Policy Recommendations

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1. Why Policy-makers Should Care

No policy-maker anywhere in the world makes decisions about agricultural research and technology transfer based solely on how those activities affect forests; nor should they. They usually think first about how to increase food production, earn more foreign exchange and raise farmers' incomes. If they paused for a moment to consider whether their efforts might have some bearing on deforestation, they might very well still go ahead with them even if they encouraged forest clearing. Indeed, most people would agree that sometimes crops and pasture should replace forests. We certainly would.

At the same time, many people also believe that the current rate of tropical deforestation exceeds reasonable limits; here again we include ourselves. Technological changes in agriculture can greatly influence whether that continues. While decision-makers must take into account a variety of potential impacts their policies may have, they should not ignore the effects on forests entirely. Radical changes, such as introducing a new crop or animal species, eradicating a major pest, shifting from slash-and-burn agriculture to sedentary systems and using machinery, chemical inputs or irrigation for the first time, can dramatically change land use. Policy-makers should consider this before promoting technologies with potentially negative effects, and might also include mitigating measures to avoid undesirable impacts on forests.

Another reason why policy-makers should understand how technological change affects forests is that research managers and development agencies increasingly seek to justify their budgets by claiming that their projects help conserve forests. As the world becomes increasingly urban and past scientific

breakthroughs allow us to produce more food than markets demand, political support for agricultural research and technology transfer has declined. In contrast, public concern about the environment, and tropical forests in particular, has never been stronger. This has led many development agencies and research managers to 'repackage' their agricultural-technology work and market it as an activity that takes pressure off forests. Projects in agricultural frontier areas assert that, by helping small farmers produce more for longer periods on their existing fields, they can keep the farmers from abandoning their farms after several years and moving deeper into the forest. National and international research centres argue that, without the added production their new technologies make possible, farmers would inevitably have to clear additional forest to meet the rising demand for food.

Some policy-makers may take the stance that the only policy tools they need to conserve forests are protected areas and permanent forest estates. Within such areas, farmers should be kept out by strict regulation and everywhere else the government should leave markets to determine land use. Such views ignore the fact that public investments in agricultural research and technology transfer can powerfully influence land use, whether policy-makers mean them to or not. Besides, few developing countries have protected areas and permanent forest estates consolidated enough for them to rely solely on these approaches and ignore the potential impact of technological change.

As noted earlier, the findings presented in this book suggest that 'win–win' situations exist where new technologies can simultaneously improve both rural livelihoods and forest condition. In other instances, the different objectives conflict and policy-makers must decide how much forest they are willing to lose in return for higher agricultural production and/or farmer incomes ('win–lose'). Occasionally, one even comes across 'lose–lose' situations, where new technologies promote the conversion of forests to alternative land uses that provide little income or employment, cannot be sustained and/or are based on large direct or indirect subsidies.

2. Win–Win Outcomes

Our research has identified five main types of 'win–win' situations, where technological change can simultaneously meet both development and conservation objectives.

2.1. Agricultural technologies suited specifically for forest-poor areas

These technologies reduce pressure on forests and increase production and the incomes of farmers who adopt them. Some are specifically adapted to the natural environments of regions that have already lost most of their forest. Others require infrastructure, human capital or market access that farmers on

the agricultural frontier do not possess. Prime examples of these types of technology include production systems involving highly perishable crops, irrigation investments in traditional lowland agricultural areas and crop varieties designed for regions that have been settled for many years. We can expect any increase in agricultural supply in already deforested regions to depress farm prices and hence discourage agricultural expansion in other areas.

The main caveat is that the technologies must not displace much labour, since people who lose their jobs may migrate to the agricultural frontier. Highly labour-intensive production systems in traditional agricultural regions, such as banana and tea plantations, and the cultivation of flowers, ornamental plants and vegetables can act as sponges for labour and discourage workers from migrating to forest-margin areas.

2.2. Labour-intensive technologies where labour is scarce and migration limited

Farmers in agricultural frontier areas are typically labour-constrained. To adopt a new technology that requires more labour per hectare, they have to stop cultivating some other area. This can reduce overall pressure on forests. However, these technologies will only simultaneously increase incomes and lower deforestation to the extent that they do not encourage in-migration from other regions.

The trick in making this win–win outcome work is to find labour-intensive technologies that farmers are willing to adopt and to avoid an inflow of migrants. In places where labour is scarce, farmers will prefer technologies that save labour, not labour-intensive technologies. Nevertheless, under certain circumstances, farmers will adopt labour-intensive technologies, even on the agricultural frontier. The most common examples involve high-value crops and dairy products whose production is intrinsically labour-intensive, such as bananas, cheese, coffee, coca leaves, pineapple and vegetables. The replacement of shifting cultivation by sedentary annual crop production is another example.

Besides helping to conserve forests, a good reason for policy-makers to promote labour-intensive technologies is that they benefit the poor more, since labour constitutes most poor households' main asset. In contrast, capital-intensive technologies that save labour have made the poor double losers. They cannot afford the new technology and the decline in labour demand depresses local wages.

Integrated conservation and development projects (ICDPs) typically seek to dissuade people living near protected areas from encroaching on those areas by helping them intensify agricultural production on their existing plots. To succeed in these efforts, the ICDPs must have viable labour-intensive alternatives to promote, similar to those mentioned above, and the households that would otherwise encroach upon the protected areas must be

labour-constrained. The project must also have some means of keeping additional families and companies from moving in.

2.3. Promote intensive systems where farmers are also involved in low-yielding extensive farming practices

Developing-country farmers are typically involved in several production systems. Capital constraints might prevent them from engaging more in intensive farming, which can reduce overall farm demand for land. In this situation, government programmes might help the adoption of more intensive land uses, which might also be more sustainable.

Government fertilizer subsidies constitute a key policy issue in this regard. In recent years, many sub-Saharan African countries have removed fertilizer subsidies as part of their structural adjustment programmes (SAPs). This may encourage farmers to revert from sedentary agricultural systems to shifting cultivation. Standing forest constitutes a readily available cheap substitute for fertilizers, so they will only utilize the latter if they can obtain fertilizers at below market prices.

2.4. Agricultural technologies that substantially raise the aggregate supply of products with inelastic demand

Green-Revolution enthusiasts have long pointed to reduced pressure on forests as one of the main positive impacts of the widespread adoption of high-yielding varieties (HYVs). They argue correctly that, were it not for the spectacular increases in cereal production the Green Revolution made possible, developing-country food prices would have risen. This, in turn, would probably have encouraged agricultural expansion into marginal areas. The key elements here are that production rose enough to significantly affect prices and that lower cereal prices probably did not increase cereal consumption by very much. Research managers have made similar arguments in regard to livestock research in the Brazilian Cerrado. There, however, it appears doubtful that either of these two conditions applies.

2.5. Technologies that promote agricultural systems that provide environmental services similar to those of natural forests

Many 'agricultural' land uses provide reasonable levels of biodiversity, carbon sequestration, erosion control and other environmental services traditionally associated with forests. They can even serve as a source of 'forest' products, such as timber and fuel wood. While agricultural land uses will never eliminate the need to maintain certain areas in natural forests or plantations,

agroforests and similar land uses may substitute for some forest functions. Agricultural research and technology transfer clearly have a role in trying to improve such systems and increase the likelihood that farmers will adopt them. Rather than seeking ways to create landscapes with highly intensive and artificial agricultural systems, on the one hand, and pristine forests, on the other, it might be better for policy-makers to encourage landscape mosaics with diverse multilayered cropping systems and forest fragments. As always, the solution depends on the specific objectives and the trade-off that exists between environmental services and agricultural production.

3. Win–Lose Outcomes

Despite what we would all like to believe, many of the impacts of agricultural technology are not win–win. Often higher incomes for farmers or lower prices for consumers come at the expense of forest cover and environmental services, creating a win–lose situation.

3.1. Agricultural technologies that encourage production systems that require little labour and/or displace labour

The prime examples here are technologies designed for mechanized cropping systems and extensive cattle ranches. By making these systems more profitable, technological innovations can provide incentives for farmers to devote more land to them. Since they do not require much labour, expanding these systems will not drive up labour costs and no feedback from the labour market will kick in to dampen the expansion. In the worst-case scenario, new technologies will actually displace labour and the displaced people will migrate to forest-margin areas and clear additional forest. In these situations, countries benefit from increased food production or foreign-exchange earnings but at the expense of environmental services and local livelihoods.

3.2. New agricultural products for sale in large markets in labour-abundant contexts

Many situations where rapid forest clearing occurs involve the introduction of some new crop for export or large domestic markets. More often than not, the new crops replace forests rather than pre-existing crops or unused degraded lands. The labour for these new activities may come from people who migrate from other regions, seasonally or permanently unemployed people within the region itself or people who abandon traditional activities to take up the new ones. At least in the first two situations, this implies a net increase in the amount of labour devoted to activities that involve forest clearing. The fact that

production goes mostly to large markets outside the region often means that supply increases only modestly dampen prices. Typically, the economy booms, at least in the short term, but forests suffer. The major caveat here is that frequently the crops involved are tree crops, such as coffee, cocoa and rubber, which farmers grow in agroforest systems that provide substantial environmental services in their own right.

3.3. Eradication of diseases that limit agricultural expansion

Over the last century, the eradication of pests, such as the tsetse-fly, and diseases, such as malaria, have allowed farmers to occupy large new areas that had previously been off limits. Similarly, the control of foot-and-mouth disease in tropical Latin America may open large new markets to cattle ranchers and encourage them to expand their pasture area. While such disease-control efforts clearly have large benefits for both human health and farmers' incomes, they can also greatly intensify forest clearing.

3.4. Technological changes in forest margin areas with rapidly growing labour forces

Any improvement in the profitability of agriculture in places with remaining forest and abundant labour is likely to provoke greater deforestation. This applies both to situations with rapid spontaneous or directed colonization and to regions with high natural population growth. Technological changes have the greatest potential for fomenting inappropriate deforestation where other government policies, such as subsidized credit, price supports and infrastructure investments, effectively subsidize forest clearing. New technologies greatly magnify the effects of these distortions. Indeed, the combined effect of technological innovation and policy distortions may stimulate much more inappropriate forest clearing than the sum of the two individual effects.

4. Win–Lose + Lose–Win = Win–Win?

As noted previously, many technological changes that farmers are likely to adopt in forest-rich areas are win–lose. Farm income and agricultural production increase, but forest cover shrinks. Many regulatory conservation efforts are lose–win. They restrict farmers' opportunities, but – when enforced – help conserve forests. Perhaps, by creating a policy package that includes both elements one could construct a win–win outcome.

Governments play a central role in agricultural research and technology transfer and could potentially offer farmers subsidized technologies and inputs. In return, farmers might restrict their forest clearing. Access to specific farm

programme benefits would be contingent on certain conservation practices. For this to work, however, would require the government to strictly enforce the agreement, which often proves quite difficult. Otherwise, farmers would have strong incentives to receive the subsidized technologies and encroach into forests. This has been a major problem in ICDPs. In principle, these are designed to create win–win packages but they have often been based on naïve assumptions about farmers' behaviour.

5. Forests or Environmental Services?

How policy-makers view the link between technology and forests depends partly on what environmental services they wish to preserve. For the sake of simplicity, this book's authors have tended to arbitrarily divide landscapes into forest and non-forest. Implicitly, this assumes that forest and non-forest are homogeneous categories. Real landscapes are more complex. They include various kinds of primary and secondary forests, fallow, plantations, agro-forests, perennial crops, scrub vegetation, annual crops and pastures – to name but a few. Each offers different amounts of environmental services and (in some cases) forest products, such as types of biodiversity, carbon sequestration, recreational values, hydrological functions, marketable goods and products households consume directly. Policy-makers must think about which of these concerns them the most and why. To the degree decision-makers ultimately care more about these specific functions and not some arbitrary definition of forests, it may turn out that perennial crops or agroforests perform as well as or better than certain forests. For example, timber plantations may score lower in terms of biodiversity conservation and erosion control than scrub or fallow.

Many significant technological changes in agriculture involve tree crops, such as cocoa, coffee, oil-palm and rubber. Depending on whether one considers tree-crop plantations 'forested', 'deforested' or somewhere in the middle, one can draw quite distinct conclusions about how these technological changes affect forests. We believe tree crops often have a potential for win–win between farm income and environmental services, particularly when compared with the relevant alternatives and not the status quo situation (which might not be a realistic alternative).

6. Economic Liberalization, Market Integration and Globalization

Agricultural markets are increasingly global. The process is partly technologically driven and partly politically driven. Improvements in processing and transport technology have made it possible for farmers to sell their products far away. Export-orientated development strategies, currency

devaluations associated with SAPs and trade liberalization have removed barriers to trade and actively promoted it.

The globalization of agricultural markets makes it much harder for localized agricultural productivity gains to feed through into lower prices and slower growth of cropland and pasture. Global markets are simply too large for most productivity increases to significantly affect prices. Perhaps more importantly, fluctuations in agricultural production in traditional agricultural regions tend to swamp the price effects arising from technological change. As a result, trade liberalization and SAPs greatly increase the likelihood that technological changes in agriculture will have negative or negligible impacts on forests. While agricultural production historically has been closely linked to local population growth, global market demand now increasingly determines local land use.

7. Poverty, Economic Growth and Forests

Many people claim that technological change in agriculture will discourage deforestation by reducing poverty either at the household or at the national level or both. Poor people and countries are excessively concerned with the short term and this leads them to deplete their forest resources too quickly. These analysts imply that, if technological change increased these households' and countries' incomes, that would allow them to take a more long-term view. Others emphasize that the demand for environmental services, such as the recreational benefits associated with forests, generally increases as income rises, while the demand for fuel wood and bush meat declines. For example, higher urban incomes often stimulate tree planting in the nearby periurban surroundings. Technological change also leads to higher economic growth, which may push up wages and discourage people from migrating to marginal agricultural frontier areas or devoting their time to clearing inaccessible forests with poor soils. At the national level, higher per capita incomes may contribute to the governments' capacity to formulate and implement environmental policies. All this suggests that technological change may help families and countries simply to grow their way out of their environmental problems – what we referred to as the economic development hypothesis in Chapter 1.

On the other hand, technological change can also fuel agricultural expansion by providing the capital farmers require for that purpose. If capital markets were perfect, farmers could simply borrow the money they need to enlarge their farms, but in many cases they are not. This forces farmers to finance at least part of their investments involving land clearing with savings, some of which can come from higher productivity and lower costs. Higher incomes also generate additional demands for agricultural products. This pushes up prices and stimulates farmers to enlarge their farms. Economic development provides new sources of capital to invest in infrastructure projects that allow farmers to move into previously inaccessible forests.

We still know surprisingly little about the net effect of these different processes. Some analysts posit the existence of an 'environmental Kuznets curve' for forests: at lower income levels, the additional income will raise deforestation, but subsequent increases will reverse that trend. The econometric evidence to support this idea remains weak. And, even if such a curve exists at the national level, there are still many aspects we do not understand. For example, we still know little about the relative contributions of each factor, the level of income beyond which deforestation begins to decrease or how the question plays out at the household level. For the moment, no one can guarantee that economic development – whether agriculturally driven or not – will lead to a forest transition and an end to inappropriate deforestation. Informed proactive policies will have to do that.