Program, has the USDA donating surplus U.S. agricultural commodities for use in school feeding and pre-school nutrition programs in developing countries. The program helps ensure that children attend and remain in school, that childhood development and achievement are improved, and that an important contribution is made to more self-reliant, productive societies.

****

The prevalence of the poor in rural areas—and within agriculture there—and the role of poverty as a driving force in undernutrition and HIV/AIDS make for desperately adverse interactions between agriculture and the pandemic. Many of those interactions have been summarized here, although more will most certainly be learned about in the future unless the spread of HIV/AIDS can be sharply curtailed. Losses in agriculture because of HIV/AIDS can only diminish that prospect.

Part V – Program Suggestions and Concluding Comments

Proposals, or program suggestions

How might agriculture, nutrition, and health programs be better coordinated, designed, and administered jointly, so that the whole is truly greater than the sum of the parts? What specific programmatic suggestions might be made? The following are submitted for initial consideration. The integration of gender considerations is anticipated by each one.

These program suggestions are derived directly from the analysis of this paper and represent attempts to respond to its findings. An advantage of several is that they also build from existing agricultural program mainstreams of USAID to exploit connections with nutrition and health. The main recommendations (#2 and #3 below) resulted from asking a collateral question: "Is there a free market, competitive, project funding mechanism available that could successfully harness agriculture, nutrition, and health?"

1. **That State Department and USAID policy makers at the highest levels in Washington, and at the regional and mission levels, promote cross-sector policies** that support results-oriented collaboration among agriculture, health and nutrition projects, particularly related to HIV/AIDS.

2. **That a Fund for Agriculture, Nutrition, and Health Collaboration be established** so that projects, policies and strategies demonstrating the agriculture/nutrition/health connection will be rapidly funded and implemented. This fund will include private sector cooperation, for example, with foundations and businesses interested in cross-sector problem solving. It will be a headquarters-based, competitive grants mechanism; and proposals will be encouraged at the mission level to fund results-based projects, policies and strategies capitalizing on the agriculture/nutrition/health connection. Benefits of collaborative ventures will be expected to be greater than the sum of their parts. Flexibility concerning multi-period funding will provide the ability to address short- and long-term challenges (including research). Gender analysis of project planning, implementation, and evaluation activities will pervade all proposals. Individual projects will empower women, be sustainable, and be accompanied by agricultural/nutrition/health training components.

3. **That priorities of the Fund focus on**:

    a) **Efforts to stimulate synergies between existing projects.** For example, the Bean/Cowpea Collaborative Research Support Project (CRSP) introduced nitrogen-fixing cropping systems to an area in an attempt to improve soil fertility, incomes, and productivity. An NGO worked on undernutrition and improved weaning foods in the same area. Beans and cowpeas are protein-rich and offer some micronutrients that are deficient in diets. To combine efforts and reinforce the goals of the two entities, social marketing tools and new recipes stimulated consumption of enriched, hand milled weaning foods.

b) **Projects where a health-nutrition buy-in to an existing or proposed agricultural sector project can leverage resources for greater impact.** For example, ACDI/VOCA's Agricultural Cooperatives in Ethiopia program has undertaken a three-year awareness and prevention initiative to address the human resources and capital impacts of HIV/AIDS on cooperatives, an ideal pre-existing audience for HIV/AIDS and nutrition programming. The program will use a "train the trainer" approach and the total co-op membership reached will be 426,886, ultimately serving a family member population of approximately 2.5 million people.

c) Initiatives that improve farm productivity toward the goals of raising rural incomes and nutrition levels and reducing vulnerability to disease. The USAID agriculture strategy should more effectively articulate the potential of programs addressing the agriculture-nutrition-health linkage to reduce poverty, raise household incomes, improve nutritional status, and address the HIV/AIDS pandemic. Larger complementary benefits and cost reductions can be anticipated from an integrated approach than from piecemeal approaches to agriculture, nutrition, and health. In this scenario, agricultural production-oriented programs will be accompanied by health and nutrition training; by addressing gender constraints to production, income earning, and household nutrition; and by sustainable improvements in existing farming systems. Prior assessments of the causes and consequences of undernutrition and HIV/AIDS will be conducted in target areas to frame projects that maximize the agriculture-nutrition-health connections.

d) Research and technology transfer undertakings involving the fortification through biotechnology of staple foods and vegetable crops already being consumed by the rural poor (particularly cassava, common beans, indigenous vegetables, maize, potato, rice, sorghum and millet, sweet potatoes, tomato, and wheat). Biotechnology will be used to increase the absolute amounts of micronutrients in the edible portions of food commodities without losing on-farm productivity--indeed, by raising productivity. Commodity and farming systems selections will be made considering implications for gender, given its significant effects on labor availability, production, and harvest. With USAID's support of the Future Harvest Centers, other International Agricultural Research Centers (IARCs), and the CRSPs, promising biofortification work is already underway. Additional resources should be committed for these initiatives, especially for their transfer and application so human health and nutrition are ultimately improved.

e) Highly skilled assessments of public policies in agriculture that will ultimately improve nutrition and help rural families cope with the impact of the HIV/AIDS pandemic. Public agricultural policies in developing nations' do not uniformly contribute to the resiliency of rural families impacted by HIV/AIDS. Imaginative modifications will be recommended and sought in extant policies that make them more supportive of the present challenges of agriculture, health and nutrition. For example, land tenure policies in West Africa most adversely affect spouses of deceased male head-of-household members, essentially preventing them from inheriting family land. Trade restrictions, export taxes, overvalued exchange rates, managed commodity prices, and the like in much of Africa and other parts of the developing world have predisposed agriculture, and the populations it supports, to poverty, undernutrition, poor health, and HIV/AIDS. Adverse gender effects of public policies will merit especially careful study.

f) Institutional strengthening projects to revitalize rural support services. Support services are a vital part of the fight against low agricultural productivity, undernutrition and HIV/AIDS in developing countries, but they are notoriously weaker in rural than urban areas. Public sector professionals dealing with agricultural extension, education, research, credit, marketing and other services have been compromised by the epidemic. They are essentially absent from more remote and less accessible rural areas. The equitable access by women to rural support services is particularly vital, given their multiple, demanding roles in support of extended families.

Two options will be pursued to help remedy this situation. First, networks of agricultural institutions, NGOs, and farmers' organizations, together with potential partners in AIDS and public health, will be supported to coalesce efforts and forge new partnerships for concerted work in rural areas. Second, public sector institutions, including particularly education, extension, and research organizations, will take "hard looks" at their recruitment practices, personnel replacement, training strategies, and employment benefits in the face of the HIV/AIDS pandemic. Support will be provided to implement needed institutional changes and strengthening.

g) **Mechanization: addressing directly the shrinkage in agriculture's labor pool, particularly in Africa**. The greatest burden of HIV/AIDS falls on agricultural labor, producers and laborers, particularly women. In Sub-Saharan Africa, AIDS deaths and disease have strangled the sector by reducing the labor pool, with a multitude of related effects—land abandonment, soil fertility losses, pest and disease outbreaks, the neglect of essential cultural practices, and significant income and production losses in rural communities.

The options available to help address this problem are two. One involves farm enterprise shifts that reduce requirements for labor. Another, deserving more investigation, design, and experimentation, involves replacing human labor with animal and mechanical sources of power. Lightweight plows that can be used by women and youth, as well as lightweight cotton planters that can be drawn by donkeys, are two examples cited in the literature. Through this recommendation, USAID will support further study of viable alternatives and designs, as well as validation trials. The Agency is especially well positioned among donor organizations to call on commercial sector manufacturers to assist with scaling up, transferring and applying findings to help solve this problem.

h) "Relief to Development" strategies that include Title II, Health, Agriculture, CRSP and Education programs. Where disaster has struck in the developing world, relief without development is not usually sustainable, and development without relief is just not feasible. Therefore, USAID has adopted "relief to development" strategies that progress along a continuum of effort. AIARD recommends that relief to development include improving the health and nutrition of people as a primary goal. It will start with Title II Programs, but then progress unfailingly to include agriculture, health and nutrition development programs to ensure the sustainability of the development effort (and the betterment of the human condition). Indicators for meeting this target will be fully consonant with those of the Fund, i.e., increasing farm production and income, reducing the prevalence of underweight children, raising the proportion of the population below the minimum level of dietary energy consumption, and preventing and mitigating the effects of the HIV/AIDS pandemic[39].

[39] Additional programmatic suggestions were considered. However, most were judged to be of lower priority, or to be covered potentially by the suggestions made above. They included, for example, bridging the rural poor, especially children, to the time when fortified foods become more generally available through supplemental feeding programs; developing weaning foods for children; raising productivity and reducing costs of non-traditional (non-staple) crops and livestock commodities, with particular nutrition potential; providing HIV/AIDS prevention, care, and mitigation services in previously underserved and more remote rural areas; and innovating an acceptable methodology and protocol for measuring the depth and extent of zinc deficiency in humans.

The paper's chief conclusions

This paper has attributed a vital role to agriculture in addressing undernutrition and the devastation of the HIV/AIDS pandemic in developing countries. The preceding specific recommendations for cross-sector investments illustrate how that vital role can be played and are consistent with the 10 chief conclusions of this paper:

- poverty is principally a rural problem in the developing world;
- undernutrition and HIV/AIDS are closely associated with rural poverty;
- rural poverty is a problem of the poverty of agriculture in developing nations;
- therefore, improvements in agriculture have a strategic role to play in combating poverty, undernutrition, and HIV/AIDS;
- yet, agriculture is not being used as a primary tool to combat undernutrition and HIV/AIDS—and it must be;
- the social costs of undernutrition are immense: they are a consequence of nutrition's impacts on a country's productivity, growth, work force, the cognitive development of children, and the overall health status of the population;
- existing micronutrient deficiencies reflect ironic past trends in agriculture, but promise to be dealt with most cheaply and sustainably through the biofortification of plant and animal species found in the agricultural sectors of developing countries;
- convincing evidence also exists which shows that poor nutrition affects adversely the sexual and mother-to-child transmission of HIV/AIDS, as well as the progression and the mortality rates of the disease; furthermore, immune system impairment from HIV/AIDS leads to undernutrition which leads to the worsening of HIV;
- the sensitivity of agrarian societies to shocks of all kinds, including droughts and poor rainfall distributions that spark famines, appears to have been increased as a result of HIV/AIDS in the developing world; and
- the pandemic has moved faster than expected and Africa is carrying the burden of the disease worldwide, as are the poor, rural areas, and agriculture, principally through the shrinkage of the agricultural labor pool; these losses in agriculture will only further diminish the prospects of arresting and eliminating HIV/AIDS.

References

AED. 2001. Improving the Nutrition Impacts of Agriculture Interventions: Strategy and Policy Brief. Washington, D.C.: FANTA. FANTA Project materials can be accessed through www.fantaproject.org.

Alderman, H., J. Hoddinott, and B. Kinsey. 2002. Long-term consequences of early childhood malnutrition. This is a draft document of IFPRI, Washington, D.C.

AVRDC. 2003. AVRDC strikes gold with vitamin-rich tomato. Centerpoint. Accessed through www.avrdc.org/centerpt.

Barnett, T., and A. Whiteside. 2002. AIDS in the 21st Century: Disease and Globalization. New York: Palgrave Macmillan.

Bollinger, Lori and John Stover. 1999. The Economic Impact of AIDS. Glastonbury, CT: The Futures Group International.

Bonnard, Patricia. 2002. HIV/AIDS Mitigation: Using What We Already Know. Technical Note No. 5. Washington, D.C.: FANTA.

Bouis, H.E., R.D. Graham and R.M. Welch. 1999. The CGIAR Micronutrients Project: Justification, history, objectives, and summary of findings, an IRRI-hosted IFPRI Workshop, Improving Human Nutrition through Agriculture: The Role of International Agricultural Research. Los Baños, Phillipines: IRRI.

CGIAR. 2001. Biofortification: A Proven Concept. Food and Nutrition Bulletin, Vol. 21, No. 4, December.

Chakravarty, I., and R.K. Sinha. 2002. Prevalence of micronutrient deficiency based on results obtained from the National Pilot Program on control of micronutrient malnutrition. Nutrition Reviews Vol. 60, S53-S58.

Chen, C, L.S. Schilling, and C.H. Lyder. 2001. A concept analysis of malnutrition in the community. Journal of Advanced Nursing, Vol. 30, pages 131-42.

CIAT and IFPRI. 2003. Biofortified crops for improved human nutrition. Washington, D.C.: IFPRI.

Cohen, Joel I., ed. 1999. Managing Agricultural Biotechnology: Addressing Research Program Needs and Policy Implications. The Hague, Netherlands: the International Service for National Agricultural Research (ISNAR) in association with CABI Publishing.

Daley, Tamara C., Shannon E. Whaley, Marian Sigman, and Charlotte Neumann. 2002. The Flynn Effect in Rural Kenya. Research Brief 02-03-CNP. Global Livestock Collaborative Research Support Program. Davis, California.

de Janvry, Alain and E. Sadoulet. 2000. Assessing the Impact of Agricultural Research on Poverty Alleviation, eds., Douglas Pachico, Reed Hertford, and Alain de Janvry. Food Policy, 25 (4), August.

Del Rosso, J.M., and T. Market. 1996. Class action: Improving school performance in the developing world through better health and nutrition. Washingon, D.C.: World Bank.

Demment, Montague W., Michelle M. Young, and Ryan L. Sensenig. 2002. Micronutrients: A Key to Human and National Development. Davis, California, University of California.

de Onis, M., E.A. Frongillo, and M. Blossner. 2000. Is malnutrition declining? An analysis of change in levels of child malnutrition since 1980. Bulletin of the WHO, 78, pages 1222-33.

de Waal, Alex and Joseph Tumushabe. 2003. HIV/AIDS and Food Security in Africa. Unpublished report.

de Waal, Alex and A. Whiteside. 2003. HIV/AIDS, food crisis and governance: 'New Variant Famine' in Southern Africa. This is a draft technical background paper of a forum cited by Loevinsohn and Gillespie, 2003b.

Drimie, S. 2002. The Impact of HIV/AIDS on land: Case studies from Kenya, Lesotho, and South Africa. Harare, : FAO, Southern African Regional Office.

du Guerny, Jacques. 2002a. Meeting the HIV/AIDS Challenge to Food Security. New York and Rome: UNDP and FAO.

du Guerny, Jacques. 2002b. Agriculture and HIV/AIDS. New York, New York: UNDP, South East Asia HIV and Development Project.

Eldridge, C. 2002. Why was there no famine following the 1992 Southern African drought? IDS Bulletin, Vol. 33 (4), pages 79-87.

Engh, Ida-Eline, Libor Stloukal, and Jacques du Guerny. 2000. HIV/AIDS in Namibia: The impact on the livestock sector. Rome, Italy: FAO, Sustainable Development Department.

Fogel, R.W. 2002. The impact of nutrition on economic growth. Washington, D.C.: PAHO.

FAO. 2002a. The socioeconomic impact of HIV/AIDS on rural families. Rome, Italy: FAO.

FAO. 2002b. Progress in reducing hunger has virtually halted. Rome, Itlay. Accessed through www.fao.org/english/newsroom/news/2002/
9620-en.html.

FAO. 2002c. Living well with AIDS. Rome, Italy: FAO

FAO. 2001. FAO State of Food Insecurity 2001. Rome, Italy: FAO.

FAO. 1994. What has AIDS to do with agriculture? Rome, Italy: FAO.

FAO/UNAIDS. 2003. Addressing the impact of HIV/AIDS on ministries of agriculture: focus on eastern and southern Africa. Rome, Italy: FAO, Sustainable Development Department.

FAO/UNAIDS. 2000. Sustainable Agriculture/Rural Development and Vulnerability to the AIDS Epidemic. Rome, Italy: FAO.

Friis, H., and K.F. Michalesen. 1998. Micronutrients and HIV infection: A review. European Journal of Clinical Nutrition, Vol. 52, pages 157-63.

Gari, J.A. 2003. Agrobiodiversity strategies to combat food insecurity and HIV/AIDS impacts in rural Africa; Advancing grass roots responses for nutrition, health and sustainable livelihoods. Rome, Italy: FAO

Gillespie, Stuart. 1989. Land use policy. Rome, Italy: FAO.
Gillespie, Stuart and Lawrence Haddad. 2002. Food Security as a Response to AIDS. IFPRI Annual Report Essay. Washington, D.C.: IFPRI.

Gillespie, S., Lawrence Haddad, and Robin Jackson. 2001. HIV/AIDS, Food and Nutrition Security: Impacts and Actions. Washington, D.C.: IFPRI.

Glahn, Raymond P., Zhiqiang Cheng, and Ross M. Welch. 2002. Comparison of iron bioavailability from 15 rice genotypes: studies using an in vitro digestion/Caco-2 cell culture model. Journal of Agricultural and Food Chemistry, 20, 3586-91.

Glewwe, P., and H.G. Jacoby. 1999. Early childhood nutrition and academic achievement: A longitudinal analysis. Food, Consumption, and Nutrition Division Paper No. 68. Washington, D.C.: IFPRI

Harrell, R.F. 1946. Mental response to added thiamine. Journal of Nutrition, 31, pages 283-98.

Harvey, Paul. 2003. HIV/AIDS: What are the implications for humanitarian action? A literature review. London, England: Overseas Development Institute, Humanitarian Policy Group, preliminary draft.

Hertford, R. 2001. Poverty in Mesoamerica. Unpublished paper for the TAC/CGIAR and FONTAGRO. Washington, D.C.

Hertford, R., and Rafael Echeverri. 2003. Pobreza en Centro América, con énfasis en la rural. Submited for publication to the Inter-American Development Bank.

Horwood, David. 2002. Making more of micronutrients in staple foods. Available at www.IFPRI.cgiar.org. Australia: ACIAR.

International Fund for Agricultural Development/FAO. 2003. Labor constraints and the impact of HIV/AIDS on rural livelihoods in Bondo and Busia Districts, Western Kenya. Rome, Italy: FAO.

IFPRI. 2003. Food for Education. Washington, D.C.: Future Harvest.

Johnson-Welch, Charlotte. 1999. Focusing on Women Works: Research on Improving Micronutrient Status through Food-Based Interventions. Washington, D.C.: International Center for Research on Women.

Levin, Carol E., Jennifer Long, Kenneth R. Simler, and Charlotte Johnson-Welch. 2003. Cultivating Nutrition: A Survey of Viewpoints on Integrating Agriculture and Nutrition. IFPRI/FCND Discussion Paper No. 154. Washington, D.C.

Lieberum, Maren. 2002. Labor saving practices and technologies to address labor constraints imposed by HIV/AIDS. Materials are the result of a meeting conducted in June is Nyanza and Western Provinces, Kenya by the Government of Japan and FAO.

Loevinsohn, Michael and Stuart Gillespie. 2003a. HIV/AIDS, Food Security and Rural Livelihoods: Understanding and Responding. Washington, D.C.: IFPRI and ISNAR.

Loevinson, Michael and Stuart Gillespie. 2003b. HIV/AIDS and the Food Crises in Southern Africa: An Agenda for Action Research and for Learning How to Respond. Washington, D.C.: IFPRI and ISNAR.

MacDonald, B., L. Haddad, R. Gross, and M. McLachlan. 2000. Nutrition: Making the Case—Fourth Report on the World Nutrition Situation. Washington, D.C.: IFPRI.

Mackey, M.A. 2000. Improving nutrition and reproductive health: The importance of micronutrient nutrition. Micronutrient Initiative. Ottawa, Canada: International Development Research Center.

Maziya-Dixon, B., et.al. 2001. Genetic variation for total carotene, iron, and zinc content in maize genotypes and cassava clones. Food and Nutrition Bulletin (Special Edition), 21 (4), December.

Mendez, M.A., and L.S. Adair. 1999. Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood. Journal of Nutrition, 129, pages 1555-62.

Natsios, Andrew. 2003. The Strategic Importance of Development Assistance in the New Millennium. Foreign Operations Subcommittee Hearing. Washington, D.C.

Ncube, N.M. 1999. The impact of HIV/AIDS on smallholder agricultural production in Gweru, Zimbabwe, and coping strategies, in Matangadur, G., H. Jackson, and D. Mukarzita, eds. AIDS and African Smallholder Agriculture. Harare.

Neumann, Charlotte G., Nimrod O. Bwibo, Suzanne P. Murphy, Marian Sigman, Shannon Whaley, Lindsay H. Allen, Donald Guthrie, Weiss, Robert E., and Montague W. Demment. 2002. Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. Global Livestock CRSP, University of California, Davis, California.

Neumann, Charlotte G., Nimrod O. Bwibo, Suzanne P. Murphy, Marian Sigman, Shannon Whaley, Lindsay H. Allen, Donald Guthrie, Robert E.
Onyango, A., K. Koske, and K.L. Tucker. 1998. Food diversity versus breast-feeding choice in determining anthropometric status in rural Kenya toddlers. International Journal of Epidemiology, 27, pages 448-89.

Oikeh, Sylvester O., Abebe Menkir, Bussie Maziya-Dixon, Ross Welch, and Raymond P. Glahn. 2003. Assessment of concentration of iron and zinc and bioavailable iron in grains of early-maturing tropical maize varieties. Journal of Agricultural and Food Chemistry, 21.

Pelletier, D.L. 1994. The relationship between child anthropometry and mortality in developing countries: implications for policy, programs and future research. Journal of Nutrition, 124 (Supplement).

Persley, G.J., and M.M. Lantin, eds. 2000. Agricultural Biotechnology and the Poor: Proceedings of an International Conference, Washington, D.C., 21-22 October 1999, Consultative Group on International Agricultural Research.

Piot, Peter, Per Pinstrup-Andersen, Stuart Gillespie, and Lawrence Haddad. 2002. AIDS and Food Security. IFPRI Annual Report Essay. Washington, D.C.: IFPRI.

Piwoz, E., and E. Prebel. 2000. HIV/AIDS and nutrition: A review of the literature and recommendations for nutritional care and support in Sub-Saharan Africa. SARA Project. Washington, D.C.: USAID.

Ramakrishnan, U. 2002. Prevalence of micronutrient malnutrition worldwide. Nutrition Reviews, 60, pages S36-S52.

Ranum, P. 2001. Solving micronutrient deficiency problems. Cereal Foods World, Vol. 46, 441-43.

Ruel, M. 2001. The natural history of growth failure: Importance of intrauterine and postnatal periods. In Nutrition and Growth, ed., R. Martorell and F. Haschke. Nestle Nutrition Workshop Series, Pediatric Program, Vo. 47. Philadelphia, PA: Nestec Ltd., Vevey/Lippincott Williams & Wilkins.

Ruel, M., and H. Bouis. 1998. Plant breeding: A long-term strategy for the control of zinc deficiency in vulnerable populations. American Journal of Clinical Nutrition. 68 (2S), 488S-494S.

Stillwaggon, E. 2002. HIV/AIDS in Africa: Fertile Terrain. Journal of Development Studies Vol. 38 (6), pages 1-22.

Tomkins, A. 2002. Nutrition and HIV: A Briefing Document prepared for the SCN Working Group on Nutrition and HIV. A draft document cited in Loevinsohn and Gillespie, 2003b.

Trigo, Eduardo J., Greg Traxler, Carl E. Pray, and Ruben G. Echeverría. 2002. Biotechnología agrícola y desarrollo rural en América Latina y el Caribe. Washington, D.C.: Inter-American Development Bank.

UN ACC/SCN. 2000. Fourth Report on the World Nutrition Situation. Geneva: UN ACC/SCN in collaboration with IFPRI.

UNAIDS. 2003. Epide. Accessed at www.unaids.org/publications/ documents/epidemiology.

UNAIDS. 1996. HIV/AIDS: the Global Epidemic. New York, NY: UNAIDS.

UNAIDS and WHO. 2001. AIDS epidemic update. Geneva, Switzerland: UNAIDS.

Welch, Ross M. 2002a. The impact of mineral nutrients in food crops on global human health. Plant and Soil, 247, pages 83-90.

Welch, Ross M. 2002b. Breeding strategies for biofortified staple plant foods to reduce micronutrient malnutrition globally, Howarth E. Bouis, ed., Special Symposium Publication of the American Society for Nutritional Sciences, Plant Breeding: A New Tool for Fighting Micronutrient Malnutrition.

Welch, R.M., and R. D. Graham. 1999. A new paradigm for world agriculture: meeting human needs—productive, sustainable, nutrition. Field Crops Research, 60, pages 1-10.

White, J., and E. Robinson. 2000. HIV/AIDS and rural livelihoods in southern Africa. Policy Series 6. Chatham, England: Natural Resource Institute.

WHO. 2002. The world health report 2002, Reducing risks, promoting healthy life. Geneva, Switzerland: WHO.

WHO. 2001. WHO Report CH3: Iron deficiency anemia. New York, NY: WHO.

Williams, J.H., T.D. Phillips, P. Jolly, and J. Styles. 2002. Preventing Aflatoxicosis in Humans in Developing Countries. Draft paper of the Peanut Collaborative Research Support Program, University of Georgia, Griffin, GA.

World Bank. 2001. World Development Report, 2000/2001: Attacking Poverty. Washington, D.C.: World Bank.

World Bank. 1997a. Confronting AIDS: Public Priorities in a Global Epidemic. Oxford, England: Oxford University Press.

World Bank. 1997b. Jamaica, Ministry of Agriculture and Mining, Agricultural Support Services Project, Annex 10. Washington, D.C.: World Bank.

Yamano, T., and T.S. Jayne. 2003. Measuring the Effects of Prime Age Adult Mortality in Kenya. Staff Paper 2002-26. Department of Agricultural Economics, Michigan State University, accessed through httt://www.aec.msu.edu/agecon/fs2/Kenya/.