Letters

YURIMAGUAS TECHNOLOGY

I find it seldom worthwhile making a statement aimed at counteracting a published article that is designed to influence policies on ecological planning or management. However, the recent article by Philip Fearnside (*BioScience* 37: 209–214) on "Rethinking Continuous Cultivation in Amazonia" has induced me to do so. The article presents a one-sided and incomplete view of the "Yurimaguas Technology," and if its message is accepted by those who influence Amazonia policies, it could have an unfortunate and retrogressive effect on what I believe is a very promising development.

My own examination of the Yurimaguas experiments, in mid-1986, does not support Fearnside's strong rejection of this interesting work. I do not wish to take issue with all of the technical details of his criticisms; the leaders of the research program can do that themselves. I would like, however, to make the following points:

- In my discussions with the Yurimaguas staff and research leaders, the technology was not promoted as "the" answer to all Amazonia problems, but as "one" answer—and a good one.
- An important point, which is ignored in the article, is that, if done correctly, intensive agriculture is not necessarily ruinous in tropical rain forest regions. I examined soil pits in undisturbed forest and in an adjacent land that had had 22 consecutive crops in seven years. The A horizon was slightly deeper in the cropped area, and the chemical and physical properties were virtually the same—admittedly (and not surprisingly) as a result of additions of lime and phosphate. This fact denies the very widely promoted myth that all tropical rain forest soils are immediately and irrevocably destroyed by cultivation.
- The experiments encompass a range of sophistication and intensification, from high technology to a system based on zero tillage and rotational fallow (including smother crops to obviate the need for herbicides), in which the trees are felled without stumping. Emerging research findings on the importance of synchrony in nutrient release and plant uptake are being incorporated into current research at Yurimaguas. It is refreshing and encouraging to witness a progressive research program that is receptive to advice and criticism and is adapting to new information.
- The problem of erosion on sloping soils is not unique to Amazonia. Once the flat areas have been used, increasing conservation measures (such as contour banks) must be taken on cultivated lands. This applies in southeast Asia, Africa, and South America. It is a problem with any form of agriculture and should not be especially associated with the Yurimaguas methods. The most important requirement is to keep the soil covered at all times, a principle of Yurimaguas systems.
- I am not convinced by Fearnside's refutation of the argument that increased productivity of arable lands will reduce the pressure on clearing more forests. Food production worldwide is increasing and markets are hard to find. It is becoming more important to increase efficiency of production than total production. Whether a relatively wealthy farmer invests in low-intensity cattle production on extensive, cleared areas or in the very high production pastures being developed at Yurimaguas will be dictated by their relative economics. I agree that the deforestation process needs to be examined more closely (and it would be useful to look at comparable areas in Africa), but I do not believe that rejection of the Yurimaguas view is warranted.

The Yurimaguas research has provided a great deal of very useful information. It is a well-conducted and progressive program that has much to offer. It deserves much better than the denigration contained in Fearnside's article, and I sincerely hope that the one-sided and mostly unwarranted criticism will not have a negative effect on the future of the program.

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I wish to comment on Philip Fearnside's recent article, which I consider scientifically biased and politically dangerous.

As a soil ecologist, I have studied soils and their management in a variety of tropical countries—western Africa (especially Côte d'Ivoire), Congo, Mexico, and Venezuela. Last year I started a research program on Yurimaguas on some biological aspects of soil fertility as part of the IUBS/MAB-UNESCO Tropical Soil Biology and Fertility (TSBF) program. This work gave me the opportunity to see the research being done there, and I was most impressed.

The first unfair aspect of Fearnside's paper is to speak of "the" Yurimaguas technology when a great variety of technologies are being tested there. These technologies, only evoked in one short sentence, range from low to high input and include a large variety of crops and associations that make the station one of the better

examples of tropical agronomic research. The so-called Yurimaguas technology is an advanced and sophisticated one. It demonstrates that a high level of scientific and technical knowledge may give good results when applied to tropical agriculture. This is not the first experiment that has given such results, and further research is likely to simplify and improve this technology.

In the present socioeconomic situation of many tropical countries, this technology will develop slowly. However, techniques derived from the Yurimaguas experience, which require less input and knowledge, are likely to expand. Most tropical countries are developing, sometimes slowly, which means that the quality of human resources and the average level of education are improving, as well as the infrastructures. Young people trained in agriculture or agronomy are thus able to use more sophisticated techniques and are understandably keen to live better than their parents.

The second side of the problem is the socioeconomic and environmental context of agricultural practices. Some of Fearnside's criticisms of high-input technology, particularly its possible impact on environment, are reasonable, though probably exaggerated. An example is techniques available to prevent erosion on steep slopes even in low-input agricultural systems. The absence of winter to control pests does not seem a really serious problem when other factors, such as seasonal drought or the impact of predators, have been shown to have equally significant effects. These problems, however, are not specific to the tropics.

High input agriculture in temperate countries is facing serious problems, such as soil erosion, the movement of nitrates towards water tables, and heavy metal accumulation due to the impurities of fertilizers or sewage sludge. These problems emphasize the need to improve current technology, including a better monitoring of soil biological processes. Though serious, these problems appear unlikely to threaten severely the productivity of agriculture.

On the other hand, traditional shifting cultivation used over much of the tropical world is a true cul-de-sac. It is destructive, especially in conditions of reduced fallow periods when available land runs short. It is also a subsistence agriculture, which will never lead to economic development. This agriculture is thus less and less appealing to young people who have higher levels of education and more need to consume than their parents and grandparents. I know of some countries where these people prefer to live in towns rather than carry out this kind of agriculture.

If high- or intermediate-level technologies are not developed, the only alternative is shifting cultivation, which has largely demonstrated its limitations. Refusing technology implies the choice of something even more destructive and with no economic future. Is that what Fearnside recommends? High-input technologies for oil palm, rubber, or sugar cane production are already being successfully used in some countries, for example Côte d'Ivoire, Cameroon, Southeast Asia, and Australia.

In the present socioeconomic context of most tropical countries (including Amazonia), high technologies perhaps offer incentives for young cultivators to improve their techniques rather than a readily applicable option. A variety of intermediate techniques, including low-input sustained agriculture based on the manipulation of biological processes (as proposed, e.g., in the above-mentioned TSBF program), is being examined at Yurimaguas. Such diverse manipulations as intercropping, application of mulches of specified qualities, and introduction of earthworm species are being tested in this program.

The work performed at Yurimaguas and at several comparable stations in the tropics is very much needed to provide solutions for the future. It is both appealing for the cultivators and stimulating for the scientists. Fearnside's argument would have applied to the situation observed 10 or 20 years ago, and it seems unduly pessimistic when the average education level of populations has increased. People have a legitimate need for a better life, and the problem of environmental destruction linked to shifting cultivation has no solution. Possible problems should not be underplayed, but there is reason to hope for economic development based on good-quality agriculture. Adequate policies and the positive and efficient participation of scientists are required. There is also reason to hope that this technology will be accompanied by satisfactory levels of environmental protection, since, for example, improvement of soil quality is pointless unless parallel measures are taken to ensure its conservation.

The conclusion of the 1978 FAO report "Agriculture towards 2000" leaves no other option than rational development to ensure the necessary doubling of food production in the tropics over the next 20 years.

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In "Rethinking Continuous Cultivation in Amazonia," Philip M. Fearnside argues that the Yurimaguas technology cannot be applied, due to the insufficient prerequisites presently prevailing in Amazonia (such as inadequate infrastructure, competition disadvantages, poor education, and lack of capital of the Amazonian farmers). He emphasizes the dangers of erosion on sites with alfisols and vertisols, he mentions the limited reserves of rock phosphate, and he points out the farmers' poor response to the new technology in that area. Finally, he expresses his fears that the new technology will eventually lead to more rapid deforestation.

This article does no justice to a most ambitious agroecological task, and it should not claim the pretentious term *rethinking*. Rethinking would require that first, the ecological problem and the scientific approach, linked with the Yurimaguas experiments, are presented. Then the results from the project should be analyzed using criteria provided by natural sciences. Only by so doing, can one do justice to this difficult, carefully performed, and well-documented scientific research of many years.

In order to make my position more precise, I should add my opinion on

the Yurimaguas technology. In my studies on the ecological difficulties of tropical land use, I analyzed the data of the Yurimaguas experimental station. I became convinced that only a small number of locations in the humid tropics are as yet suitable for applying the Yurimaguas technology, which, in its present state, does not represent a general breakthrough to a new era of crop production on tropical ultisols and oxisols. But I still esteem the scientific work carried out at Yurimaguas. With their sophisticated experiments, Pedro Sanchez, Dal Bandy, José Benites, and the other team members have contributed tremendously to our understanding of the intrinsic disadvantage of tropical agriculture and of how difficult it is to manage an ecosystem of permanent crops on tropical low base status soils.

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Letters

YURIMAGUAS REPLY

It is a pleasure to reply to the letters by B. H. Walker, P. Lavelle, and W. Weischet (*BioScience* 37: 638–640) commenting on my article "Rethinking continuous cultivation in Amazonia" (Fearnside 1987a). My article discussed the Yurimaguas technology experiments in Peru and questioned both the feasibility of applying the system to wide areas in Amazonia and some of the potential economic and environmental benefits claimed by the system's inventors (Nicholaides et al. 1985; Sánchez et al. 1982). The three letters defend the technology and merit a point-by-point rebuttal.

Walker begins his letter by stating that he does "not wish to take issue with all of the technical details of [Fearnside's] criticisms; the leaders of the research program can do that themselves." Needless to say, it is these technical details that lend force to my argument. If one is to refute an argument, one must either present evidence showing that the premises on which it is based are false or one must show that the logic used to draw conclusions from those premises is faulty. One cannot simply disagree with the conclusion. To my knowledge, the Yurimaguas project leaders have not yet responded to the article. It should also be mentioned that a draft of the manuscript was sent to all of the Yurimaguas authors over a year before publication. Only J. H. Villachica responded with comments (some of which were mentioned in the article). I interpret this silence as a confirmation that the facts and reasoning are correct as presented.

Walker goes on to say that the Yurimaguas researchers had not promoted the technology "as 'the' answer to all [of] Amazonia['s] problems, but as 'one' answer—and a good one." I did not say that the Yurimaguas researchers had claimed to have found such an all-encompassing answer (although government planners are tempted to interpret their claims in this way). Nevertheless, as demonstrated in my article, the system's potential contribution to solving Amazonia's problems is less than was claimed by Nicholaides et al. (1985) and Sánchez et al. (1982). Decrease in deforestation is not likely to materialize, largely because of the nonsubsistence motivation of most clearing in the region (Fearnside 1987b).

Walker's next point is that "if done correctly, intensive agriculture is not necessarily ruinous [for soil properties] in tropical rain forest regions." As Walker concedes, this is not disputed in my article. However, the "if done correctly" caveat is essential—and not likely under real circumstances in Amazonia.

The point is raised that the "experiments encompass a range of sophistication and intensification, from high technology to a system based on zero tillage." Only the high-input system known as the *Yurimaguas technology* was the subject of my article; the presence of other experiments at the station to which my criticisms do not necessarily apply was clearly stated at the outset of my article.

Soil erosion is dismissed as "a problem with any form of agriculture." Walker observes that when land is not flat "conservation measures (such as contour banks) must be taken on cultivated lands." Faith that farmers will take the appropriate soil conservation measures when the need arises is heartening, but the record in Amazonia is poor so far. Walker goes on to state that the "most important requirement is to keep the soil covered at all times, a principle of Yurimaguas systems." While continuous cover is indeed desirable, it is not possible in the Yurimaguas technology of continuous cultivation: land must be left bare for some time between crops and when the crop plants are too young to cover the soil.

Walker is "not convinced by Fearnside's refutation of the argument that increased productivity of arable lands will reduce the pressure on clearing more forests." However, he follows this with a statement that, if he considers its implications, should help convince him: "Whether a relatively wealthy farmer invests in low-intensity cattle production on extensive, cleared areas or in very high production pastures being developed at Yurimaguas will be dictated by their relative economics." This was precisely my point: the extensive system is presently more profitable, especially when contributions from land speculation are included. Policies to remove the profitability of unsustainable systems are needed urgently, and cannot be substituted for by the technology.

Walker concludes by saying that the Yurimaguas research "deserves much better than the denigration contained in Fearnside's article." While disagreeing strongly with the interpretation Nicholaides et al. (1985) and Sánchez et al. (1982) give to their results, my paper does not denigrate the research. Considerable care was taken in drafting the article so as not to appear to do so.

Lavelle begins his letter by saying that he considers my article "scientifically biased and politically dangerous." Neither charge is substantiated. They appear to be based on the mistaken assumptions that my article should discuss all of the various lines of research underway at the Yurimaguas Experiment Station rather than only the high-input continuous cultivation system and that I advocate shifting cultivation as the alternative to the Yurimaguas technology.

Lavelle writes that it is "unfair to speak of 'the' Yurimaguas technology when a great variety of technologies are being tested there." I would remind him that the term *Yurimaguas technology* was given to the high-input continuous cultivation system by the research team itself (see Nicholaides et al. 1984, 1985). This is the system that is the subject of the article in *BioScience* by Nicholaides et al. (1985), and which has become known and influential in Amazonian development planning circles. My article was not intended as a review of the Yurimaguas Experiment Station's research program, but as a discussion of the Yurimaguas technology and its development implications.

Lavelle asserts that if "high- or intermediate-level technologies are not developed, the only alternative is shifting cultivation." I certainly do not accept this dichotomy, and neither do the Yurimaguas researchers (see Fearnside 1983, Sánchez and Benites 1987). Lavelle pursues this line of reasoning to the point where he even questions whether I believe that

people "have a legitimate need for a better life." I would direct him to the extended discussion of the goals of development in my book (Fearnside 1986).

Weischet is in the odd position of chastising me for having written the article while basically agreeing with it. He says the article "does no justice" to the Yurimaguas technology, and that to qualify as "rethinking" the project would have to be "analyzed using criteria provided by natural sciences." My discussion not only questions the features of the technology that run counter to limits indicated by natural science but also addresses the technology's social and development policy aspects. These nonnatural science criticisms are no less valid or important.

Weischet writes that "only a small number of locations in the humid tropics are as yet suitable for applying the Yurimaguas technology, which, in its present state, does not represent a general breakthrough to a new era of crop production," and that the Yurimaguas team has "contributed tremendously to our understanding of the intrinsic disadvantage of tropical agriculture and of how difficult it is to manage an ecosystem of permanent crops on tropical low base status soils." That was exactly my point.

The three letters taken together provide a gratifying indication that I hit the mark rather well in my article. Most striking is what has *not* been questioned by my critics: the main points in my paper that lead to its strong conclusions (economic performance, labor requirements, resource availabilities, and the dependence on subsidies). The published letters appear to express shock that a cow so sacred could be questioned but do not refute my argument.

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