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1 AUG 18 19 2 Agricultural Economics Library ENHANCING NATURAL RESOURCE USE TO INCREASE WORLD FOOD PRODUCTION 3 4 Jan/van Schilfgaarde 5 The natural resources we have available to grow our food--land, 6 water, and energy--are finite in extent, and their use for agricul-7 ture is often in competition with other uses. Recent inventories suggest that 3.4 billion ha, or 25% of the world's land surface, in 8 9 principle could be cultivated; at present the cultivated area is less 10 than 11%. Thus the potential for expansion of cultivated area is substantial, but much of this land is not where the people are; 11 12 furthermore, its development could readily lead to drastic and ir-13 reversible resource deterioration, both on-site and off. A similar 14 situation prevails for water. The currently 170 million ha of 15 irrigated land could be doubled, but not without tremendous invest-16 ment and substantial risk. The obvious alternative for increasing 17 food production is to increase production per unit of land. Both 18 avenues must be pursued.

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19 Two divergent, yet related, concepts are often advocated: to
20 transfer the technology of U.S. commercial agriculture to other
21 regions, and to greatly expand basic biochemical research--photo22 synthesis, nitrogen fixation, genetic engineering--in "pure" academic
23 institutions. Both have their proper place in increasing food pro24 duction, but they must be placed in perspective. I propose that
25 higher priority be given to learning to use our natural resources
26 effectively and conservatively, by adapting known principles
27 imaginatively to existing ecological and socioinstitutional circum-

Prisented at AAEA/WAEA yount incernig, San Diego, J-Ly 31 - Aug. 3, 1977. stances, and by further developing these principles to aid in con structive development. This approach is less direct and more
 difficult than transferring large-scale mechanization, and less
 glamorous than biochemistry. It calls for inputs from more than the
 physical and biological sciences; from economics, if you wish, but
 not for myopic benefit-cost analysis.

Some examples may clarify the issue. In Nigeria, it is not un-7 common to encounter 50 plant species that make up a farming system 8 9 for a small community. Introducing monoculture techniques would be socially and agronomically disastrous, as well as expose the land to 10 11 severe erosion. But the recent development of a hand-operated drill for precision planting in mulch or sod can greatly increase labor 12 13 productivity. Combined with a back-carried herbicide sprayer that ap-14 plies 10 ℓ/ha (as compared to the more usual 500 ℓ/ha), the energy 15 required for planting is reduced more than tenfold, while production 16 is increased by improving the existing multiple cropping system.

17 Pereira related an experience in Kenya, where some 20 years 18 ago forest vegetation was transformed into a tea plantation, using 19 the best conservation practices known. Peak runoff flows quadrupled 20 during clearing and planting, and still were double those from 21 forested watershed after a full canopy was established, even though consumptive use was equal. Brazil is committed to develop-22 23 ing 3 million ha of Oxisol savannahs of their Cerrado by 1979, and 24 50 million by 2000; Peru plans to develop 2 million ha of its Amazon 25 jungle by 1990. Do we know how to avoid adverse consequences, and 26 if we do, can we implement the proper measures?

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In Puerto Rico, intercropping a new planting of coffee with plan tains the first 2 years, and taniers the third, increased net income
 more than \$8000 per ha over the 3-year period. Furthermore, imagina tive management practices resulted in subsequent annual coffee yields
 ten times the regional average.

6 Thus the potential has been demonstrated of significant impact
7 on production by adapting imaginative concepts to existing farming
8 systems. So have the dangers of large-scale changes without full
9 realization of the consequences.

Within this framework, exciting possibilities exist for research to realize the full potential of the available resources, natural and human. The thrust of such research should be to help the independent, generally relatively small farmer improve his productivity with a minimal dependence on capital-intensive external inputs. This certainly does not obviate the need for sophisticated and basic research.

17 A key problem, especially in the tropics, is to provide adequate 18 plant nutrition. In view of dwindling (and high priced) supplies of 19 petrochemicals and phosphate rock, one valid approach involves accel-20 erated research to manufacture ammonia more efficiently and from 21 feedstocks other than natural gas, and to improve the inexcusably 22 wasteful methods prevalent in the phosphate mining industry. An 23 alternative, of at least equal merit, is to use the resources at 24 hand to 'reduce the dependence on artificial fertilizer. The amount 25 of major nutrients in organic wastes in 1971 was eight times that in 26 the fertilizers sold. In the U.S., the N excreted by animals in 27

1 confinement was about two-thirds that sold as fertilizer. Clearly. the potential for improved waste recycling techniques is large. 2 Furthermore, research on the use of bacteria (rhizobia) to enhance 3 nitrogen fixation and fungi (mycorrhizae) to increase phosphorus 4 uptake by roots has tremendous potential for improving plant nutri-5 tion without dependence on expensive or even unavailable inputs; 6 such research requires a high level of sophistication, but the re-7 sults lead directly to simple field application. 8

Another opportunity concerns the adaptation of crop plants to 9 environmental stresses. Historically, plant breeding has emphasized 10 selection to fit an environment in which stresses -- nutrient defi-11 ciencies, water, salinity--have been minimized. The selection of 12 grains for aluminum tolerance and some preliminary results showing 13 a wide range of salt tolerance among barley strains indicate the 14 potential of fitting the plant to the environment, rather than the 15 16 reverse.

17 Considering, now, irrigation, the need is for efficient use of 18 water in the first instance. Current practices, in the U.S. and 19 elsewhere, result in substantial waste of both water and energy and 20 unnecessary degradation of land and water. The problems are partly 21 technical, but as illustrated by Reidinger, institutional and 22 economic issues frequently dominate.

23 Space does not permit further examples, but clearly there are 24 tremendous opportunities as well as many problems in increasing pro-25 ductive use of limited natural resources within the framework of 26 socially acceptable farming systems--problems that require technical 27 innovation but, just as urgently, imaginative inputs from social

| 1 | scientists. Some of these are close at home, like the need to pro- |
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| 2 | vide adequate incentives for academicians to address multidisciplinary |
| 3 | real-world problems; others focus elsewhere, where textbook economic |
| 4 | analyses have often aggravated rather than resolved unhappy situa- |
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| 1 | FOOTNOTES |
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| 2 | The author: Director, U. S. Salinity Laboratory, Agricultural |
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