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A Review of "Developing Sustainable Agriculture in the Third World: Lessons from Indo-U.S. Experience"

by

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Developing Sustainable Agriculture in the Third World: Lessons from Indo-U.S. Experience

Richard R. Harwood

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OVERVIEW

Although this thoughtful paper may be of interest to policymakers with a philosophical bent, it is probably of more use to academic theoreticians. Harwood's main purpose is to argue for the realignment of development projects "with the sound principles of agricultural evolution" (p. 19). Those who feel comfortable with Harwood's five stage model of agricultural evolution (which starts at the subsistence stage and ends up with "post-industrial" agriculture) may be able to get something out of this article. Those who are less sure about the state of our knowledge of how and why agricultural patterns change from one society to another are likely to remain in a puzzled state throughout the 29 pages of Harwood's essay.

HIGHLIGHTS OF PAPER

The "sustainability" agenda for agriculture

Harwood's principal concern in this paper is to delineate ways in which the United States can help India develop a "sustainable" agriculture. Sustainability, in this context, means essentially the development of an agriculture which is both efficient at production and sparing in its use of techniques which degrade the environment. As used by Harwood, the sustainability agenda is really a call for the inclusion of new goals in public policy towards agriculture beyond those normally identified in neo-classical economic theory.

According th Harwood, Western Development specialists tend to overlook the costs associated with highly mechanized industrial input intensive methods because they are unaware of the evolutionary nature of agriculture. Thus, they often advocate "industrial stage" solutions to problems of societies whose agricultures are at the earlier "participatory, commercial stage."

Although this framework might seem to be to abstract to have any policy relevance, the lessons drawn by Harwood from all this are not far removed from mainstream thought. Specifically, he says that public policy towards agriculture should:

- be cognizant of the need to conserve soil and water resources as well as the genetic base of plants and farm animals;
- promote gradual and predictable social changes
- aim to value resources at their long-run costs
- correct for externalities

Actually, as is evident from this list, a large amount of Harwood's agenda could readily be justified on straight efficiency terms. His concerns about limiting soil erosion, maintaining groundwater potability and promoting sound cropping practices could indeed justify state intervention under standard neo-classical theory on the grounds that it is the government's responsibility to make sure that externalities are reflected in market practices. A few other items that crop up in the paper (animal rights, organic fertilizers, etc...) may, however, have shakier economic justifications.

Conclusion

The last ten pages of the article are devoted to a discussion of possible areas for profitable collaboration between the U.S. and India. Those wishing to bypass the earlier theoretical discussion can start reading on page 19 without much loss. According to Harwood, the U.S. has a lot to offer to India in the areas of monitoring soil and groundwater contamination. Other possible areas for cooperation include: nitrogen fixation research, the provision of genetically improved fodder varieties and low-cost livestock feed, and forestry.

DRAFT

DEVELOPING SUSTAINABLE AGRICULTURE IN THE THIRD WORLD: LESSONS FROM INDO-U.S. EXPERIENCE

Richard R. Harwood

The paradigm and directions of agricultural development are going through rapid evolution in the 1980s in response to a multitude of forces. For lack of a better term the words "sustainable agriculture" are commonly used to identify this new sector form and substance. Definition is confounded by the nature of agriculture being one of evolution along differing pathways in each country. We thus confront multiple, moving targets. The agricultural development agency of the future must have both a considerable awareness of the scope of a sustainable agriculture and the process by which it is defined. Development assistance will then depend on a careful targeting of limiting factors.

DEFINITION

A workable definition of sustainable agriculture is **an agriculture which has the ability to evolve indefinitely toward greater human utility** (including, for the foreseeable future, increased production), **greater productivity** (increased efficiency of resource use), **and a more stable balance with an environment which is favorable to both humans and to the majority of other species.**

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It is acknowledged that this definition is heavily value-laden, but of necessity it must include social agenda if it is to accurately reflect the real-life situation of development. One must be acutely aware of unease and even conflict within the scientific community over such a definition. The ongoing debate over the boundaries of "true" scientific inquiry would have the Bertrand Russell "school" of analytical analysis decrying such nonscience while the A. N. Whitehead integrative systems analysts would feel more comfortable. Many widely accepted social goals of agriculture have been articulated by U.S. scholars (Leopold, 1948; Aiken, 1978; Berry, 1978; O'Niell, 1986; Thompson, 1986). A more specific ongoing controversy involves the boundaries set by neoclassic economics with its focus on market forces and analysis. That these boundaries are broadening to include factors exogenous to present markets (Bonnen, 1987) is heartening. In short, a working definition of sustainable agriculture is proposed which can serve as a framework for policy formulation and scientific input. It will have the support in principle of a growing segment of the scientific community. More importantly, it is consistent with the parameters of an emerging social and political agenda for development.

But our definition is still generic. In order to understand the process by which it is translated into substance in any given country, one must have at lease some sense of public agenda, the translation of that agenda into policy, and the roles of agenda and policy in the development process.

A PUBLIC AGENDA FOR AGRICULTURAL DEVELOPMENT

Public agenda is the accumulation of issues around which debate and concern occur. The actors include a plethora of individuals, social groupings, institutions, government agencies, and power brokers. Issues achieve agenda status when they receive widespread and continuing recognition. Public agenda items then receive policy status when they receive official (government) sanction in the form of law, funding or other official pronouncement or action. It is useful to group

agricultural development agenda items into the following five categories (with examples of frequently heard specific concerns):

1. Increase the utility of agriculture
   - maintain adequate production
   - provide adequate livelihood (considering equity, stability, safety, lifestyle) for desired number of participants
   - provide food of acceptable quality and diversity (pesticide-free, low heavy metals, less fat, good flavor, less processing, storage without preservatives, eliminate cosmetic quality standards, eliminate prophylactic use of antibiotics in animal feed, regulate synthetic hormone use)

2. Increase productivity
   - develop more productive biotypes (with pest resistance, tolerance to adverse conditions)
   - maintain soil organic matter, tilth
   - maintain crop diversity
   - practice rotations
   - use of integrated animal/fish/crop/tree systems
   - practice nutrient cycling

3. Maintain an environment favorable to humans and the majority of other species
   - protect groundwater from contamination
   - reduce or eliminate the use of pesticides
   - reduce use of synthetic fertilizers
   - encourage wildlife maintenance
   - recognize animal rights (reduce stress in confinement, etc.)

4. Assure the ability to evolve indefinitely
   - minimize soil loss (from erosion, conversion to nonagricultural use)
   - stop overdraft of fossil groundwater
   - reduce energy use (especially of fossil fuels)
   - develop better technologies for biological nitrogen fixation

- develop perennial cereals
- maintain existing genetic diversity

5. Develop agricultural macro structure consistent with national agenda
   - create adequate physical and institutional infrastructure
   - develop market channels which respond to both market and ocial needs
   - manage corporate activities which may control portions of the agricultural sector
   - monitor (or manage) land ownership (land is usually considered to be a quasi-public resource)

Recognition of these points is given or implied in the above definition of sustainable agriculture. Most of the five categories are recognized in a current definition by TAC (1988):

> "sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation"

USAID, in its most recent iteration (Committee on Agricultural Sustainability for Developing Countries, December 18, 1987) avoids a specific definition but identifies a lengthy list of parameters which fall into the five suggested categories.

The agenda listing here is purposefully broad to include most possible items. In reviewing the agenda in most countries where debate is prevalent the concerns are remarkably similar. The priorities obviously change with resource base, stage of agricultural development, and national politics. The consistency and speed with which particular items reach policy status depends on the size and influence of the proponent group, the perceived seriousness of the problem, and government responsiveness. Those relationships are largely mysterious, even here in the United States. They are to some extent influenced by

prominent events (a pesticide spill, farm bankruptcies or major disasters).

The most prominent and perhaps the issue of greatest public emotional appeal is that of chemical contamination. Volumes have been written as part of the public agenda, spurred on by such disasters as the Bhopal, India spill (Aggarwal et al., 1985; Postel, 1986, 1987). Many countries have elevated public concern over chemical contamination to policy status, while some, such as Indonesia, have taken more drastic steps by reducing the pesticides permitted for use on rice (Postal, 1987).

Within scientific circles alternative farm development strategies are now under debate. The ecological approach to systems structure, termed agroecology (Altieri, 1987, Dover et al., 1987) is one of the more complex. Low input agriculture (Harwood, 1987) is a current buzzword. Crop and animal diversification both within the farm and within regions is often seen as a way to stabilize and increase incomes, more effectively use resources and improve farmer well-being (IIMI, 1987).

It bears repeating that development agencies must be sensitive to national public agendas, as items are often slow to be translated into policy. It is fortunate that the agendas are, for the most part, similar in makeup (Aggarwal et al., 1985; Myers, 1987). The great difficulties come in disagreement over priorities. There is today increasing priority on issues of equity, while development agencies tend to mirror the priorities (or political expediency) of their own national agenda (environmental protection, for instance, for United States agencies).

FACTORS IN THE DEVELOPMENT PROCESS

Public agenda, policy and market forces interact in complex fashion to influence agricultural development (figure 1). During the 1960s when food scarcity was a most critical issue the so-called green revolution strategy was very much production-focused, with analyses concentrating

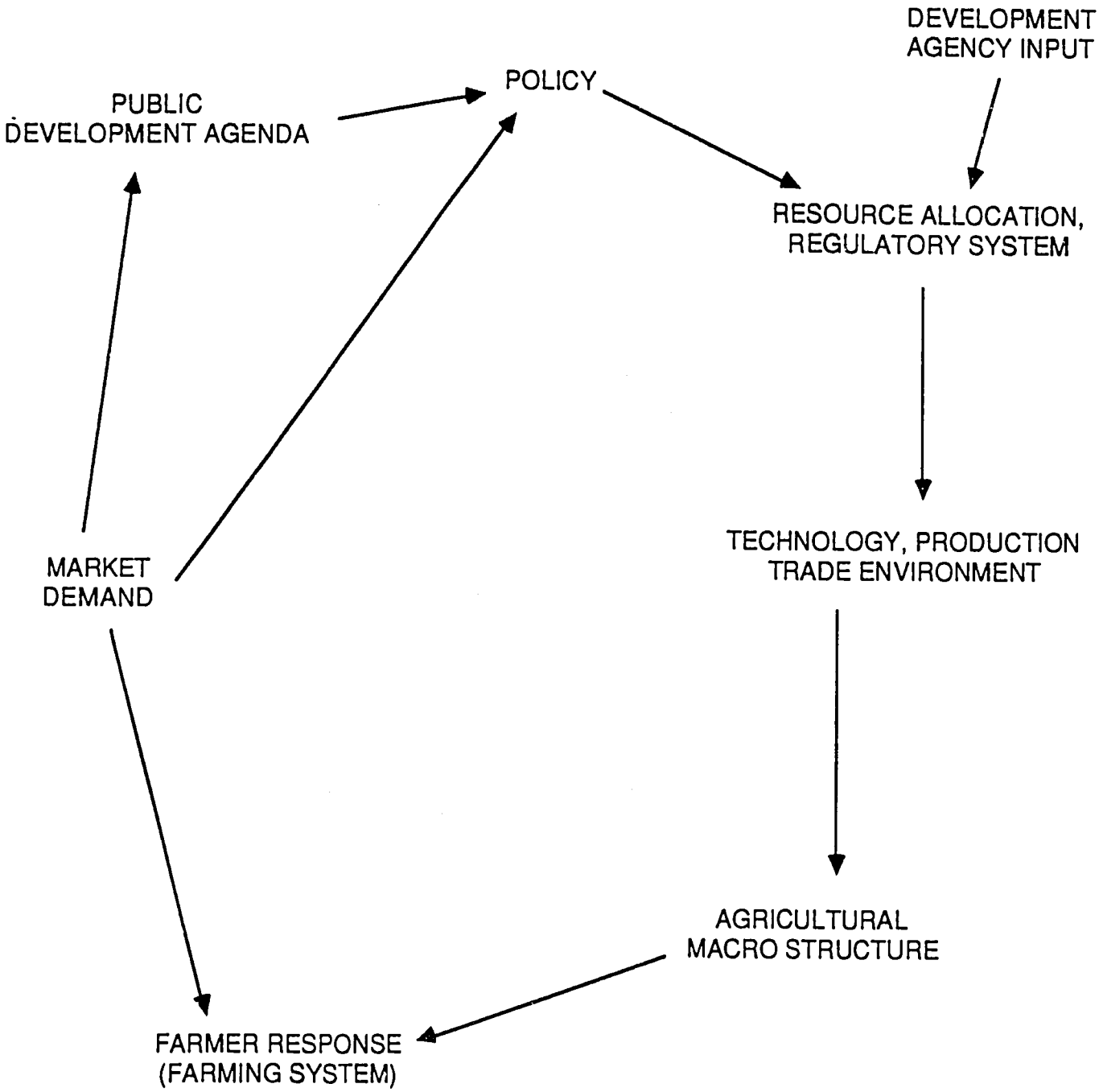


Figure 1. Factors in the development process.

on market demand (in its more narrow sense). Market was thus the primary determinant of policy. In recent years environmental and social issues have become more predominant. Some would say that this change, along with movement to a service economy and the shifting of public investment to nonproduction-related ends marks the transition to a post-industrial development stage. However stages are defined, the development agenda is usually reflective of social and economic needs.

The Influence of Development Stages

Agricultural evolution progresses through overlapping development stages. A grouping of five stages is used here for brevity. While this categorization is very rudimentary, it is useful in anticipating and understanding the prevalence of many agenda issues.

Stage 1. Subsistence

This early developmental stage often includes both hunting/gathering and husbandry for family use. Little is sold or traded. Marketing systems are either not present or are restricted to a local area, and inputs external to the village or local farming system are minimal. Within subsistence systems, hunting/gathering gives way to husbandry (the tending and management of crops or animals) as population pressure increases on a given resource base or as greater stability is desired. By implication, husbandry requires the changing and strengthening of social institutions to allocate access to resources. Major additions or changes in technology are required as husbandry becomes common.

Stage 2. Participatory, Partly Commercial

This is the beginning of a market economy. Craft specialization and some urbanization occur. Market and other institutions take form and are strengthened. A differentiated macro structure begins to form as production areas and market areas are distinguished. Production inputs begin to flow.

Most people still are involved with primary production (are farmers). Other characteristics are

- transportation system improves
- trade is mostly local
- little processing of food occurs
- few services are available
- some inputs are available

Stage 3. Participatory, Commercial

Production is largely smallholder, as more than 50% of the population is involved with primary production. One-half of the produce is sold. Other characteristics are

- transportation system is highly evolved
- trade channels are lengthened so that the producer is far removed from and has no contact with the consumer for most of his products
- processing and packaging increase
- there is maximum availability of local service
- inputs are readily available
- institutions become highly evolved with considerable public and private sector investment

Stage 4. Industrial

In this stage there is major reduction in numbers of farmers with substitution of capital for labor. The local farm service sector is markedly reduced as the fewer and larger farmers are increasingly served directly from the industrial sector (by manufacturers directly rather than by local "dealers"). Other characteristics are often

- trade channels are extremely long with fewer entry points; channels tend to be specialized by product
- production is specialized to few commodities per farm
- farmers use little if any of their own produce
- service costs are more than 80% of total product value at the consumer level
- the "global marketplace" becomes dominant

- there is lowered consumer use of primary products
- changing market structures force all farmers into an industrial mode, making it extremely difficult for small-scale producers to survive without social intervention

Stage 5. Post-industrial

Post-industrial agriculture has yet to be defined. (It is always easier to define a development stage in historical perspective.) Many sense that the changing resource base, changing social values, and a changed market structure signal a progression from industrial to something both qualitatively and quantitatively different. Some of these changes appear to be

- a stabilizing of the number of people employed in agricultural production
- the growth of food services relative to the production sector
- a shift in direction from increasing specialization to at least some degree of enterprise integration for efficiency of resource use and for stability
- a shift toward biological (genetic) control of biological processes and interactions rather than chemical control
- increase in the prevalence of social and environmental considerations in public investment in agriculture

Much conflict in the public agenda stems from dislocations and perceived social loss in the transition from stage to stage. Some could seemingly be ameliorated with understanding and planning. For instance, with industrialization of agriculture in the United States, there has been a lengthening and a narrowing of market channels that has tended to exclude remaining diversified farms. The industrialization process has thus "fed on itself," excluding farmers who could not or would not shift to production of the narrow commodity base served by local markets. Significant public expenditure and effort has subsequently gone into creation of "farmer markets" to meet both the demand for local, fresh produce and the needs of diversified local producers. A similar narrowing would be disastrous in Third World countries where industrial

agriculture (poultry, swine) often exist side by side with participatory small-scale commercial agriculture. What should the evolutionary process be for market channels in a developing nation? Which segments of Third World agriculture should industrialize and what should that model be? As we will see from the case of India the implications of that question are sobering. The stages and their characteristics are summarized in table 1.

STRUCTURAL ELEMENTS OF THE AGRICULTURAL SECTOR

The structural components (figure 2) evolve with stage of evolution in agriculture. There is always a public policy component which allocates publicly held resources or collects revenues from the various segments during the evolutionary process. These, together with regulation, are highly influential in determining structure and degree of participation as well as technology generation and geographical location. Some choose to think that development is only according to market forces, or that the public policy environment is really an extension of the marketplace. That they closely interact is evident, but it does little to help understanding or to determine the need for corrective action when they are treated as one.

The small-scale, private sector production segment evolves first. As commercialization occurs the input services sector grows to meet the demand for inputs (AI1). The growing industrial sector both provides inputs (AI2) and absorbs farm product (A06). With commercialization comes processing and the provision of secondary products (A05). As industrialization of agriculture proceeds, the industrial production sector increases, with reduction in numbers of small farmers. The input services sector then declines as the smaller number of large farmers is increasingly served directly by industry (AI4). Market channels become specialized and lengthened. Trade becomes global. In the industrial mode there is a tendency, where land resources are extensive, for industrial agriculture to export raw product and import value-added products from countries with lower wages or a more permissive regulatory climate.

Table 1. Phases in agricultural evolution and their characteristics.

	Institutional development	Public participation	Technologies
1. Hunting/gathering subsistence	minimal	entire population	biological only
2. Participatory, partly commercial	mostly local, concerned with land use; some markets starting to develop	dominant portion, increasing with population growth	mostly biological
3. Participatory, commercial	generally equal distribution of national, regional, and local levels	dominant portion but decreasing	well-developed small-scale machinery and other industrial inputs
4. Industrial	global	small number actually producing	industrial inputs substituting for biological
5. Post-industrial	blend of local regional, and global institutions based on balance of resource use efficiency and local employment needs	stable	biological controls predominant; systems interactions are intricate and quantified

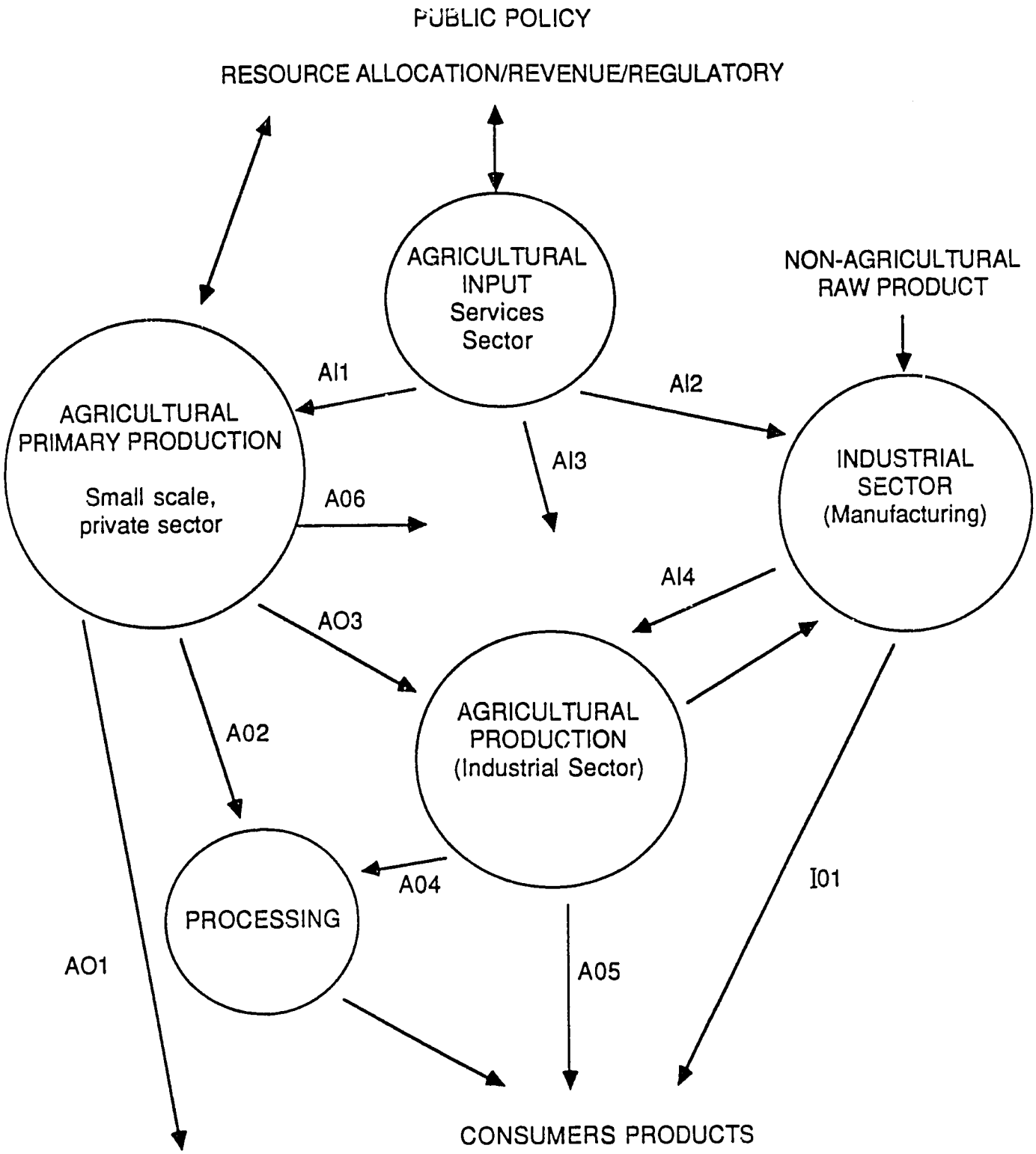


Figure 2. Structural elements of the agricultural sector.

As industry develops, an increasingly critical issue is its geographical distribution. Concentration in the greater metropolitan areas such as Bombay, Manila, Jakarta, and Bangkok create massive urban problems and leave a large rural poor with little access to off-farm income (Panayotou, 1987). Regional disparities in income are further aggravated with a resulting social instability.

While this list is not exhaustive, it includes most agenda issues. There is major concern for the future to preserve both the environment and the resource base. The reasons for agenda status are multiple. First is the perceived failure of the free marketplace to internalize environmental costs. In several instances structural evolution has led to environmental overload with seemingly no solution but to reverse a structural trend (for instance, geographical concentration of industrial poultry or cattle production with resulting unmanageable nutrient loading on surrounding farmland and contamination of both ground and surface water). There is also strong feeling that social concerns and costs are not accounted for in the evolutionary process (higher utility functions are overlooked).

Another undesirable structural trend is the shrinkage of the farm service industry with depopulation of rural towns. This was unforeseen in the United States in time to affect development of alternative industries in the towns and to prevent personal hardship, financial loss, and reduced quality of life caused by loss of services, social institutions, and a smaller tax base. In other cases the fragility of the environment was unforeseen in time to develop alternative technologies. The leaching of nutrients and pesticides into groundwater as input levels increased was unforeseen, resulting in an increasingly large portion of the United States having groundwater which is nonpotable. The magnitude and long-term impact of this problem is yet to be assessed. A major effort is being mounted to identify technologies for reducing or eliminating such contamination. The examples are endless! Many agenda items reflect concerns about the social costs of the rapid shift to an industrial stage and others reflect the unfavorable environmental impact of both structure and

technologies as industrialization proceeds. All concerns have at least some legitimate basis, and many reflect very serious problems.

SPECIAL DEVELOPMENT PROBLEMS FOR SECOND AND THIRD WORLD COUNTRIES

While the "developed" countries are feeling their way through a series of industrialization problems, other countries experience differing complicating factors. In India there is overlap of subsistence, commercial and industrial stages, bringing even more severe social and environmental stress. India began its early commercial stage of growth after independence around 1950, with rapid growth in output accompanied by increasing levels of inputs and increased commercialization.

The year 1980 marked an additional turning point with movement to full commercialization (Planning Commission, 1981; Swaminathan, 1983 as reported in Ahuja, 1987). Simultaneous with the rapid evolution of the full commercial stage is the industrialization of the poultry sector. Poultry and swine, being highly responsive to scientifically-determined rations and high-technology quarantine and health care, have major economic advantages in both vertical integration and in industrialization (large-scale, capital-intensive, even corporate ownership). These animal production segments are rapidly entering the industrial sector in India, Thailand, the Philippines, and other Asian countries. The resulting efficiencies of production practically eliminate small-scale competition. This trend has obvious tradeoffs, mostly considered by development specialists to be favorable. One social benefit of industrialization is the reduced need for public sector technology generation and extension, which is now done within the private sector. A major problem area is the lack of associated systems for handling the concentration of waste products. Regulatory processes are also not in place for monitoring antibiotic or pesticide levels in the food products.

A much more serious problem exists with the large segment of Indian society dependent on hunting-gathering or shifting cultivation.

Evolution of the commercial system brings housing and basic goods into the marketplace, requiring cash income and also creating a desire on the part of all people for consumer goods. Increasing pressure on common lands from increased population, from the need for more cash income as well as from the commercial sector has caused severe overuse, soil erosion and further loss of production to the masses of subsistence farmers that depend on them. Social institutions have not evolved to regulate access, permitting investment, use of improved technologies, and management for optimum production. The regression of this sector is probably the greatest immediate environmental challenge facing India. More will be said on this point later.

One final critical point is the susceptibility of large numbers of resource-poor rural people to environmental degradation. A decrease in water quality in rural India has major implication to rural poor people who experience shortage of water to start with.

It is very important that the development specialist understand the evolutionary process of the agricultural sector. This gives insight into reasons for concerns among those arguing for sustainability. It helps us to understand the reasons for change and how they are influenced. It helps up to tear down the "false god" of the inevitability of many of the changes and to better assess the weaknesses in the change process. Understanding and a broadened viewpoint may even give those of us engaged as "development professionals" the courage to challenge the tyranny of the marketplace and to relegate it to a more proper role as "benevolent dictator," with better reflection of social and environmental values.

Expansion of the Terms for Sustainability

Given the ongoing evolutionary process, certain sustainability factors seem to transcend stages and national boundaries:

- The requirements for protection of soil, water, and the plant and animal genetic base.

- Social changes should be gradual and predictable where large numbers of people are involved.

- Resource investment should be accumulative (to avoid wasting scarce resources in short-term investment activities).

- Public policy (resource allocation, revenue, regulation) should be consistent with orderly progression through development stages and consistent with social, economic, and environmental goals. (In the United States, short-term public policy is often in direct conflict with goals for sustainability.)

- Since structural evolution is highly determined by economic factors, it is extremely important that major resources be valued at true cost in the long run. Short-term subsidies should not determine structure, as in the United States where they have resulted in long-term inefficiencies and the need for eventual readjustment at huge social and financial costs.

- External costs should be built into market values wherever possible (industry responsibility for recycling or degrading of industrial wastes, for instance).

- Regulatory mechanisms should be evolved where market or other policy options fail to achieve desired end results.

- Evolution toward new stages of agriculture with its social and economic changes should create a pull toward better options rather than forced exodus from present activities as now often occurs. Many U.S. farmers face exclusion rather than improved options! Most developing countries cannot accept this in their own societies.

In democratic societies real care is essential in designing institutional structure to foster desired evolution. The need for national and state participation in research is one. For the most part, however,

local level participation is a key factor in any implementation. The tendency is often quite the opposite.

Farm-level Requirements for Sustainability

There seem to be several general requirements for sustainability of small farms which transcend stage and national boundary.

- Small farmers must have off-farm income, produce at least some high value products or have secondary processing enterprises if they are to escape a subsistence mode. The increased production of food or feed grains or raw product for industry on a small farm will not markedly increase small-farm income.

- Small farms, if labor is available, need diversity of enterprises for economic as well as biological stability and for efficient use of production resources.

- Crop diversity and rotation are essential for pest control, for reduction of downward movement of nutrients in soil and for significant input from biological nitrogen fixation. They are also essential for making full use of the growing season. If properly arranged, rotations lead to significant efficiencies of integration, reducing energy input per unit of output by 50% to 60% (Harwood, 1984).

- Crop diversity and integration efficiencies are most effective when livestock are either on the farm or located nearby, creating a market for quality livestock feed.

- Farm services and diverse market channels must be available at the local level to service small farmers much more so than for large farms.

A summary of production system characteristics for long-term sustainability is thus:

- Control of pests and weeds must be built into the systems rather than depend on outside intervention.

- Nutrient cycles must be as much as possible, closed.

- Farm-level diversity of production is essential.

A CREED FOR INTERNATIONAL COLLABORATION TOWARD A SUSTAINABLE AGRICULTURE

Given all of the above similarity of problems and complexity of process, Indo-U.S. collaboration should be guided by the following:

1. Public (nonproprietary) knowledge is the common property of all humankind, knowing no national boundaries. This implies
   - an obligation by farmers, scientists, and nations to freely share
   - the right of scientists and nations to free access of such information (selectively as desired)

2. The obligation of agricultural scientists to serve the well being of this clientele who are
   - farmers first
   - secondly, society through farmers

   (There is little room for scientific elitism on public monies.)

3. The ultimate right of farmers in a free society to choose their own development objectives within boundaries set by society.

4. The obligation of scientists, farmers, and policymakers to posterity in the protection of
   - the soil as a production resource
   - surface and groundwater as a common good
   - genetic diversity of plant and animal species

Development projects should be clearly consistent with sound principles of agricultural evolution. To ignore past weaknesses which are well proven is foolhardy if not irresponsible. Given the broad scope of development needs, priorities are critical.

INDO-U.S. COLLABORATION: THE SUSTAINABILITY MANDATE

The evolution of Indian agriculture is centering rapidly on the participatory commercial stage. Most projections have overestimated the net exodus from agriculture, with current evidence indicating that the agricultural work force is still increasing (Dantwala, 1987). Major problems center around incomplete adjustment to commercialization, or to the inequities between commercial sectors and those subsistence groups that have been left behind. Commercialization is progressing faster than institutions or technologies can be evolved and employed to counter side effects. In many of these areas such as in the monitoring of environmental impact, the U.S. partner has experience. In others, the problems are common and could well be jointly researched.

India's development mandate is broad, with a public agenda of concern nearly identical to that of the United States. It's priorities, as seen from the scientific and political aspects are as follows (Sharma, 1987; Ahuja, 1987, Planning Commission, 1981):

- to increase production through intensification of land use and increased productivity of the most productive land (vertical development)

- to achieve more equitable income generation for rural people

- to protect the environment and in particular marginal lands where desertification is progressing rapidly

Three thrusts or focal areas are envisioned which are highly interacting, mutually supportive, and which strike at the core of production and environmental concerns. They are summarized in figure 3. They combine areas of relevant experience in the United States with problems and needs of sustainable agricultural development in both countries.

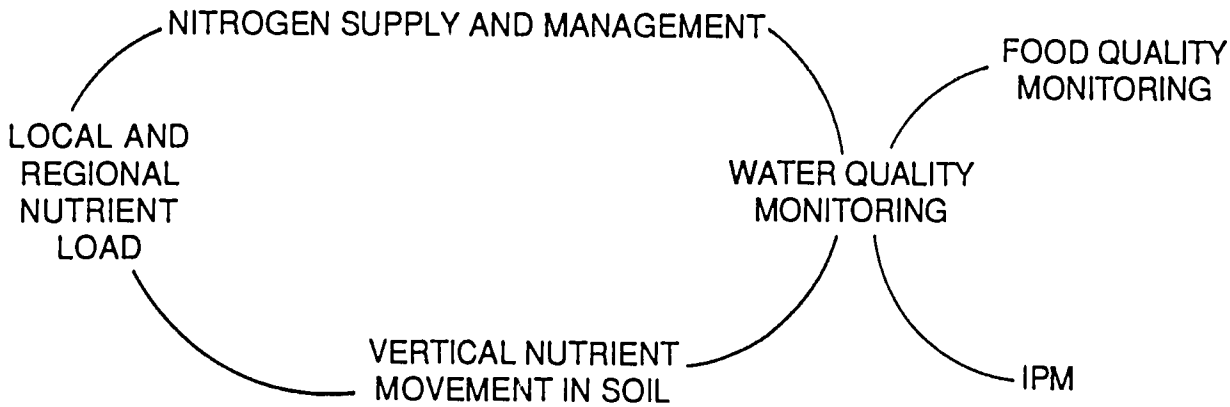
Nutrient, Biocide Management in Intensive Agriculture

As agriculture modernizes, production and environmental concerns alike focus on the supply and management of key production resources. Their source, form, quantities, and confinement within the production system are crucial to sustainable agriculture.

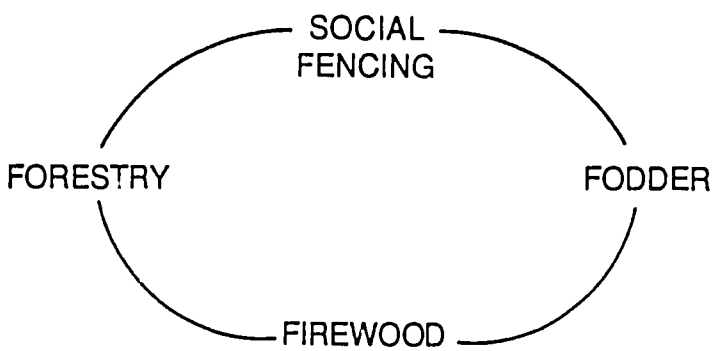
Groundwater and Surface Water Monitoring and Establishment of a Scientific Database

As commercialization and industrialization progress, there is need for a reliable database of key potential contaminants of both ground and surface water. The United States is rapidly building a massive base which indicates background levels as well as regional and local buildup. This draws attention to trouble spots for public alert as well as for corrective action. Nutrient levels, heavy metal concentrations, and biocide levels are the major targets for monitoring.

A. NUTRIENT, BIOCIDE MANAGEMENT IN INTENSIVE AGRICULTURE



B. LOW-CULTIVATION HUSBANDRY



C. STRUCTURAL ISSUES OF EVOLUTION, POLICY

LOCATION PLANNING, ASSESSMENT
MARKET EVOLUTION

Figure 3. Priority areas for Indo-U.S. collaboration in sustainable agriculture (a summary).

The importance of agricultural impact on water has been recently summarized by Hallberg (1987), noted for his work on groundwater contamination in Iowa.

> There is no longer much question that agricultural activities affect groundwater; in most technical circles, current discussions more commonly focus on how significant this contamination is and, more constructively, what can be done about it. The facts emerging from these studies of the subject raise more than concern from "environmentalists." They raise legitimate questions regarding public health, because of the contamination of drinking water; questions of economics, because of the evident inefficiency of agricultural chemical usage, to say nothing of the potential costs of health impacts and water-quality monitoring and treatment; and question of liabilities.

A nationwide monitoring system requires computerized data handling. Future management action will require a history of fertilizer and biocide use. Present Indian capabilities may well be augmented by U.S. assistance.

Research on Nutrient Loading Patterns

The United States has broad experience with localized groundwater buildup of nitrates in the Orange County area of California, in the upper Chesapeake Bay, and on a statewide basis in Iowa with considerable ongoing research in these and other areas.

A logical follow-on of the water quality monitoring would be collaborative research on nutrient loading for needed corrective action as well as predictive capability for development planning.

The Research of Nutrient Movement in Soils

Considerable attention is being paid to methods for reducing downward movement of nutrients in soils. Collaborative work in this area seems opportune. There is indication, for instance that conversion of mineral forms of plant nutrients into organic forms for incorporation into crop

rotations has not only an impact on the form and activity of soil organic matter but influences retention of nutrients in the upper soil horizons (Papendick et al., 1987; Harwood, 1984).

Long-term Fertility Research -- Nitrogen Management

There is considerable difficulty in dealing with problems of "integrated" nutrient supply (Harwood, 1987; Liebhardt, 1985). It would be far simpler and ultimately more effective to focus only on nitrogen. Here one has the advantage of working with biological fixation and the environmental contamination problem with the most mobile of nutrients. The management of nitrogen flow so necessary for a closed-system agriculture (Edens, 1982) will, for the most part, control flow of other nutrients as well. Nitrogen management could well be the "vehicle" for managing all crop nutrients and animal wastes. The process and technologies for its management will, in turn, hold other nutrients in the system. Soil erosion control will be one such activity in nitrogen management.

Projections are possible at the national and farm levels for both future nitrogen prices and value under various farm scenarios. Production costs for biological nitrogen fixation (BNF) can be projected. Recycling problems can be pinpointed. This work would tie in nicely with both water protection and soil nutrient movement research. Technology for modeling of nutrient flows is available and should be used.

Food Residue Monitoring

Technologies for monitoring pesticide, heavy metal, and other contaminant levels in food are likewise becoming highly advanced. Costs of analyses are decreasing as equipment is perfected and automated. U.S. inputs into this area would seem appropriate. To ignore such contaminants is to essentially underprice the product and to incur significant social costs.

Integrated Pest Management

This area should not be overlooked as a means of reducing use of pesticides. The work is crop- and pest-specific, and should focus on major problem areas where nonchemical methods seem appropriate. New biotechnologies hold significant long-term promise.

Low Cultivation Husbandry

Management of Degraded Lands: Social Institutions for Managing Access to the Commons

The intersect of India's major problem of rural poverty, its major sources of environmental degradation, its lack of effective utilization of a major production resource and a source of major gender inequity is the effective use of common land. Singh (1986) speaks of "common property and common poverty" and outlines a plan for transfer to private ownership. In actuality there are a multitude of situations of commons, all of which will require different solutions. Some, such as management of nomadic grazing or the interaction between tribal peoples and government ownership are so complex as to defy short-term solution.

The progression from a hunting/gathering/grazing mode to one where husbandry is practiced with investment (capital, technology, production inputs) requires a reclassification from the traditional land use categories. These former boundaries, often established by law, have little relevance in an evolving agriculture with increased population and economic pressures (Romm, 1981). New management units must reflect land use capability and management by the individual or institution and reflect the nature of the social group which is to manage the land. It is most generally felt that under intensive population pressure those groups must be local. Whether they are panchayat, village, or subvillage level may depend on landform and social makeup of the panchayat or village. Government action in the form of legal changes in land description are essential.

Social fencing (access controlled by agreement at the local level) obviously requires the development of local institutions, the establishment of new management boundaries, and probably the changing of existing land use law (Romm, 1981; Mishra, 1987). Once these management units are established, the need for new technology immediately arise. It is essential that local participants be the key to this technology selection (Chambers et al., 1985). There is little evidence that poor people with uncertain land tenure (guaranteed only by agreement among members of a fragile social grouping) will accept long-term investment in timber or fuelwood plants. Neither should they be producing raw product for industry (typically low value product).

Fodder for Livestock, Grazing

Most evidence indicates that livestock feed is not only a pressing national need, it is one of the most urgent felt needs of the rural landless poor (Agarwal et al., 1985). Considerable work is underway in India on fodder improvement and on the management of grazing lands (Singh, 1986; Chatterjee, 1987; NWDB, 1987; Shanker, 1987). Models from other countries are available for comparison (Prinz, 1987).

In the U.S. livestock forages and grazing land management receives a major portion of federal and state research budgets. Considerable technology is available in the form of genetic materials for an extremely broad range of species adapted to the complete range of climatic conditions of India. Low cost rapid assay for feed quality has been developed. In short, the United States has much to offer in the entire area of livestock feed. This area is crucial to large and small farmers alike, and offers perhaps the single greatest potential contribution to stabilizing fragile and degraded soils. It is difficult to see how benefit could not be derived from accessing at least some of the U.S. forage technology.

Forestry

Indo-U.S. collaboration in traditional forestry seems relevant and is moving ahead with focus on educational institutions (Campbell, 1987). The effectiveness of joint educational programs has long been proven in institution building. It will have long-term impact on production of industrial wood products which will have growing market demand for the foreseeable future (Romm, 1987). It is assumed that farm forestry will be a major component of that institutional buildup and training.

A major decision point seems eminent in the social forestry area. In spite of the great promise (Bachkete, 1986; Malhotra, 1985) social forestry is seen to have major weaknesses. With private sector interest so strong, farm forestry is seemingly in a takeoff stage. It is ironic that had the goals of social forestry been strictly production-oriented the programs would have been a resounding success. The inability to reach the landless was seemingly the result of having the wrong technology and the wrong product to serve as the vehicle.

There is always a tendency to draw back from a less than complete success. Yet it would be unfortunate to step back completely from field involvement to the safe haven of research and education, ignoring India's most pressing social and environmental problem.

The Sukhomajri example is striking (Mishra, 1987). That example portrays not the most difficult of areas, but it was not the easiest. Watershed management and communal irrigation requires a high level of technology and management. These villages also had to deal with forest land managed by another agency. There would seem to be far easier targets where the need is still great.

The present social forestry projects supported by U.S. assistance, combined with those of numerous other agencies provide overwhelming evidence that the key with which to begin is a change in government policy concerning access to land. One would then presumably choose areas of social and political stability with at least moderate rainfall

and where the panchayats or village presumably could control their surrounding land. Small tanks for water entrapment may or may not be part of the technology. Local organizations would presumably assist in organizational efforts, with the major input into technologies selected by villagers. Livestock feed, fiber products for local industry, or firewood seem to be the most commonly desired.

For heavily degraded lands the U.S. technologies in improved Prosopis species may be highly relevant as a fast growing shrub for firewood.

This would seem to be an ideal area for the Government of India, international development agency, and local PVO linkage. It would seem to be a short but very meaningful step from social forestry to social fencing.

Structural Issues of Evolution, Policy

The commercialization (rate of evolution) and participatory levels of India's agriculture are being carefully followed (Dantwala, 1987; Raj, 1985).

Experience from U.S. agriculture has shown that a careful monitoring of industry location and its relationship to resources, resource pricing, and environmental loading can save considerable "downstream" agony. Areas which should be considered are

- policy change concerning access to common lands which would permit movement from a colonial land holding structure

- develop models for animal industry location accounting for environmental loading, integration with feed production, and for markets

- develop models for location of high-value crop industry (vegetable, fruit, and other perishables) and an assessment of eventual packaging, refrigeration, shipping requirements

- model the location of wood product processing and production

- model groundwater needs by geographic region

- Assess market channel development and permanence. The commercial farmers' markets of the United States came into being after market channels had narrowed. Could present local markets in India evolve into broad-based commercial channels as a normal part of the evolutionary process?

SUMMARY

The proposed definition of sustainable agriculture covers the five characteristics or dimensions of a sustainable system: Its public utility, productivity, environmental balance, structure, and ability to evolve indefinitely. The public agenda for sustainable agriculture is seen as an expansion of these five dimensions. Development agencies, to be effective, must be sensitive to the public agenda of each country and understand its relationship to policy and to the agricultural development process.

The Indo-U.S. example is used to conceptualize a process for blending mutual concerns of India and the United States for sustainable agriculture to arrive at a small number of focal areas for joint action (figure 4).

The three suggested focal areas directly target major groups of production constraint. All three focus on major environmental and(or) social issues and deal with most agenda items of concern for sustainability. The language used is a compromise and hopefully acceptable to most parties to the environmental debate.

Within each of the three focal areas, the activities build on each other and interact closely. An obvious purpose is to bring focus to the joint efforts.

An assumption underlying all of this work is that unless both social and environmental concerns and costs are dealt with, agricultural products remain undervalued, with true costs ultimately being paid by future generations. As we move toward a global marketplace the underpricing of agricultural products by not factoring in social and environmental costs is a lose-lose situation. It exploits farmers and environments on both ends of the market channel. Short run gains are made at enormous future cost. Unfortunately, for densely populated countries, a major portion of that cost is often human misery.

A second and brighter assumption, however, is that if issues of sustainability are dealt with early in the evolutionary process, corrective actions in structure and technology are far easier and far less expensive.

Development organizations, to be effective, must adapt to the described patterns and work in a collaborative mode to relieve key constraints. Ultimately the actual development inputs must focus on key aspects of institution building, of technology generation and transfer, and of the solving of specific problems. It is the selection of those targets and the way that they are approached which will determine whether resulting evolutionary change is sustainable.

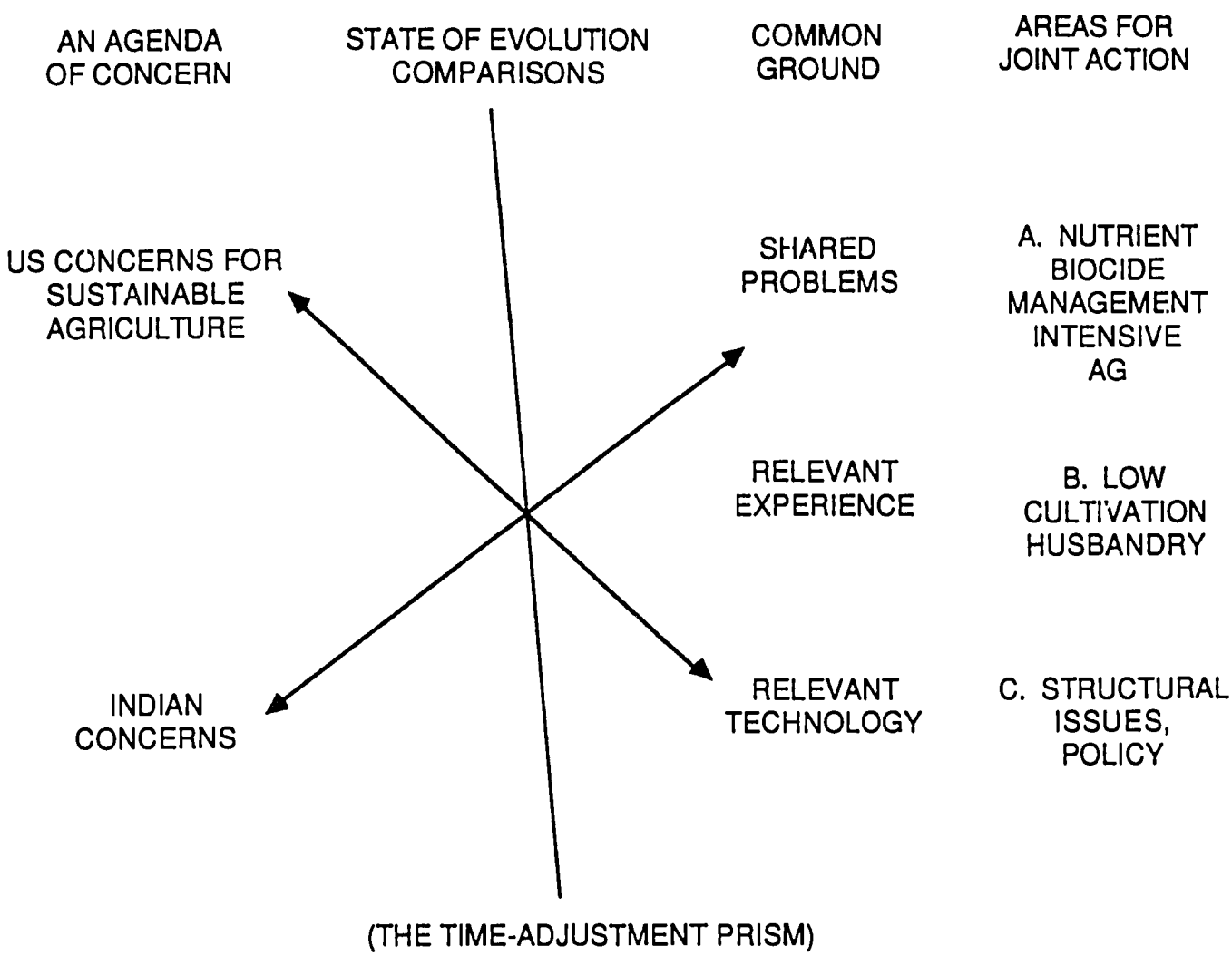


Figure 4. Conceptualization of the sustainable agriculture mutual interests.

LITERATURE CITED

Aggarwal, A. and S. Narain (eds.). 1985. The State of India's Environment 1984-1985. The second citizen's report. Centre for Science and Environment, New Delhi.

Ahuja, K. N. 1987. India's food demand in 2000 A.D. In: International Seminar on Agricultural Research Systems and Management in the 21st Century. NAARM alumni association, National Academy of Agricultural Research Management, Rajendranagar, Hyderabad, India. pp. 31-42.

Aiken, W. 1978. The right to be saved from starvation. In: World Hunger and Moral Obligation. W. Aiken and H. LaFollette (eds.). Englewood Cliffs, NJ. Prentice-Hall.

Altieri, M. A. 1987. Agroecology: The Scientific Basis of Alternative Agriculture. Westview Press. 236 p.

Bachketi, N. D. 1986. Social Forestry in India, Birla Institute of Scientific Research. Economic Research Division. 153 p.

Berry, W. 1978. The Unsettling of America. Sierra Club Books.

Bonnen, J. T. 1987. A century of science in agriculture: Lessons for science policy. In: V. W. Ruttan and C. E. Pray. Policy for Agricultural Research. Westview Press. pp. 105-137.

Campbell, J. Y. 1987. Tropical forestry and biological diversity in India and the role of USAID/New Delhi, USAID mimeo. 73 p.

Chambers, R. and J. Jiggins. 1985. Agricultural research for resource-poor farmers: A parsimonious paradigm. Institute of Development Studies, University of Sussex (mimeo). 44 p.

Chatterjee, A. K. 1987. Fodder development-policies and strategies and development of grazing resources. Workshop on national grazing policy and fodder development. National Dairy Development Board. 13 p.

Committee on Agricultural Sustainability for Developing Countries. 1987. The transition to sustainable agriculture: An agenda for AID. USAID/S&T. Washington (December 18). 29 p.

Dantwala, M. L. 1987. Growth and equality in agriculture. Indian Journal of Agricultural Economics 42:(2)149-159.

Dhawan, B. D. 1988. Irrigation in India's Agricultural Development. Sage Publications. 268 p.

Dover, M. and L. M. Talbot. 1987. To Feed the Earth: Agro-Ecology for Sustainable Development. World Resources Institute. 88 p.

Edens, T. C. and D. C. Haynes. 1982. Closed system agriculture: Resource constraints, management options, and design alternatives. Ann. Rev. Phytopeth. 20:363-385.

Hallberg, G. R. 1987. Agricultural chemicals in groundwater: Extent and implications. American J. Alternative Agriculture. Institute for Alternative Agriculture. Greenbelt, Maryland. pp. 3-15.

Harwood, R. R. 1984. The integration efficiencies of cropping systems. In: Sustainable Agriculture and Integrated Farming Systems. Michigan State University Press, E. Lansing, Michigan.

Harwood, R. R. 1987. Biofertilizer technology and sustainability in agriculture. In: Report of the First Working Group Meeting on Biofertilizer Technology. National Agricultural Service Center, Kathmandu, Nepal.

Harwood, R. R. 1987. Low input technologies for sustainable agricultural systems. In: V. W. Ruttan and C. E. Pray (eds.). Policy for Agricultural Research. Westview Press. 558 p.

International Irrigation Management Institute (IIMI). 1987. Irrigation Management for Diversified Cropping. IIMI, Sri Lanka. 282 p.

Khoshoo, T. N. (ed.). 1987. Perspectives in Environmental Management. Oxford and IBH Publishing Co. New Delhi. 484 p.

Leopold, A. 1948. A Sand County Almanac. Oxford University Press.

Liebhardt, W. C., C. A. Francis, and M. Sands. 1985. Research needs for soil fertility and the development of resource efficient technologies. In: Regenerative Farming Systems. A Workshop Report. Rodale Institute. pp. 41-100.

Malhotra, S. P., H. S. Trivedi, and Y. N. Mathur. 1985. Agroforestry: A judicious use of desert ecosystem by man. Central Arid Zone Research Institute, Jodhpur, India. 40 p.

Mishra, P. R. and M. Sarin. 1987. Social security through social fencing: Sukhomajri and Nada's road to self-sustaining development. Conference on sustainable development, International Institute for Environment and Development. London. 32 p.

Myers, N. 1987. Not Far Afield: U.S. Interests and the Global Environment. World Resources Institute. 73 p.

National Wastelands Development Board. 1987. Agenda notes: Fifth meeting. Ministry of Environment and Forests.

O'Niell, O. 1986. Faces of Hunger. Rowman and Allenheld.

Papendick, R. I., L. F. Elliott, and R. B. Dahlgren. 1986. Environmental consequences of modern production agriculture: How can alternative agriculture address these issues and concerns? American Journal Alternative Agriculture 1(1):3-10.

Panayotou, T. 1987. Investment, Growth, and Employment in Thailand: From Agriculture to Rural Industry. The Journal of Business Administration 16:1.

Planning Commission (1981). Sixth five year plan (1980-1985). Govt. of India. Planning Commission, New Delhi.

Postel, S. 1986. Altering the Earth's Chemistry: Assessing the Risks. Worldwatch. 66 p.

Postel, S. 1987. Defusing the Toxics Threat: Controlling Pesticides and Industrial Waste. 69 p.

Prinz, D. 1987. Improved fallow: Increasing the productivity of smallholder farming systems. Information center for low external input agriculture. Leusden, the Netherlands. III(1)3-7.

Raj, K. N., N. Bhattacharya, S. Guha, and S. Padhi (eds.). 1985. Essays on the commercialization of Indian agriculture. Oxford University Press, New Delhi. 354 p.

Romm, J. 1981. The uncultivated half of India. Centre for monitoring Indian Economy. Bombay. 48 p.

Romm, J. 1987. Forestry for development: Some lessons from Asia. Department of Forestry and Resources Management University of California at Berkeley (mimeo). 17 p.

Scott, J. C. 1985. Weapons of the Weak: Everyday Forms of Peasant Resistance. New Haven, C. T. and London. Yale University Press. 389 p.

Shankar, V. and S. Kumar. 1987. Grazing Resources of Jaisalmer District: Ecology and developmental planning with special reference to Sewan grasslands. Central Arid Zone Research Institute. Jodhpur. 92 p.

Sharma, A. 1987. Resources and Human Well-Being: Inputs from Science and Technology. Indian Science Congress Association, Calcutta. 123 p.

Singh, Chhatrapati. 1986. Common Property and Common Poverty: India's Forests, Forest Dwellers, and the Law. Oxford University Press, Delhi. 75 p.

Singh, R. V. 1986. Summary of the report of the committee on fodder and grasses. Forest Research Institute, Dehradun. 17 p.

Swaminathan, M. S. 1983. Agricultural evolution in India. In Science and the Conquest of Hunger. pp. 377-478.

Technical Advisory Committee (TAC). 1988. Sustainable Agricultural Production: Implications for International Agricultural Research. The Consultative Group on International Agricultural Research (AGR/TAC:IAR 87/22). 108 p.

Thompson, P. B. 1986. The social goals of agriculture. Agriculture and Human Values III(4)32-42.