Environment and Development Economics 6 (2001): 419–433
Copyright © 2001 Cambridge University Press

Agroindustrialization, globalization, and international development: the environmental implications

CHRISTOPHER B. BARRETT
Department of Applied Economics and Management, Cornell University, Ithaca, NY 14853–7801

EDWARD B. BARBIER
Department of Economics, University of Wyoming, Laramie, WY

THOMAS REARDON
Department of Agricultural Economics, Michigan State University, East Lansing, MI

1. Introduction

'Agroindustrialization' comprises three related sets of changes: 1 growth of commercial, off-farm agro-processing, distribution, and input provision activities; 2 institutional and organizational change in the relations between farms and firms both upstream and downstream, such as a marked increased in vertical integration and contract-based procurement; and 3 related changes in product composition, technologies, and sectoral and market structure (Reardon and Barrett, 2000). The actual and potential environmental effect of these changes have been sparsely documented to date. There does not seem to have been any attempt at a reasonably general analysis of the pathways by which such effects might occur or of the instruments governments might have at their disposal to influence these pathways. This essay is meant to fill the latter gap while the articles

This special issue originated with the international preconference to the 1999 annual meeting of the American Agricultural Economics Association, held in Nashville, TN, USA. We thank the AAEA Foundation, the Cornell International Institute for Food, Agriculture, and Development, the Farm Foundation, the Food and Agricultural Organization of the United Nations, the International Food Policy Research Institute, the International Livestock Research Institute, and Michigan State University for generous financial support of the preconference, and Charles Perrings and Rosalind Stockley for their excellent editorial guidance. Related papers appear in two other special journal issues born of the conference, Barrett and Reardon (2000) and Reardon and Cook (forthcoming).

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

and policy forum that follow provide more detailed findings and perspectives on constituent issues.

Developing countries have long promoted value-added processing of primary products as a path to industrialization. The past decade has brought unprecedented growth in agroindustrialization, both across and within countries. This trend has multiple causes. Human population increases fuel demand for agricultural products generally, while increasing incomes and urbanization induce disproportionately rapid growth in demand for higher-quality processed and packaged foods and for greater variety in diet. Growing volumes of commercialized agricultural production have led to scale economies in processing and distribution, thereby inducing increasing profitability and new entry. Meanwhile, falling real international transport and communication costs and widespread relaxation of trade and foreign direct investment restrictions have stimulated fixed capital formation in export-oriented industries both upstream and downstream from farm-level agricultural production in low- and middle-income countries. The effect of these changes on the form agroindustrialization takes and on its ultimate environmental impact depend on several simultaneous and countervailing factors. The sections that follow address these in turn.

2. New entrants, institutions and organizational forms

Poor farmers typically have little land or capital to invest in either expanding upstream into the manufacture and sale of farm inputs or downstream into the processing or distribution of agricultural commodities. Small-scale processors and distributors in the informal sector likewise face substantial obstacles to expansion (Fafchamps, 1994; Barrett, 1997). Larger firms therefore typically play a central role in the transition from semi-subsistence to commercially oriented, agroindustrial production. Part of this comes through consolidation, as larger firms already in the agroindustrial channel absorb smaller ones offering complementary operations. In other cases, domestic non-agricultural industries with significant overcapacity move into agricultural processing, taking advantage of underutilized capital, technology, and managerial skills.[1] In still other places, multinational firms have entered emerging markets at various stages of the agricultural marketing channel from production of seed, fertilizer, and machinery, to processing, to supermarket retailing.

New entrants and larger incumbents often introduce new technologies, marketing organisations, and a different approach to retail consumers and government regulators. Larger, better capitalized firms with better-educated managers typically adopt new technologies earlier than do smaller, more cash-strapped ones with less-educated managers. This is a phenomenon that applies equally to the use of improved environmental management techniques and of modern chemicals and machinery (Feder *et al.*, 1983, Dasgupta, Hettige, and Wheeler, 2000; Barrett *et al.*, forthcoming). Because their capacity is substantial, larger firms require a steady

[1] Much recent Chinese agroindustrialization has resulted from such sectoral crossovers (Saywell, 1999).

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

volume of business and therefore rely relatively more on contracting and vertical integration than do informal firms that operate primarily in spot markets. Contracts enable vendors to provide complementary services (e.g., training on the use of new fertilizers or equipment) and buyers to specify product characteristics of interest to downstream consumers. Finally, larger and publicly traded firms tend to be more subject to government regulatory oversight and to public pressure from consumers or shareholders with respect to production practices. These distinctive characteristics of agroindustrialization have multiple prospective effects on the natural environment. These can usefully be categorized into three classes: direct effects on farming and upstream supplier industries; direct effects on downstream processing and distribution in the commercial agrifood channel; and indirect effects due to income growth and induced structural changes. The subsections that follow briefly explore these in turn.

3. Direct effects on farming and upstream supplier industries

Agroindustrialization is commonly associated with the introduction of improved production technologies, increased farmgate prices, and greater availability and quality of purchased inputs, all of which tend to stimulate greater output. This raises the age-old question of whether additional output comes through intensification of production on lands already under cultivation or whether it induces expansion on to fragile forest, range and wetland margins, potentially causing deforestation, desertification, biodiversity loss, etc.[2] The empirical evidence appears decidedly mixed on the effects of related phenomena of economic liberalization, and agricultural technological change and commercialization on rural natural resource degradation (Barbier, 2000; Lee and Barrett, 2000; Angelsen and Kaimowitz, 2001; Reardon and Barrett, 2001; Barrett, Place, and Aboud, forthcoming).

The potential impacts of agroindustrialization on land-use patterns in the developing world need to be considered in light of current trends. Currently, the annual deforestation rate across tropical countries is approximately 0.8 per cent, or 15.4 million hectares (ha) per annum (FAO, 1993 and 1997). Over the last 15 years, the decline in forest and woodlands in most tropical areas is mainly the result of land conversion, in particular agricultural expansion. The agricultural expansion occurring in tropical regions appears partly related to structural features of low-income agriculture, such as low irrigation and fertilizer use leading to poor crop yields. Increasing agricultural productivity and input use reflect greater agricultural intensification and development, which in turn means less pressure to convert forests and other marginal lands to farming (Barbier, 1997b; Lee and Barrett, 2000). Whether the 'backward linkages' offered by agroindustrialization can stimulate sustainable agricultural intensification remains a hotly debated issue.

An important area of current economic research into tropical deforesta-

[2] Expansionary effects can be direct or indirect, due to displacement of villagers who subsequently colonize frontier regions (Barbier, 2000).

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

tion and agricultural land-use expansion consists of cross-country, regional and selective country-level statistical analyses of the factors determining declining forest cover. Several surveys have illustrated and synthesized the important findings of this growing literature (Barbier and Burgess, forthcoming; Brown and Pearce, 1994; Kaimowitz and Angelsen, 1998; Koop and Toole, 1999; van Kooten, Sedjo, and Bulte, 1999). These surveys suggest several key factors have an important influence on land-use changes both within and across countries. In particular, increases in incomes, population pressure, agricultural prices, access to markets, tenure insecurity, and political instability are associated with greater agricultural land-use expansion and deforestation. In general, countries with larger forest stocks and land endowments also display higher rates of deforestation and agricultural expansion. The analyses have offered more mixed results with respect to the relationship between deforestation and agricultural productivity, logging prices and exports. In sum, the economic and demographic factors driving agricultural land-use patterns and deforestation in developing countries are highly complex. It is therefore very difficult to predict the effects of agroindustrialization and technological change in agriculture on these land-use trends.

Turning from land use to use of other inputs, Pingali (this issue) argues that the structural transformation of Asian agriculture in response to commercialization and agroindustrialization has had significant environmental impacts, both good and bad. Farmers are responding to consumer demand for unblemished produce by using greater volumes of insecticides and fungicides. They also respond to the labor market effects of employment creation in the industrial sector by substituting herbicides for increasingly expensive weeding labor. On the other hand, higher-value crops are less water intensive than cereals. Induced movement away from intensive cereal monoculture could reduce water-induced salinization and demands on groundwater flow. A core argument in Pingali's contribution to this special issue is that input and output pricing reforms can have a considerable effect on farmers' incentives to overexploit water, chemicals, and fossil-fuel-based agricultural inputs. Several contributors to the Policy Forum that appears in this special issue echo that observation.

Dasgupta, Mamingi, and Meisner (this issue) present troubling evidence on pesticide use in Brazil. Retail consumers, especially in wealthy overseas markets, increasingly value the aesthetic appeal of produce, thereby inducing farmers to use chemical fungicides, insecticides and pesticides in greater volumes than ever before. Pesticide use in Brazil has more than doubled over the past decade. Using spatially explicit nationwide data, Dasgupta, Mamingi, and Meisner find that pesticide use is concentrated in areas that are heavily dependent on export-oriented cash cropping and have relatively many large farms. More than one-third of water samples are excessively contaminated, resulting in serious threats to human health and widespread poisoning of birds and other wildlife.

The emerging livestock revolution (Delgado *et al.*, 1999) similarly poses serious questions about nutrient overloading due to animal wastes, especially in peri-urban areas. Wealthy countries are struggling with the

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

environmental repercussions of rapid vertical integration in hog and poultry farming. The regulatory methods used with limited efficacy in the OECD economies are almost surely not feasible in poorer countries, raising serious concerns for water pollution and odor control. Nonetheless, industrial livestock production could also prove an environmental boon in that concentrated animal wastes provide an opportunity to partially resolve persistent soil nutrient depletion associated with reduced fallows and low rates of inorganic fertilizer application. Plant matter decomposes far faster in rumen than in soil; therefore, as long as ruminant livestock excreta are used as soil fertility amendments, industrialization of livestock production can accelerate nutrient cycling and thereby retard soils degradation.[3] Markets for animal manure exist – and sometimes extend scores of kilometres – in much of the low-income world and could be usefully stimulated by the spatial concentration of livestock production. Whether the concentration of livestock production results in adverse water pollution, favorable soil nutrient repletion, or both remains to be established empirically.

Industrial genetic engineering of higher yielding, drought resistant, or naturally pest resistant crop varieties is increasingly viewed as an alternative pathway to increased (and potentially more nutritious) output without expansion on to fragile lands, as *The Economist* article in the accompanying Policy Forum explains. Yet the transferance of genetic material across species boundaries also raises a host of environmental concerns, as Batie and Ervin (this issue) point out. The ecological risks of genetically modified organisms remain poorly understood. These autonomous technologies are shaped by private firms that do not have to take social costs and benefits into account since they are shielded from competitive pressures by intellectual property law. Batie and Ervin argue that public institutions must therefore play an enhanced regulatory role. While acknowledging that transgenic crops clearly have significant potential to improve welfare and even the environment, they propose expanded public research on monitoring and risk assessment related to transgenic plants and implementation of the precautionary principle in the United States, building on European experiences.

Agroindustrialization has potential environmental effects beyond those associated with conventional extensification/intensification and technology. Vertical co-ordination through contracting or organizational integration permits downstream interests to exert unprecedented influence over farming practices in which they are not directly engaged. On the down side, this may take the form of stipulations over the aesthetic appearance of produce, which can induce sharply increased rates of chemical fertilizer and pesticide application with adverse environment effects, as both Dasgupta, Mamingi, and Meisner and Pingali discuss extensively. It may also usher in an era of increasingly centralized control over production processes by corporations having little long-term interest

[3] One caution is that expansion of industrial livestock production is less rapid among ruminants that confer these soil fertility benefits than among monogastric species (hogs, poultry), the excreta of which have less salutary effects on soils.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

in the health of the land (Thompson, 1995). On the other hand, vertical coordination may result in inducements to adopt environmentally friendly processes in order to get premium prices. These can come from (primarily wealthier) consumers willing to pay for credence goods[4] such as shade grown coffee, dolphin-safe tuna, or organically grown cereals or vegetables. They may also emerge from investors willing to pay a 'green premium', (e.g., for compliance with ISO 14000 standards) or who are concerned about downside liability risk. Since larger corporations are commonly more susceptible to government monitoring and because they vertically integrate in part to stabilize throughput volumes, they may be more inclined than smaller, atomistic firms toward voluntary compliance with environmental standards in order to avoid regulatory disruption. In theory, the potential strength of each of these countervailing forces should grow with downstream buyers' market power, although the net effects are ambiguous and remarkably understudied. It remains to be seen what effect worldwide consolidation in food retailing is having on the ecological footprint of farming.

A good example of the mixed environmental effects of agroindustrialization arises in the case of Kenyan horticultural production, which has exploded over the past decade, thanks to contract farming and standardization driven by European importers of flowers, strawberries, tomatoes, and other high-value fresh produce.[5] Kenyan producers make extensive, unregulated use of methyl bromide, a chemical soil fumigant that is both toxic and considerably more destructive to the ozone layer than chloroflourocarbons. Rich country governments and flower growers shun the chemical and, under the Montreal Protocol, governments agreed to a gradual phase-out of methyl bromide use by 2015. Agroindustrialization's effects can also be seen, however, in the trumping of government agreements by pressure applied by European consumer groups demanding that supermarkets label horticultural products 'grown without the use of methyl bromide'. Retail chains with significant market share are forcing a change in production methods half a world away. Private Kenyan producers, the second largest source of cut flowers on the Dutch auction market, are now rapidly and voluntarily abandoning the use of methyl bromide as a soil fumigant, even though no equally effective, affordable substitute chemical or method has yet emerged to replace it.

4. Direct downstream effects in agricultural processing and distribution

In spite of some prominent gaps in knowledge, the preceding questions of agroindustrialization's direct effects on farming and upstream supplier industries have been far better studied than have the corresponding issues of agroindustrialization's downstream or indirect effects. To our great surprise, a widespread call for papers and several direct approaches to scholars working on related issues failed to attract a single publishable

[4] Credence goods involve unresolvable information asymmetry problems, as when a consumer cannot tell from the product whether it was grown in a particular way.

[5] This paragraph draws heavily on Guracha (2000) and Ojanji (2001).

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

submission on downstream or indirect effects for this special issue. For reasons that this section and the next make plain, we do not believe this lacuna results either from the absence of important questions or from an abundance of compelling theoretical or empirical analysis. These are clearly understudied topics in need of further research.

The rise of downstream value-added activities such as processing and distribution is a central feature of agroindustrialization. Where the primary concerns surrounding induced changes in smallholder farming tend to revolve around 'green' issues of area expansion, habitat destruction, deforestation, overuse of water, etc., the downstream issues are typically more 'brown', centering on air and water pollution, solid waste and energy. We address these now in turn before concluding the section with some general thoughts on the role of government in controlling the environmental effects of downstream agroindustrial processors and distributors.

Air and water pollution: Recent studies have consistently found the agroindustrial sector (e.g., food processing, tanneries, textiles) among the dirtiest of industries in developing countries as measured by air and water pollution generated (Brandon, 1993; Pargal and Wheeler, 1996; Lanjouw, 1997; Dasgupta, Hettige, and Wheeler, 2000; Jayaraman and Lanjouw, 2000). Some of this results from the nature of the biochemical processes involved in much agroindustry. Harsh chemicals used in bleaching textiles, curing leather, etc. perhaps predispose agroindustrial ventures toward pollution.

The organization of the processing and distribution sectors may matter as well. An extensive empirical literature has generally failed to find economies of scale in agricultural production. Scale seems to matter, however, in processing and distribution, where fixed capital and contracting costs create minimum efficient scales of operation that are relatively large by the standards of many developing countries. So as low-income agriculture becomes commercialized and industrializes, there is a natural tendency toward increasingly concentrated processing and distribution subsectors. OECD countries have been undergoing this process for the past 20 or 30 years and similar processes are now appearing in many developing countries.

This transformation may matter insofar as developing country governments' fledgling efforts at pollution control focus largely on point sources at large industrial plants. Smaller, informal sector firms tend either to face explicitly different regulatory standards (Beghin and Metcalfe, 2000) or to fly beneath the regulatory radar. The recent literature on urban clusters of small-scale tanneries, brick kilns, textile mills, slaughterhouses, breweries, grain processors, etc. consistently finds severe environmental damage caused by air and water pollution unmonitored and not sanctioned by government agencies (Bartone and Benavides 1997, Lanjouw, 1997; Blackman, 1998; Blackman *et al*., 2000; Dasgupta, Hettige, and Wheeler, 2000; Jayaraman and Lanjouw, 2000). Moreover, as firms get larger, they may become: 1 better able to finance acquisition of pollution-control equipment; 2 more likely to become subject to routine, effective monitoring and enforcement by public regulators; and 3 more vulnerable to reputation effects and community pressure.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

Furthermore, while considerable concern has been voiced about the potential for a 'race to the bottom' in environmental standards, it may also be true that multinational entrants are better positioned to import more stringent OECD environmental standards to which they have already adapted. Endowed with this technology advantage, multinational processors may then lobby host country governments for stricter environmental standards that will turn this difference to the firm's competitive advantage. Upjohn has followed this strategy in its animal pharmaceuticals operations in Mexico as has Pepsi in vegetable processing in India.[6]

We do not want to give the mistaken impression, however, that larger-scale processing is unambiguously better for the environment. For one thing, larger-scale industrial processors tend to substitute machinery for human labor, with the likely consequence of greater air pollution, *ceteris paribus*. Moreover, since the spatial concentration of suspended particulates and toxic effluents matters fundamentally to the ecological response to pollution, even lower aggregate volume could nonetheless have more serious environmental effects if concentrated disproportionately over a smaller area. The air and water pollution effects of changing scale of processing and distribution remain poorly understood today in low- and middle-income countries.

Solid Waste To the extent that agroindustrialization introduces processing and packaging beyond that which has already taken place, it adds to the solid waste stream. Call this the 'fast food effect' – since the rise of convenience foods with a high density of packaging per unit food consumed (e.g., from fast food restaurants) indisputably introduces a new layer of waste to traditional farm-to-table systems. But insofar as developing country agroindustrialization simply moves processing that would take place anyway closer to source markets for raw commodities, it merely induces spatial redistribution of solid waste, a 'relocation effect'. Any change in the aggregate volume of solid waste from the relocation effect must be due not to the emergence of processing plants in a low-income country – for these merely substitute for processing plants elsewhere – but to either associated changes in processing technologies' efficiency or to the indirect effects of induced changes in demand, on which more in the next section. At present, we know relatively little about how large any of these three effects really are in developing countries.

One of the crucial parameters determining agri-food processors' efficiency with respect to solid waste generation is the proportion of by-products recycled. Many opportunities exist for recycling waste products. For example, used cooking oil is relatively easily converted into biodiesel, which has almost identical chemical structure to petroleum-based diesel fuel, yet burns cleaner. Biodiesel is used experimentally in municipal electricity generation and public transport in a few rich countries, but it remains relatively expensive, thereby discouraging use in the developing world.

[6] Birdsall and Wheeler (1992), writing about Latin America, similarly suggest that multinationals may be more sensitive to environmental risks.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

Perhaps the biggest opportunity for recycling food processing industries' solid waste lies in concentrated livestock feeds.[7] Byproduct feeds such as grain milling residues, brewery wastes, outdated infant formula and shelf-stable milk, fish and bone meal, etc. can be good sources of protein, calcium and phosphorous for both ruminant and monogastric livestock. Markets already exist in such products, not least because they tend to be cheaper than commercially produced feeds and less subject to seasonality in supply than are forage grasses and traditional silage (Mbugua, 1999). Byproduct feeds enable livestock producers to extend animal production capacity without bringing new land into operation. This is especially important as livestock production increasingly moves to zero-grazing systems in peri-urban areas proximate to burgeoning markets for fresh dairy and meat products. However, byproduct feeds typically require modest further processing subject to minimum efficient scale. As a consequence, byproduct feeds rarely emerge in significant volume from small-scale processing sectors. Consolidation in the processing sector may therefore lead to more efficient recycling of solid processing wastes, with indirect benefits on land quality in areas vulnerable to overgrazing. Whether such a hypothetical effect indeed emerges remains to be seen.

Energy Energy use has profound effects both on local environmental conditions, such as forest cover and air pollution, and on global conditions, particularly global warming due to greenhouse gas emissions. Agroindustrialization inevitably changes both the volume and form of energy consumption, thereby affecting both global and local environments. These effects come through multiple channels.

First, by emphasizing larger-scale downstream processing, agroindustrialization commonly involves some substitution of machinery for human labor within the processing sector, thereby increasing demand for hydrocarbons-based energy *ceteris paribus*. Alternatively, in so far as there exist scale economies in processing, the substitution of industrial processing for home processing may conserve energy in aggregate, especially for prepared foods (e.g., alcohol, canned foods) requiring extended cooking that typically uses inefficient-burning fuelwood or charcoal when done residentially. At present we know little about how energy consumption in one segment of the farm-to-table chain substitutes for energy use in another, and the relative efficiencies of the alternatives.

The biggest potential shift in energy use associated with agroindustrialization probably arises from changes in the volume and form of transport. Agroindustrialization is inextricably linked to the commercialization of agricultural output. Increasing domestic and international trade in agricultural products stimulates derived demand for transport. More product transported more kilometers almost inevitably means additional burning of hydrocarbons, a scale effect.

[7] For example, Harpster *et al*. (1997) report on successful feeding trials using byproduct feeds based on outdated infant formula, blood and feather meal from a rendering plant, and carrot and potato processing residues.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

More subtle, but potentially equally important environmental effects arise from changing the location of processing of primary commodities, and from changes in forms of packaging and transport. Energy consumption in transport is a function of distance traveled, weight hauled, and transport mode. Insofar as agroindustrialization in developing countries moves processing closer to farm sources of raw commodities, it cuts down on weight hauled for the same shipped final consumption volume. It is also true, however, that low-value commodities are commonly transported by slower, more environmentally friendly modes of transport, such as barge and rail, while higher-value products are commonly transported by faster, less clean methods of air and road (van Veen-Groot and Nijkamp, 1999). So once again, the net effect of changing from semi-subsistence production with commercialization of raw commodities to market-oriented production and marketing of processed agricultural products has analytically mixed environmental effects. There is a pressing need for good empirical research to establish the net effects with some confidence.

General issues In each of these areas – air and water pollution, solid waste, energy – the proper role of government is a key issue. What instruments are effective in combating agroindustrial pollution? Should regulators develop and impose standards? If so, should they be performance standards or mandated technology ones? Theory favors performance standards because they can induce regulation-led innovation to cut costs or increase efficiency (Porter and van der Linde, 1995). Do poor countries have the fiscal and human resources necessary to regulate pollution effectively in any manner?

Government regulation may be less important than the traditional environmental economics literature suggests. An intriguing recent literature on voluntary compliance raises the real prospect that firms may voluntarily develop and adopt environmental standards, although compliance is by no means either automatic or universal, especially with regard to standards originating outside local industry (Sykes, 1995; Segerson and Miceli, 1999; Dawson and Segerson, 2000; Barrett and Yang, 2001). Many firms do, however, perceive and respond to pressure from environmentally minded consumer groups and shareholders (Dasgupta, Hettige, and Wheeler, 2000). In that sense, agroindustrialization may lead to environmental benefits by tying processors and distributors more closely to final retail markets. Recent research in Asia and Latin America finds informal regulation through social and political means induces extralegal compliance (Pargal and Wheeler, 1996; Hettige *et al*., 1998; Blackman and Bannister, 1998; Dasgupta *et al*., 1998; Blackman, 2000; Dasgupta, Hettige, and Wheeler, 2000). Governments can also turn to market-based instruments, such as emissions taxes, marketable pollution permits, subsidized filtration equipment, or environmental management training, and to peer monitoring to motivate even unregulated firms to reduce emissions (Pargal and Wheeler, 1996; Blackman and Bannister, 1998; Frijns and Van Vliet, 1999; Blackman, 2000; Blackman *et al*., 2000; Dasgupta, 2000). Serious environmental regulation is so recent a phenomenon in the developing

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

world that the empirical evidence on the efficacy of regulatory and extra-regulatory methods of environmental protection in those areas remains thin. Accelerating agroindustrialization raises the stakes for getting and analyzing such evidence so as to establish how governments can best induce better environmental performance in a sector that is traditionally environmentally unfriendly.

5. Indirect effects due to income growth and induced structural changes

Agroindustrialization is actively encouraged by many developing country governments as a means to stimulate employment creation and income growth in rural areas and to improve the nation's balance of payments position. With government controls over agricultural marketing and processing largely ended during the structural adjustment era of the 1980s and 1990s, most developing country governments are actively encouraging private investment in commercial plantations for high-value crops and in processing plants intended to capture the value added from transforming raw commodities into products ready for retail distribution in urban and, perhaps especially, overseas markets. Any success agroindustrialization achieves in advancing these macroeconomic objectives can spark important second-order effects due to increased incomes, trade or both. The broad scale transitions involved in agroindustrialization thereby raise core questions familiar from the environmental Kuznets curve (EKC) and trade and environment literatures. We have no intention of revisiting those literatures in detail here since recent special issues of this journal have focused on each (Barbier, 1997a; Barrett, 2000). It is nonetheless important to call attention to the core principles and concerns each literature raises, as they do relate to the agroindustrialization–development–environment relationships.

The core EKC hypothesis is that environmental degradation first increases, then decreases as per capita income grows, thereby exhibiting a inverted-U relationship between those two variables.[8] Most explanations of the EKC turn on patterns of structural economic changes, technological advances, and income-driven demand for improved environmental quality that are essentially indistinguishable from those describing agroindustrialization more specifically. This similarity is cause for concern in the agroindustrialization context because the initial positive EKC relationship between income growth and environmental degradation finds more widespread empirical support than does the posited subsequent negative relationship. If there is a lesson to be learned from the EKC literature, it is that agroindustrialization might have significant adverse effects on the natural environment if not addressed proactively in the next decade or two.

The trade and environment literature evinces several distinct yet interrelated effects that are at play in agroindustrialization as well. The scale effect – that higher output levels bring more pollution, all else equal – predicts increased environmental degradation unambiguously. The decisive

[8] Barbier (1997) offers an excellent summary of the relevant issues in the EKC literature.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

factors of the environmental effects of increased trade thus relate to the sign and magnitude of the 'composition', 'technique', and 'standards' effects associated with changing spatial patterns of production (e.g., between places with tougher or weaker environmental protection laws), induced technological change, and environmental regulatory change resulting from increased marginal willingness to pay for a cleaner environment as incomes rise, respectively. If agroindustrialization moves processing from inefficient coal- and wood-fired mills in rural areas to more efficient peri-urban plants powered by hydro-electric power and simultaneously income increases help stimulate more stringent local environmental protection, it is conceivable that net environmental improvement could result. Much of the literature on trade and the environment has focused on the claim that differential standards of environmental enforcement confer non-trivial cost advantages that enhance the global competitiveness of polluting industries in developing countries.[9] The limited available empirical evidence largely fails to corroborate this popular claim, however (Tobey, 1990; Low, 1992; Grossman and Krueger, 1993). Moreover, the structural shifts associated with agroindustrialization are often less about international reallocation of market share than about intra-national shifts and consolidation within the marketing channel. So, while one can draw on the analytical constructs of the trade and environment literature, its empirical findings are only partially relevant, with scant empirical work done on the consolidation and intranational composition effects specific to agroindustrialization.

6. Conclusions

This special issues calls attention to the environmental effects of agroindustrialization, an accelerating phenomenon throughout the low- and middle-income world. Like the rest of the extant literature, the papers in this issue focus heavily on upstream effects. These basically boil down to two core questions: What do the emergence of genetically engineered cultivars developed by multinational corporations, and the continued intensification of agriculture by Green Revolution methods of irrigation, machinery and use of chemical fertilizers and pesticides mean for the environment? And what policies might governments effectively implement to control the adverse effects and reinforce the favorable effects of such processes?

In this introductory essay, we have tried to incorporate those issues into a more general conceptualization of the environmental effects of agroindustrialization in developing countries. In particular, we extend the standard upstream issues in three directions. First, we raise questions about the environmental effects of the changing organization of farming and its relationship to the agricultural marketing channel. Second, we address the environmental effects of rapidly growing and changing downstream processing and distribution subsectors, emphasizing in particular effects related to air and water pollution, solid waste, and energy. Third, we briefly connect agroindustrialization to related literatures on the

[9] See Barrett (2000) for a nice survey of current work on this topic.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

environmental Kuznets curve and trade and the environment. These areas are ripe for rigorous analytical and empirical work. Indeed, although agroindustrialization appears both desirable and inevitable in the low- and middle-income world, its potentially far-reaching impacts on the environment are analytically ambiguous and badly underresearched empirically.

References

Angelsen, A. and D. Kaimowitz (eds.) (2001), *Agricultural Technologies and Tropical Deforestation*, Wallingford: CAB International.

Barbier, E.B. (ed.) (1997a), Special issue on 'The environmental Kuznets curve', *Environment and Development Economics*, **2**(4).

Barbier, E.B. (ed.) (1997b), 'The economic determinants of land degradation in developing countries', *Philosophical Transactions of the Royal Society, Series B* **352**(1356): 891–899.

Barbier, E.B. (2000), 'Links between economic liberalization and rural resource degradation in the developing regions', *Agricultural Economics*, **23**(3): 299–310.

Barbier, E.B. and J.C. Burgess (eds.) (2000), Special issue on 'The economics of tropical deforestation and land use', *Land Economics*.

Barrett, C.B. (1997), 'Food marketing liberalization and trader entry: evidence from Madagascar', *World Development*, **25**(5): 763–777.

Barrett, C.B. and T. Reardon (eds.) (2000), Special issue on 'Agroindustrialization, globalization and international development', *Agricultural Economics*, **23**(3).

Barrett, C.B., F. Place, and A.A. Aboud (forthcoming), *Natural Resources Management in African Agriculture: Understanding and Improving Current Practices*, Wallingford: CAB International.

Barrett, C.B. and Y.N. Yang (2001), 'Rational incompatibility with international product standards', *Journal of International Economics*, **54**(1): 171–191.

Barrett, S. (Ed.) (2000), Special issue on 'Trade and environment', *Environment and Development Economics*, **5**(4).

Bartone, C. and L. Benavides (1997), 'Local managements of hazardous wastes from small-scale and cottage industries', *Waste Management and Research*, **15**(1): 3–21.

Batie, S.S. and D.E. Ervin (this issue), 'Transgenic crops and the environment: missing markets and public roles', *Environment and Development Economics*, **6**(4): 435–457.

Beghin, J. and M. Metcalfe (2000), 'Market hogs? An international perspective on environmental regulation and competitiveness in the hog industry', *Choices*, 28–33.

Birdsall, N. and D. Wheeler (1992), 'Trade policy and industrial pollution in Latin America: where are the pollution havens?', in P. Low (ed.), *International Trade and the Environment*, Washington, DC: World Bank.

Blackman, A. (2000), 'Informal sector pollution control: What policy options do we have?', *World Development*, **28**(12): 2067–2082.

Blackman, A. and G.J. Bannister (1998), 'Community pressure and clean technology in the informal sector: an econometric analysis of the adoption of propane by traditional Mexican brickmakers', *Journal of Environmental Economics and Management*, **35**(1): 1–21.

Blackman, A., S. Newbold, J.-S. Shih, and J. Cook (2000), 'The benefits and costs of informal sector pollution control: Mexican brick kilns', Resources for the Future Discussion Paper 00–46.

Brandon, C. (1993), 'Towards an environmental strategy for Asia', World Bank Discussion Paper 11831–ASIA.

Brown, K. and D.W. Pearce (eds.) (1994), *The Causes of Tropical Deforestation: The Economic and Statistical Analysis of Factors Giving Rise to the Loss of the Tropical Forests*, London: University College London Press.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

Dasgupta, N. (2000), 'Environmental enforcement and small industries in India: reworking the problem in the poverty context', *World Development*, **28**(5): 945–967.
Dasgupta, S., H. Hettige, and D. Wheeler (2000), 'What improves environmental compliance? Evidence from Mexican industry', *Journal of Environmental Economics and Management*, **39**(1): 39–66.
Dasgupta, S., N. Mamingi, and C. Meisner (this issue), 'Pesticide use in Brazil in the era of agroindustrialization and globalization', *Environment and Development Economics*, **6**(4): 459–482.
Dawson, N.L. and K. Segerson (2000), 'Voluntary agreements with industries: participation incentives with industry-wide targets', Mimeo, University of Connecticut.
Fafchamps, M. (1994), 'Industrial structure and microenterprises in Africa', *Journal of Developing Areas*, **29**(1): 1–30.
Food and Agricultural Organization (FAO) (1993), *Forest Resources Assessment 1990: Tropical Countries*, Rome: FAO.
Food and Agricultural Organization of the United Nations (FAO) (1997), *State of the World's Forests 1997*, Rome: FAO.
Frijns, J. and B. Van Vliet (1999), 'Small-scale industries and cleaner production strategies', *World Development*, **27**(6): 967–983.
Grossman, G. and A. Krueger (1993), 'Environmental impacts of NAFTA', in P. Garber (ed.), *The US–Mexico Free Trade Agreement*, Cambridge, MA: MIT Press.
Guracha, K. (2000), 'Horticulture pollution causing serious concern', *[Nairobi] Daily Nation*, 27 January.
Harpster, H.W., J.W. Comeford, R.L. Swope, and V.I. Baumer (1997), 'Management systems for utilizing food processing byproduct feeds', Proceedings of the 1997 Cornell Nutrition Conference for Feed Manufacturers, Cornell University, Ithaca, New York.
Jayaraman, R. and P. Lanjouw (2000), 'Small-scale industry, environmental regulation and poverty: the case of Brazil', Mimeo, World Bank.
Lanjouw, P. (1997), 'Small-scale industry, poverty and the environment: a case study of Ecuador', Mimeo, World Bank.
Kaimowitz, D. and A. Angelsen, (1998), *Economic Models of Tropical Deforestation: A Review*, Bogor, Indonesia: Center for International Forestry Research.
Koop, G. and L. Toole (1999), 'Is there an environmental Kuznets curve for deforestation?', *Journal of Development Economics*, **58**(2): 231–244.
Kooten, G.C. van, R.A. Sedjo, and E.H. Bulte (1999), 'Tropical deforestation: issues and policies', in H. Folmer and T. Tietenberg (eds.), *The International Yearbook of Environmental and Resource Economics 1999/2000*, London: Edward Elgar, pp. 199–248.
Lee, D.R. and C.B. Barrett (eds.) (2000), *Tradeoffs or Synergies? Agricultural Intensification, Economic Development and the Environment in Developing Countries*, Wallingford: CAB International.
Low, P. (ed.) (1992), *International Trade and the Environment*, Washington, DC: World Bank.
Mbugua, P.N. (1999), 'Production and use of concentrates in the smallholder dairy sub-sector in Kenya', Kenya Ministry of Agriculture Smallholder Dairy project report.
Ojanji, W. (2001), 'Rich countries betray local flower industry', *[Nairobi] Daily Nation*, 4 January.
Pingali, P.L. (this issue), 'Environmental consequences of agricultural commercialization in Asia', *Environment and Development Economics*, **6**(4): 483–502.
Porter, M.E. and C. van der Linde (1995), 'Towards a new conception of the environment-competitiveness relationship', *Journal of Economic Perspectives*, **9**(4): 97–118.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press

Reardon, T. and C.B. Barrett (2000), 'Agroindustrialization, globalization, and international development: an overview of issues, patterns, and determinants', *Agricultural Economics*, **23**(3): 195–205.

Reardon, T. and C.B. Barrett (2001), 'The ambiguous effects of policy reforms on sustainable agricultural intensification in Africa: renewed threats to fragile margins?', in A. Angelsen and D. Kaimowitz (eds.), *Agricultural Technologies and Tropical Deforestation*, Wallingford: CAB International.

Saywell, T. (1999), 'Down to earth', *Far Eastern Economic Review*, 27 May, pp. 60–61.

Segerson, K. and T.J. Miceli (1999), 'Voluntary environmental agreements: good or bad news for environmental quality?', *Journal of Environmental Economics and Management*, **36**(2): 109–130.

Sykes, A.O. (1995), *Product Standards for Internationally Integrated Goods Markets*, Washington, DC: Brookings Institution.

Thompson, P.B. (1995), *The Spirit of the Soul: Agriculture and Environmental Ethics*, London: Routledge.

Tobey, J. (1990), 'The effects of domestic environmental policies on patterns of world trade: an empirical test', *Kyklos*, **43**: 191–209.

van Veen-Groot, D.B. and P. Nijkamp (1999), 'Globalization, transport and the environment: new perspectives for ecological economics', *Ecological Economics*, **31**(3): 331–346.

https://doi.org/10.1017/S1355770X01000249 Published online by Cambridge University Press