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July 20, 1992

A Policy Perspective on the
Sustainability of Production Environments:
Toward a Land Theory of Value

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A briefing paper presented at "Challenges and Opportunities for the National Agricultural Research System (NARS) in the Year 2000 and Beyond: A Policy Dialogue." Berlin, Germany, January 13-18, 1992. My thanks to Vernon W. Ruttan, Karl Stauber, Burt Sundquist, Edward Lotterman and to Glenn Fox for comments in the preparatory phase of the paper. Research on which this paper is partially based provided by the Northwest Area Foundation, St. Paul, Minnesota.

Working Paper P92-2

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Overview

The growing importance of environmental issues is changing the face of agricultural economics and politics, both domestically and internationally. The National Agricultural Research Systems (NARS) are increasingly affected by the debate over "sustainability." It has become obligatory to gesture to the environment as of growing importance, but what exactly should be done? What policies can maintain and improve agricultural productivity, while at the same time protecting environmental benefits and minimizing the environmental damages of modern agricultural production methods?

Broadly speaking, in the developed countries, it is the commodity composition of agricultural growth together with the increasing use of water, fertilizer and chemical inputs in food production, and intensive animal production, which account for the majority of environmental concerns in agriculture. In developing countries it is deforestation and habitat destruction in areas opened to cultivation. Commodity composition refers simply to the mix of farm products produced. Agricultural production has become increasingly specialized at the farm level since the 1950s, especially in the OECD countries. Specialization due to comparative advantage occurs naturally in the course of agricultural growth and development. But the degree of intensive specialization at the farm level in such crops as maize or cotton, as well as the concentration of livestock production in limited geographic areas, has been driven in many developed countries less by market demand than by domestic and related trade policies that subsidize this narrow production focus directly and indirectly. The increasing use of chemical inputs has occurred in large part because the demand for them is derived from the demand for farm output, whether the demand arises in the market or from government subsidies and purchases. In both developed and developing countries, the crops which governments have subsidized have accounted for the bulk of irrigation, fertilizer and pesticide applications. In addition to the derived demand for water, fertilizer and chemicals, many governments have further subsidized the use of these inputs by tax allowances or price markdowns that make them less expensive to use.

Many of these changes in production, especially in developing countries, have been justified as necessary to feed growing populations or to increase food self-sufficiency as a matter of trade policy and national security. The result has been that adverse environmental consequences have been treated as unfortunate but probably justifiable by-products (externalities) in meeting these challenges. As this perspective changes, especially in the OECD countries, the demand for new environmental regulations will effectively raise the cost of environmentally irresponsible farm production methods, inducing new, more environmentally benign technologies. However, this process is just beginning, and the market and government failures of the post-war period have clearly generated substantial environmental damages. And as long term population growth continues to require increases in food production, environmental issues in agriculture are likely to remain important.

In developing countries, farmers are typically taxed rather than subsidized, in the form of food prices held below market levels in response to the political influence of urban consumers. While depressing production, these policies do not necessarily conserve natural resources, for two reasons. First, poor farmers are often compelled to farm marginal lands subject to erosion and runoff, or to clear forests which have held soil in place, in order to earn a subsistence level of income. If the household is already operating at or near subsistence, lower prices do not cause

reduced output. Second, subsidies are sometimes paid to reduce the costs of farm inputs (fertilizer, chemicals) which lead to overapplications and consequent water and soil contamination. While fertilizer, in particular, has been vital to meeting food demands, many government policies have had untoward effects on the environment. Although insufficient research is available, several studies suggest that the impacts of government policy in developing countries are at least as important as in developed countries, both in distorting markets and harming the environment.

While all of the market failures associated with agriculture in the developed countries are replicated in the developing world, the incapacity of government to intervene effectively to regulate the environment is even more evident. Environmental quality is a "superior good," the demand for which rises increasingly in proportion to increases in income. By contrast, food production is an "inferior good," the demand for which falls in proportion to increases in income (Engels' Law). In the high-income developed countries, for example, regulations affecting pesticide use have become more stringent in the last two decades. Food quality increasingly dominates food quantity as concerns over environmental health and safety grow. In low-income developing countries, by contrast, the political and economic constituencies of most interest to governments are composed of urban consumers of food who demand low prices. Environmental quality has a weaker constituency. Food producers are a large and politically unorganized source of revenues, and are thus generally taxed, in large part by extracting their product at below market prices. In partial compensation, input subsidies are paid to increase yields. In some cases, these subsidies may be justified to maintain soil fertility through nutrient applications. In other cases, the environmental effects are clearly negative.

Responding to the dual challenge of agricultural productivity gains and environmental protection requires more carefully targeted and articulated policies at three levels. First is at the national and multinational levels: the agricultural and environmental policies of the OECD nations and developing countries. Second is at the farm level, where technological and environmental choices are ultimately made. Third is at the level of agricultural research policy, which will guide the long run choices of national policymakers and individual producers.

While this brief document cannot provide detailed policy recommendations, the perspective developed points in the following directions (for a detailed analysis, see Runge, 1991 and Cochrane and Runge, 1992). At the national and multinational level, agricultural policies should incorporate environmental objectives explicitly. Traditional agricultural policies promoting commodity-specific increases in output should be replaced with "decoupled" policies combined with incentives to farm less intensively lands which are highly vulnerable to environmental damages. A system of financial penalties should be applied to damaging environmental practices, and a system of rewards for environmental "affirmative actions." At the farm level, implementing these policies will require more clearly targeted approaches to lands according to their agronomic characteristics, including potential productivity and vulnerability to environmental damages. On productive lands vulnerable to such damages, "precision farming" methods will be at a premium (Munson and Runge, 1990). Farmers should be encouraged to adopt these technologies on vulnerable land areas, but should not be discouraged from yield goals on productive land with low levels of environmental vulnerability. At the level of research policy, the "mix" of environmental and yield-increasing agricultural research will depend on the types of land and landscape in question, and the different weight attached to environmental quality versus

food production, especially in the North versus South.

The context in which these policy prescriptions emerge is a view of the sustainability debate as an outgrowth of conflicts between two research agendas. The first is the traditional commodity oriented agenda that has dominated the NARS from their origins. The second is an environmental or "green" research agenda. Sustainability reflects the conflicts between these agendas, but also offers opportunities for a synthesis. Defining such a synthesis, and the policies which should underlie it, is the primary objective of this brief.

The brief is divided into four parts. Part one provides a basic description of the agricultural production process as a dynamic flow, producing not only commodities but environmental goods and "bads" (damages). Part two discusses the research agendas that have influenced this production process, and the conflicts between traditional commodity oriented research and the newer environmental research agenda. Part three takes up the common ground uniting these two agendas: a concern for the uses of land and the effects of this use on both commodity and environmental flows. Part four offers some specific recommendations for reforms in land policy and targeting at the national level, the farm level, and the implications of these reforms for agricultural research systems.

I. Agricultural Production as a Process

Agricultural policy, and research, continue to focus on an optimal set of hydrocarbon based inputs such as labor, capital, energy, nutrients, chemicals and water in combination with land to produce various types of foods, feeds and fibers.¹ Naturally the cost of these inputs varies greatly from time to time and place to place, giving rise to efforts to overcome constraints in their availability through technological and institutional innovations. This process of induced innovation has exercised an important guiding influence on the NARS and their missions (see Pardey, et. al., 1991 and Ruttan, 1992). In particular, it has led to a conviction that agricultural production paths can be "designed" through policies affecting the supply and demand for agricultural inputs and outputs (Figure 1).

However, some inputs (e.g., hydrocarbon-based energy) are constrained not only locally but globally, and not all of the outputs of this process have been given full weight. Specifically, land produces not only flows of commodities including foods, feeds and fiber, but other streams of product. One such product is environmental amenities, such as landscape quality, wildlife habitat, groundwater recharge, and recreation opportunities. Another is environmental damages, such as water pollution, resulting in large part from intensive use of energy-based plant nutrients. These flows of environmental goods and "bads" have had neither high political value nor been reflected in market demand for much of agricultural history. But a new era is dawning, in which public demands for both environmental goods, and reductions in environmental bads, increasingly dominate political and economic discussions. As a result of the implicit value given to the

¹Macroeconomic policies affecting the cost of capital (discount rates) and energy also have had profound effects on input use, but are somewhat beyond the scope of this policy brief.

environmental aspects of land and its production, the process of technological and institutional innovation is being given new "inducements," of which this conference is an example (see Runge, 1987).

However, the paths of technological and institutional change taken in response to these pressures are by no means uniform. In particular, there are major differences in the apparent "weight" attached to traditional agricultural commodities versus environmental goods and bads in the North and South (Runge, 1990). This North/South gap poses a special challenge for those who assert that "sustainability" is of equal importance to all nations, and suggests one of the many senses in which assertions of sustainability as a covering concept for policy are "not enough" (Ruttan, 1988; Graham-Tomasi, 1991; see also Fox, 1990). I will return to this issue at the conclusion of this paper.

II. Research Agendas in Conflict: What Synthesis is Possible?

The conflict between the traditional commodity-oriented agricultural research and the new agenda of environmentally oriented research is much noted (e.g., Norgaard, 1991; Batie, 1989). It may be useful therefore to characterize the differences in emphasis of the two streams of thought. I will call them "environmental research" and "agricultural research" (Figure 2).

Environmental research, at least in agricultural economics and the applied agricultural sciences, has had the following general characteristics.

- (1) It is process oriented, in that it focuses on the flow of various damages such as nitrate pollution through the agricultural production system and into natural systems such as waterways.
- (2) It is conducted on the general assumption that market signals are insufficiently strong to guide decisions by farmers; such "market failure" creates a presumptive role for regulation.
- (3) It is largely critical of analysis that views increased production (yields) and aggregate growth as ends in themselves.
- (4) It assumes that the relative scarcity of natural resources in the face of population growth, even with technological change, is likely to be binding over time, promoting "resource pessimism."
- (5) It places an implicit value on improvements in environmental quality, reflecting the income-driven valuations of high-income developed countries.

In contrast, the traditional agricultural research of the NARS has had the following general characteristics.

- (1) It is product oriented, focusing on specific commodities and disciplinary attempts to develop more efficient, or robust, varieties of these commodities in different agro-environmental settings.
- (2) It is comparatively market driven, giving value primarily to those commodities in greatest demand.
- (3) It is accepting of increased production (yields) and growth as legitimate ends in themselves.
- (4) It is dominated by an optimistic view of natural resource systems in agriculture as manipulable through technological change, so that a Malthusian collision between population and resources can be avoided.
- (5) It places greatest emphasis on food and fiber production, and the provision of those

commodities to low income groups, notably in developing countries.

Even if these contradictions are only approximately accurate, they suggest that the two agendas are not likely to be combined without conflict. Nonetheless, I submit that a new synthesis is emerging.²

III. Sustainability as a Synthesis

A compromise of two differing agendas is unlikely to be neat and orderly, as framers of legislation in democracies know. That is why definitions of sustainability are either excessively qualified or overly general in focus: they need to be in order to reflect the differences of the two agendas above. But in practical terms, this does not detract from the utility of pursuing synthesis through compromise, any more than differences of opinion among democratic leaders imply the inutility of final agreements. It will be recalled that Figure 1 illustrated the central role played by land as a factor of production, whether from a strictly commodity-based or more environmental perspective. Along each of the five lines discussed above, I would argue that a new synthesis is now emerging, based on altered considerations of land use. In this sense sustainability is almost a restatement of Physiocracy, a "land theory of value" (Figure 3).

First, the commodity and disciplinary emphasis of agricultural research is giving way to "systems" approaches with an interdisciplinary emphasis. This change in emphasis is linked to, and will be enhanced by, movements at the level of policy away from commodity-specific farm income support and in the direction of a decoupled system of land and landscape-based agricultural subsidies and penalties. These subsidies and penalties will reward farmers for land-conserving practices, and penalize them for damages.

Second, the growing public demands in the "political marketplace" of high income countries for environmental goods such as landscape quality and reductions in environmental "bads" such as water pollution are creating a stronger presumption in favor of regulating agricultural land use to achieve environmental objectives. On the other hand, government interventions designed simply to enhance output are falling from favor due to chronic surpluses. These changes will create new incentives to alter the mix of commodities produced on agricultural land, and the way in which they are produced. However, the "political marketplace" is sending different signals in the developing countries, where food and fiber production continue to dominate environmental concerns.

Third, and related to the above, is a decreasing enthusiasm for yield increasing technologies, per se, in the North, but a continuing emphasis on the need for such technologies in the South.

Fourth, the resource pessimism of the environmental agenda is challenged by the success to

²Whether the synthesis is an "appropriation", as Ruttan (1991) suggests, by the traditional establishment of the progressive sustainability movement's criticisms is an interesting issue in the sociology of research, but will not be pursued here.

date of agricultural technology in overcoming widespread starvation. However, the imperative to continue increases in yields and output is being combined with attention to environmental effects to generate a new round of technological innovations which we have called "high precision farming" technologies (Munson and Runge, 1990). The role of research in advancing these technologies may depend on institutional innovations which support them.

Fifth, and perhaps most significantly for the NARS, is the challenge of differentiating the research agendas relevant to North and South. Here the lessons of the induced innovation hypothesis reinforce the notion of different paths of technological change and land use, in which the tolerance for environmental damages may differ. But in an integrated world economy, such divergent parties create problems of trade conflict over environmental barriers (Runge, 1991).

Thus, the emerging synthesis is spawning new conflicts, to which innovators of technology and institutions must creatively respond. What should some of these policy responses be?

IV. Policy and Sustainability

If the centrality of land use is accepted as a basis for thinking about the sustainability of production environments, how might we target different land categories in terms of policy intervention? Consider the typology below, depicting differences in a land area (including watersheds) in terms of vulnerability to environmental damages (e.g., soil erosion, water pollution) and potential productivity (Figure 4). Note that the level of aggregation of the land parcel is, for present purposes, arbitrary: it could be a single farm, a region, or an entire nation.³ Note further that we describe land use as the center of a production system, not simply as a clump of soil.

In the upper left-hand corner are lands which are low in productivity potential and relatively low in vulnerability to environmental damages. These highly marginal lands are neither candidates for policy interventions to promote production nor likely to reward investments in agricultural or environmental research. In the upper right are those lands which remain low in productivity potential but are highly vulnerable to environmental damages. Here environmental agencies must take the lead to create disincentives such as fees or penalties to discourage agricultural production. Research on these lands should be directed toward environmental objectives, not agricultural ones. In the lower left are high productivity potential lands with low environmental vulnerability. Here traditional yield increasing incentives and research directed to traditional agricultural objectives will have the highest payoff.

Finally, and of greatest relevance to sustainability issues, is the lower right quadrant, where high productivity potential is combined with high vulnerability to create major environmental damages from agriculture. It is on these lands that a synthetic approach, combining yield

³This method was used at various levels to target land set asides in Minnesota for a state environmental set aside program. See Larson, et. al. (1988). While it focuses primarily on vulnerability to damages, it is readily adaptable to environmental services such as landscape quality and wildlife habitat.

enhancing technologies with high-precision methods, are most needed, and where the synthesis of environmental and agricultural research, or "sustainability research", is most relevant.

Now consider the specific implications of this perspective for policy reforms at various levels. At the national and multinational level, policies which continue to reward the production of specific commodities, irrespective of the land category on which they are produced, will tend to promote inappropriate production patterns with adverse environmental effects. Agricultural policies of "decoupling," in contrast, will allow more diverse cropping mixes, but in themselves will not promote environmental objectives unless combined with appropriate environmental policies to encourage landscape quality and discourage agricultural production on vulnerable land areas. This will imply both fees and penalties on vulnerable lands, and subsidies for environmental improvements.

At the farm level, production on high productivity and low vulnerability land areas should be encouraged; where lands highly vulnerable to environmental damage are in production, farmers should be encouraged to employ high precision methods which minimize these damages over time. These methods can take many different forms, and are discussed in detail elsewhere (Munson and Runge, 1990).

Finally, at the level of research policy, a clearer delineation of research directed to environmental objectives or to agricultural production should be made. For many land areas, traditional agricultural research will continue to have relevance; but where lands are vulnerable to environmental damages, more systems oriented, interdisciplinary research, emphasizing the trade-offs between increased yields and environmental damages, development of high precision technologies, will come into play.

Since the proportion of land falling into each category, and the importance attached to environmental vulnerability itself varies greatly, it follows that the policies, farm practices, and relevance of research results will also vary considerably from nation to nation, region to region, and even farm to farm. Most significant, the relative difference in these qualities between North and South suggests that sustainability is, and probably ought to remain, a mutable concept.

It is very difficult to envision a single research agenda based on sustainability which unites the objectives of the food systems of North and South, except insofar as land use becomes a unifying theme. Land use (and misuse) provides a general basis on which agricultural production and productivity gains can be considered at the same time as reductions in the intensity of production on lands most vulnerable to environmental damages. We are increasingly able to use modern technologies both to differentiate such lands, and to apply more precise agricultural techniques on them. What is lacking is an institutional commitment to develop incentives for changes in national, farm level and research system behavior consistent with our renewed awareness of the centrality of land in agricultural and environmental flows.

References

- Batie, Sandra. 1989. "Sustainable Development: Challenges to the Profession of Agricultural Economics," American Journal of Agricultural Economics. December: 1085-1101.
- Binswanger, H. P. April, 1989. "Brazilian Policies that Encourage Deforestation in the Amazon." World Bank. Environment Department Working Paper No. 16.
- Cochrane, Willard W. and C. Ford Runge. 1992. Reforming Farm Policy: Toward a National Agenda. Ames: Iowa State University Press, forthcoming.
- Fox, Glenn. 1990. "The Economics of the Sustainable Agriculture Movement." Canadian Journal of Agricultural Economics 38: 727-739.
- Graham-Tomasi, Theodore. 1991. "Sustainability: Concepts and Implications for Agricultural Research Policy" in Philip G. Pardey, Johannes Roseboom and Jock R. Anderson, eds., Agricultural Research Policy: International Quantitative Perspectives. Cambridge University Press: 81-102.
- Larson, G. A., G. Roloff and W. E. Larson. 1988. "A New Approach to marginal Agricultural Land Classification," Journal of Soil and Water Conservation. 43(1) (Jan./Feb.): 103-106.
- Munson, R. D. and C. F. Runge. 1990. Improving Fertilizer and Chemical Efficiency Through 'High Precision Farming'. Center for International Food and Agricultural Policy. Department of Agricultural and Applied Economics. St. Paul: University of Minnesota.
- Norgaard, Richard B. May 22, 1991. "Sustainability as Intergenerational Equity: The Challenge to Economic Thought and Practice." Washington, DC: World Bank, Office of the Chief Economist, Asia Region.
- Pardey, Philip G., Johannes Roseboom and Jock R. Anderson, Eds. 1991. Agricultural Research Policy: International Quantitative Perspectives. Cambridge: Cambridge University Press.
- Repetto, R. 1985. Paying the Price: Pesticide Subsidies in Developing Countries. World Resources Institute. Washington, D.C.

- Runge, C. Ford. 1991. Environmental Effects of Trade in the Agricultural Sector: A Case Study. A paper prepared for the Organization for Economic Cooperation and Development (OECD) Environment Directorate, Paris. Center for International Food and Agricultural Policy. Department of Agricultural and Applied Economics. St. Paul: University of Minnesota.
- Runge, C. F. August, 1987. "Induced Agricultural Innovation and Environmental Quality: The Case of Groundwater Regulation," Land Economics 63(3): 249-258.
- Runge, C. F. Spring, 1990. "Trade protectionism and Environmental Regulations: The New Nontariff Barriers," Northwestern Journal of International Law and Business. 11(1): 47-61.
- Ruttan, Vernon W., Ed. 1992. Sustainable Agriculture and the Environment: Perspectives on Growth and Constraints. Boulder: Westview Press, forthcoming.
- Ruttan, Vernon W. Spring/Summer 1988. "Sustainability is Not Enough," American Journal of Alternative Agriculture. 3: 128-130.
- Ruttan, Vernon W. November 1991. Sustainable Growth in Agricultural Production: Poetry, Policy and Science. Staff Paper P91-47. Department of Agricultural and Applied Economics. St. Paul: University of Minnesota.

Figure 1

Production Flows in Agriculture

	<u>INPUTS</u>		<u>OUTPUTS</u>
	Labor		
	Capital		(+) Commodities (food, feed, fiber)
Hydro- Carbons	Energy	Land	(+) Environmental Goods (landscape quality, wildlife)
	Nutrients		
	Chemicals		(-) Environmental Bads (water pollution)
	Water		

(+) denotes positive value
(-) denotes negative value

Figure 2.

Conflicting Research Agendas

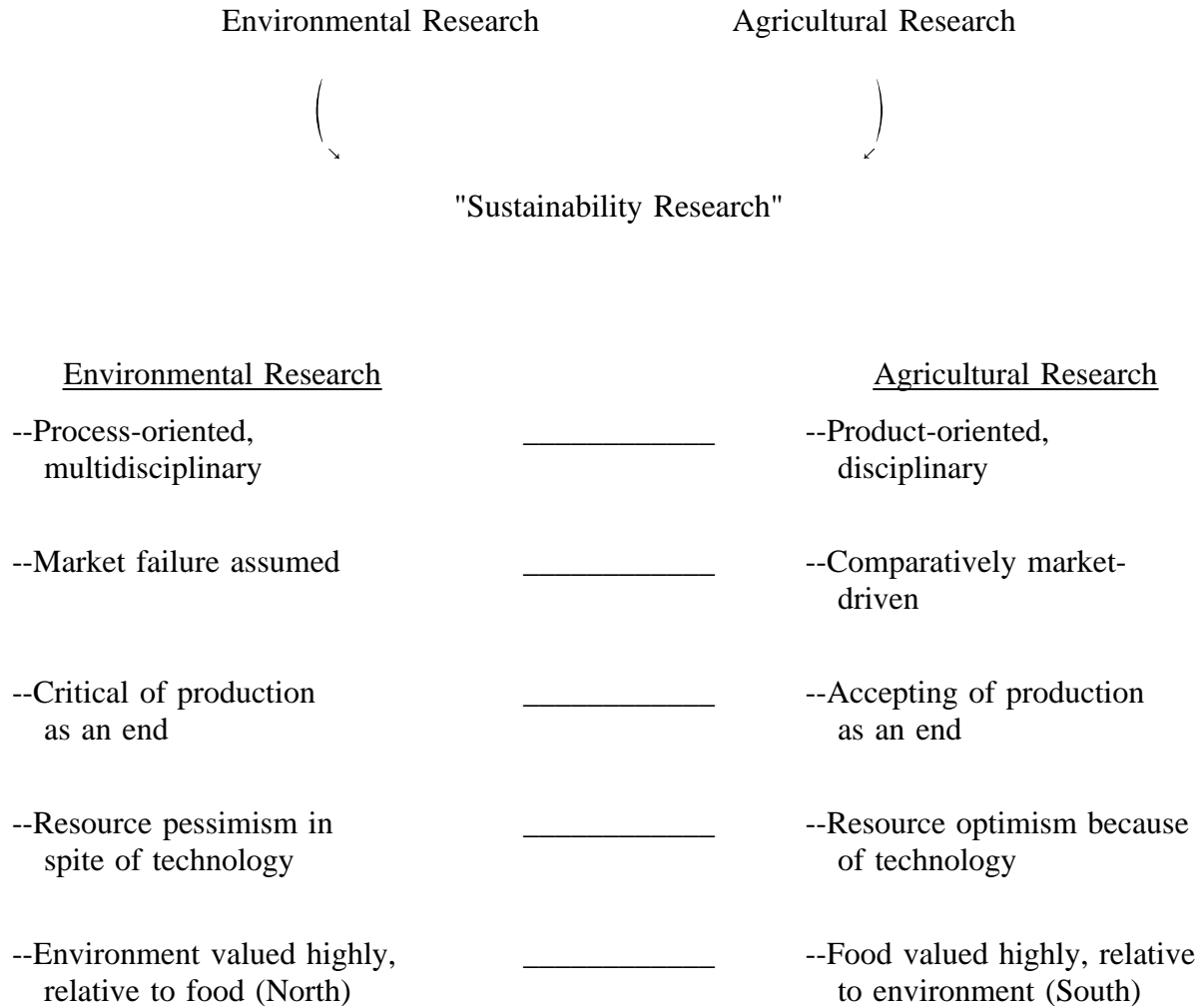


Figure 3

Sustainability as Synthesis

Process oriented,
multidisciplinary

Product-oriented
disciplinary

Systems-oriented,
interdisciplinary

Market failure assumed

Comparatively market-driven

Regulate environmental goods,
bads (in North);
Reduce crop-specific price supports

Critical of production
as an end

Accepting of production
as an end

Reduced support for yield increases per se
in North, continued support in South

Resource pessimism in
spite of technology

Resource optimism because
of technology

High precision farming
technologies

Environment valued highly,
relative to food (North)

Food valued highly, relative
to environment (South)

Differentiate
North/South
objectives

Figure 4

A Typology of Land Use, Policy and Research Needs

AGRICULTURAL LAND AREAS

		<u>Vulnerability to Environmental Damages</u>	
		Low	High
<u>Productivity Potential</u>	Low	<p>Low policy intervention</p> <p>-----</p> <p>Low research priority</p>	<p>Penalties for damages</p> <p>-----</p> <p>Environmental research</p>
	High	<p>Yield-promoting policies</p> <p>-----</p> <p>Yield-promoting agricultural research</p>	<p>Policy promoting "high precision farming"</p> <p>-----</p> <p>"Sustainability research"</p>