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AGRICULTURE IN A TURBULENT WORLD ECONOMY

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Edited by
Allen Maunder, Institute of Agricultural Economics, University of Oxford, England
and
Ulf Renborg, Department of Economics and Statistics, Swedish University of Agricultural Sciences, Uppsala

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Gower

ACHMAD T. BIROWO AND DIBYO PRABOWO

The Pressure on Natural Resources in Indonesian Agricultural Development

INTRODUCTION

Resources are basic for the economic development of any country, particularly those in the early stages of economic development. For that matter, a country like Indonesia, has to be fortunate with the luxury of abundant natural resources. In the old days people used to call the country 'An Emerald of Natural Resources in the Equator'.

However, up to the present, there are still many poor people in certain parts of the country. Growth in economic development in some parts of the country has been very slow and in others very rapid. Certain sectors of the economy enjoy a high rate of economic growth whereas others remain stationary. Compared with countries like Japan and Singapore, the wealth of natural resources in Indonesia is exorbitant, whereas economic development of Japan and Singapore is high compared with Indonesia. Does it mean that a wealth of natural resources are not that important in economic development? Or maybe, resources are overexploited so that their productive services soon become zero? Or maybe, the resources are managed inappropriately?

The objective of this paper is to unveil policy issues in the management of natural resources for the agricultural development of Indonesia under serious population pressures. The discussion will be centred around two categories of agricultural development activity, namely, crop husbandry and forestry.

GENERAL TOPOGRAPHIC RESOURCES BASE

Indonesia is an archipelago with a land surface of about 190 million hectares, situated between 94° 15'E and 141° 05'E meridian and 6° 08'N and 11° 15'S parallel, running right through the equator. The archipelago consist of 13,677 islands of which 931 or 6.8 per cent are inhabited by around 147 million people. Most of the land surface is covered by forest (60 per cent). The remaining surface are: 8 per cent agriculture, 7 per cent bare lands and 25 per cent other. 41 per cent of the land area is mountainous, 31 per cent hilly and 28 per cent lowland. Some 80 per

cent of the country's 147 million people live in rural areas and agriculture employs about two thirds of the total labour force. In 1980, the agricultural sector provided 31.4 per cent of the total GDP, of which food crops (19.1 per cent) provided the largest share, followed by cash crops, estate crops, forestry, livestock and fishery. In the decade 1970–81, agriculture grew at a rate of 3.8 per cent per annum against a 7.9 per cent growth in total GDP. Hence a decreasing role of agriculture.

According to the 1980 Population Census there were in 1980 around 17.5 million farm households, of which 11.0 million (63 per cent) operated on land of less than 0.5 ha. The corresponding figures in 1973 were 14.4 million farm households, of which 6.6 million (44 per cent) operated on land of less than 0.5 ha. During the period 1973–80, then, the number of farms increased by 2.8 per cent annually, of which, the 'mini-farmers' with less than 0.5 ha increased annually by 7.7 per cent. In 1980 the number of landless farmers were 8.1 millions, which, during the period 1977–80, increased annually by 2.2 per cent. Land fragmentation also became a serious problem.

Java is the most fertile and densely populated island. There, 60 per cent of Indonesia's people live in an area of about 7 per cent of the total land surface. In Java the number of agricultural population per ha was 7.5 in 1973, as compared to 4.9 for the whole of Indonesia. The area of arable land per person actively engaged in smallholder agriculture, except in Kalimantan, is about the same in all parts of the country, i.e., 0.109 ha for Java-Madura, 0.107 ha for Sumatra, 0.090 ha for Sulawesi and 0.113 ha for the total of Indonesia. These figures indicate the limited level of farming technology in the small-holder sector, where, despite an abundance of land resources, the level of technology puts a limit on the amount of land a farmer can operate.

Out of a total of farm households in 1980 of 17.5 million, 73.6 per cent were owner operated, 14.9 per cent tenanted and 11.5 per cent farming a combination of the two. The corresponding figures in 1973 were 74.8 per cent, 3.2 per cent and 22.0 per cent, respectively. Hence, during the period 1973 to 1980 the number of tenants increased annually by 28.2 per cent, owner operator by 2.6 per cent and mixed −6.3 per cent. Although the number of owner operators are still more than two-thirds of the total, the number of tenants is increasing very rapidly.

The above figures indicate that although the resource base for agriculture is abundant, its distribution is uneven. The technology of resource utilisation for agriculture was still limited. With this background, an analysis is made of policy issues on resource management under population pressure in crop husbandry and in forestry.

CROP HUSBANDRY

Management of natural resources in crop husbandry has been pushed mainly towards reaching food self sufficiency, particularly in rice[1]. In the massive efforts to reach food self-sufficiency, intensification programmes

called *Bimas* and *Inmas* have been launched since the late 1960s. *Bimas*, an acronym for *Bi*mbingan *Mas*sal which literally translated means *mass guidance*, is basically a package programme consisting of: (1) intensive extension activities, (2) provision of fertilizers, pesticides and high yielding rice varieties at subsidised prices, (3) provision of credit at subsidised low interest rates and liberal terms to purchase modern inputs as well as to meet the increasing production costs due to the application of improved technology, and (4) a floor-price guarantee at farm gate level. The intensive extension is directed towards stimulating *Panca Usaha*, or *Five Proper Crop Husbandry Practices*, i.e. (1) proper soil preparation, (2) appropriate irrigation management, (3) application of sufficient fertilizer, (4) proper pest and disease control through the use of modern inputs, and (5) appropriate crop husbandry. *Inmas*, the twin programme of *Bimas*, is practically *Bimas* without credit provision, assuming that the farmers are in a financial position to join the intensification programme. In 1981 around three quarters of the total farm land was either under *Bimas* or *Inmas* programme, as compared to a corresponding figure of 25 per cent in the late 1960s. The results of *Bimas* and *Inmas* programmes have indeed been very impressive. National average yield of milled rice per hectare increased from 1.2 tons in the period 1960–7 to 1.65 in 1968–75 and 1.9 tons in 1980–81. After Japan, Taiwan and Korea, today Indonesia has the highest land productivity for rice growing in Asia. Rice production increased from 12.2 million tons in 1969 to 22.9 million tons in 1982. Rice imports were 1.862 million tons in 1973, 1.842 million tons in 1978 and down to 0.458 million tons in 1982. In fact with an annual stock of rice reserves of over 1.5 million tons by 1981, with a 22.3 million ton milled rice production, Indonesia has already reached a situation, in which national consumption needs could be met by domestic production even at a consumption standard of 150 kg per caput per year. Imports were still needed then to provide the annual reserve stock for controlling floor and ceiling prices, as well as for emergency in cases of natural catastrophes. A prerequisite for joining the intensification programme is good irrigation in land management. In 1977 around 5 million ha were under irrigation. Of those, around 3.9 millions ha were under the Department of Public Works and the rest under village administration.

Effective irrigation depends on efficient water management as well as water supplies. The first and second Five Year Plans, 1969–74 and 1974–79, emphasised the large-scale development of irrigation. Quite recently, however, emphasis was put on small-scale irrigation and simple irrigation.

Dibyo Prabowo and Affendi Anwar (1982; pp. 52–3) quoted a study indicating that there was evidence that irrigation water management and utlisation is inefficient at the farm level. They mentioned (ibid, p. 52) that farmers in fully irrigated areas in Klaten, Central Java, typically receive and apply 50 per cent more irrigation water than is necessary for optimum production. Thus, half of the irrigation water currently applied is wasted.

By water reallocation, a significantly larger area could be served in a normal year. Poor management and low irrigation efficiency in Indonesia is partly due to physical facilities that are worn out because of age and lack of maintenance. There has been a lot of discussion about who should pay the costs of operation and maintenance as well as the repayment of the construction costs of the irrigation system. Presidential Instruction No. 1/1969, specified that the costs of water distribution and maintenance of the irrigation system should be borne by those obtaining the direct benefits from irrigation water. The provincial governors were then authorised to charge land owners certain fees. But by long established tradition, irrigation water is free and no water charges are levied. Thus the payment for O & M (Operation and Maintenance) is regarded as a contribution of the land owner to irrigation development, abbreviated as IPEDA, (*I*uran *P*embangunan *Da*erah). The financing of the main system O & M is assisted by a Central Government subsidy of around 50–80 per cent of the total costs. A recent study from East Java (Dibyo Prabowo et al. 1982, p. 55), indicated that O & M expenditure for the primary through the tertiary canals should at least be $21.10/ha. If the large investments allocated in irrigation construction should be followed by efficient water management, the issue of water charge to cover O & M expenses should be solved immediately and appropriately.

FORESTRY

Through Indonesia, forest land covers around 122 million hectares, roughly 60 per cent of the total land surface. In 1979, almost 75 per cent was rain forest. The second largest forest types – secondary or idle forest and swamp forest – occupied less than 15 per cent of the total forest area. The remaining four types – coastal, peat, deciduous and mangrove – each covered about 2–3 per cent of the total forest land. The predominance of rain forest is not surprising because the country is an archipelago within the monsoon rain belt (Birowo 1981, p. 117).

As shown in Table 1, between 1972 and 1979 forest exploitation jumped by around six times to reach 63.1 million hectares. Similarly,

TABLE 1 *Forest area by function in 1972 and 1979 (million ha)*

Forest function	1972	1979	Change in %
Protection	11.5	14.2	23
Production	11.1	63.1	568
Nature conservation	3.5	7.9	126
Reserved	96.1	37.0	−62
Total	122.2	122.2	

Source: Directorate General of Forestry, 1980.

protection forest increased by 23 per cent and nature conservation forest more than doubled. These increases were possible because the area of reserved forest was reduced by more than 60 per cent. The changing structure of the export market, with decreasing supply from the Philippines, produced a tremendous demand, resulting in the rapid growth of forest exploitation. In terms of geographic distribution, more than 90 per cent of the total forest lands are in Sumatra, Kalimantan and Irian Jaya. However, the forest uses differ in the various provinces.

Because of excessive over-exploitation it was reported that around 30 million hectares were critical (Birowo 1975). The critical lands are those, which, (a) regarding the hydro-orological functions are very bad, (b) from the national economic viewpoint have no productive value and (c) from the physical and technical properties have no more value for agricultural development.

On Java, intense population pressure causes people to be land hungry. People are cultivating more crops on steep lands. They go to the forest to gather firewood for own consumption or to sell for cash. The land is often put under cultivation after the trees have been cut. Outside Java, land is not so scarce but the soil is generally much less fertile, more fragile and more subject to erosion if denuded or cultivated. Shifting cultivation, extensive logging and development or transmigration settlements were creating soil depletion problems. Erosion rate and sediment concentration are two indicators of the extent of critical lands. Erosion rates on river basins on Java range from 0.1 to 23 mm per year, whereas in areas outside Java they range from 0.03 to 0.87 mm per year (Dibyo Prabowo et al., 1982, pp. 39, 40). Sediment concentration on river basins on Java ranges from 1,500 to 20,000 mg/l, whereas outside Java it ranges from 150 to 10,000 mg/l.

The erosion rate is continuously rising, as indicated by a study in the Cimanuk river basin (Dibyo Prabowo et al., 1982, p. 43) in which the erosion rate in 1952 was 0.6 mm/year while in 1967 it had increased to 5.3 mm/year. Sedimentation has a serious effect on the dams of reservoirs, decreasing capacity to store water and hence, shortening service life. Due to sedimentation, Karangkates reservoir in East Java is losing its capacity by 1.2 per cent annually.

To solve the problem of the critical lands, reforestation and afforestration are two important efforts. Massive development budgets have been allocated to finance these two programmes. To give an example, in the fiscal year 1975–6, US $140 million were allocated for these two programmes, corresponding to about 20 per cent of the total agricultural development budget, five times the budget for livestock development, three times the budget for commercial crop development and twice the total development budget for fisheries (Birowo 1975). However, up to the fiscal year 1982–3 only around 1.5 million hectares were the result of afforestation and 2.0 million hectares for forestation, just over 50 per cent of the prescribed plan. Skilled personnel are the major bottleneck. Because a huge amount of funds are managed by a very limited number of

project personnel, a number of mass media have lately reported project financial mismanagements. Hopefully with the establishment of a Ministry of Forestry in the new cabinet starting in 1983, the implementation of reforestation and afforestation should be handled more efficiently.

ECONOMIC VIABILITY OF THE RESOURCE CONSERVATION PROJECTS

This section attempts to evaluate the economic viability – the costs and benefits of the technology that has been extended through the resource conservation projects. When the estimate of benefits is not available, at least the estimate of costs will be presented.

Check Dams

These check dams are budgeted not to exceed $150.00/ha of upstream watershed. Once constructed, maintenance costs are minimal. Direct costs are primarily for local labour (60 per cent). which is paid the prevailing wage rate, and material (40 per cent) obtained at the site (except cement). The construction costs vary from $20,000 to $30,000 and required 12,000–15,000 mandays of labour. Compensation is paid to owners of the land flooded by the dam at a rate of $7.50/ha. After the check dam silts up, the land is returned to the original owner.

Terracing on 50 per cent slope or less

The cost of bench terracing and associated structures is largely a function of the slope of the hillside to be terraced. Estimates of labour requirements per hectare suggest a significant manpower input is needed, ranging from 500 to 1,800/md/ha depending on the slope. Some projects paid the farmer to construct the terrace and others did not. Yet, even if the farmer is not paid, he must forgo opportunities to earn a daily wage. At full ($0.70/md) and 50 per cent opportunity costs of labour these manpower requirements imply construction costs of $263 to $1,283/ha. Costs of planning material, tools, and fertilizer required to build and establish a crop on the terrace in year one average $70/ha. Total labour and material costs would range from $1,293 to $1,319 depending on slope and assumed labour costs. While maintenance requirements are reported to be minimal and may be considered as a normal part of land preparation, waterways and drop structures will require yearly maintenance. Consequently, building bench terraces requires a significant investment of time and money.

Improved cropping patterns

Upper Solo River Basin Projects. Results suggest that the improved practices more than double labour demand/ha on severely eroded slopes and increase labour requirements by 27 per cent on the moderately

eroded land. The implicit daily wage the farmer earns for himself by adopting the technology is about three times the pre-adoption level. Net farm income – the consequence of both more days worked per year and a higher wage/day – ranged from 3.5 to 8.3 times that without project, on severe and moderately eroded slopes respectively.

Citanduy River Basin Project. The improved pattern makes possible triple cropping. For the farmers who grew only one crop before development, the improved pattern tripled the labour requirements, tripled the daily wage and increased net income ninefold. For the farmer who grew two crops before the development, the improved pattern increased labour demand by 35 per cent, doubled the wage rate earned, and increased net income by two and a half times.

Livestock component. The cost of establishing a grass cover on the terrace is approximately $45.00 for material and 2–5 md/ha of labour, if 20 per cent of the area is in terrace rises and lips. A mature female sheep/goat costs about $40–45 per head.

The major variable input in small ruminant production is labour. Owning these animals provides an opportunity for the household to self-employ family labour, often child labour with a low opportunity cost. Typically, livestock forage needs are provided by men or boys who cut grass along the roadways and on other public land and carry it back to the pens in which the animals are confined. To feed small ruminants, the household must spend 1 hour/animal/day in the wet season and 2 hours/animal/day in the dry season. Consequently, flock size seldom exceeds 4–8 animals per household. Establishing grass intensively on the terraces greatly reduces the time required to harvest daily food requirements. This enables the household to either raise a greater number of animals with the same labour input or raise the same number of animals with perhaps only 20 per cent of the labour input required under the traditional extensive cut and carry system. Hence, the grass/livestock enterprise can be expected to increase labour productivity and the implicit wage earned from ruminant production by 2–3 times. Furthermore, livestock provide farmers with an additional income stream, reducing vulnerability to crop failure. At the same time, livestock provide a mechanism by which farmers can accumulate capital. Whenever the occasion arises, this asset can be sold to meet family consumption and investment needs.

Development on slopes greater than 50 per cent. The cost of establishing tree crops/grass is dependent on the type of tree planted and the spacing. The long run returns to tree crops such as cloves and citrus are significantly greater than food crops, once they reach maturity. For example, a clove plantation with trees planted at a rate of 250 seedlings per ha gives an annual gross return of over $1,500 per ha.

PRODUCTION AND EXPORTS

In 1981 Indonesia produced 24.6 million m^3 of timber of which 21.2 million m^3 were logs and 3.4 million m^3 were sawn timber. Both the composition and total production have changed since 1970. Log production has increased twofold, whereas sawn timber production has expanded more than 10 times. In general, increasing amounts of processed forest products were produced.

In 1980 forestry exports amounted to US $1.8 billion and were more than ten times that of 1970. In terms of volume, exports had doubled. The general upward trend of export prices indicated the increasing gap of demand over supply. However, major constraints to the development of exports of forest products have been inadequate harbour facilities, high shipping costs, poor quality control and lack of trade skill and management. Between 1969 and 1980 timber exports varied between about 60 per cent and 85 per cent of total production. The period when a high percentage of total production was exported (1975–77) was followed by a decline. Apparently, with increasing incomes, domestic markets are able to use more of the output, particularly of processed wood products.

The market rise in the value of wood as a commodity in the Pacific area has occurred because of the supply and demand in the 1980s, the interest in wood as a renewable energy resource, and the emergence of South Korea and China as significant purchasers. This may stimulate government and investors to channel their resources of capital, land and personnel into a belated but still necessary effective afforestation effort. Today in Indonesia there are 525 firms holding forestry concessions with a total invested capital of about US $1.5 billion. Of these, 430 firms are operating under domestic investment facilities and 95 under foreign investment facilities. The government has encouraged the firms to produce more processed wood and fewer logs. In 1980, a new regulation was issued under which firms would export no more than 50 per cent of their logs and were required to process 50 per cent locally. A few months later, the requirement was increased so that an export permit would be issued for one unit of logs if the firm could produce evidence that it had sold two units for local manufacturing.

From an international perspective it seems likely that Indonesia will become a producer of plywood and other manufactured goods. The major constraint would seem to be the availability of managerial skill. Special plans are being considered to encourage the establishment of timber manufacturing. Under these plans no new forest concessions will be granted to applicants who do not submit plans for establishing a wood-processing plant.

CONCLUSION

Management of natural resources for agricultural development under population pressure cover development activities in crop husbandry and

forestry. The abundant vast resources of Indonesia are unevenly distributed among regions. Limited levels of technology, however, put a limit on the application of resources per unit of agricultural population. Due to rapid population increase the number of mini farmers is increasing vastly, the number of landless farmers likewise growing rapidly and the number of tenant farms are increasing alarmingly.

In crop husbandry, land management in general has been satisfactory. To maintain and operate water management efficiently, however, the problems of how to finance the operation and maintenance of the irrigation system need to be solved appropriately. Improvement of water at the farm level may increase the efficiency of irrigation services.

In forestry, erosion and sedimentation due to excessive forest eploitation are growing at an alarming rate. Programmes for reforestation and afforestation need to be given more serious attention. Reforestation and afforestation projects need more skilled personnel urgently in order to manage the development activities efficiently. The government has encouraged forestry firms to produce more processed woods and fewer logs.

If all bottlenecks could be tackled successfully, proper management of natural resources in agricultural development even with the serious population pressure in Indonesia may definitely increase farm incomes and maintain and improve a healthy and sound environment.

NOTE

[1]Others include expansion of cash crops to increase exports; these issues will not be discussed in this paper, since they have little bearing on population pressure.

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DISCUSSION OPENING I – JOSEPH VON AH

Experts all over the world agree that pressure on natural resources is an important issue at the present time, and, even more so in the future. The Vice President Programme was, therefore, well advised to invite two prominent members of our association to introduce the topic. We are grateful for two comprehensive, informative and competent papers: Farrell and Capalbo covering the situation of the United States as a case of an industrialised country; Birowo and Prabowo presenting prospects of populous Indonesia, situated in the Asian tropics. As discussion opener, I want to highlight four points – needless to say they reflect (in part at least) my background, present interests, personal biases and preferences.

(1) What are really the *facts* on the environmental issues: locally, nationally and world-wide? Both papers have an optimistic undertone: there are problems, certainly, alarming signals due to rapid deforestation (e.g. in Indonesia); dangers and risks of a modern, hard line, chemically based agricultural technology (e.g. in USA). Neither of the two speakers indicated, however, that the situation would deteriorate into chaos and global catastrophe. Similarly Kramer writes in his 'International Overview of Soil Conservation Policy'[1]: 'Soil erosion is not the imminent threat to mankind that some doomsday prognosticators would claim ...'.

This position I set in contrast to widely read, quoted and discussed publications (especially in the Swiss media and by students) like *Global 2000 – Report to the President*, or Fritjof Capra *The Turning Point*[2] – to name just two. At this Conference, Bromley in his highly stimulating paper 'Natural Resources and Agricultural Development in the Tropics: Is Conflict Inevitable?'[3], puts the production of tropical cash crops for export under the heading of 'International Resource Degradation'. Do university professionals or journalists know better? Are administrators in responsible positions always ignorant or biased? How about experts in all camps who hold contrary views to each other?

(2) What is the place of glamorous *biotechnology* for the problem at hand? Birowo does not mention the term; for Farrell it is 'a genie in the bottle' whose release should be carefully evaluated beforehand.

Ricardo has described the scenario of a world with a decreasing man-land ratio and agricultural technology remaining constant; Malthus formulated his dismal solution to the problem as vice, misery and death – also, it seems to me that past trends of agricultural technology must not be simply carried into the future. In fact, today we are 'eating oil' with our highly developed agricultural technology. On the other hand, oil resources are going to be depleted in the foreseeable future. Health hazards for man and beast as well as environmental hazards of an oil-based civilisation and of food production techniques cannot be overlooked (Farrell gave a list of examples.) For these reasons, it is puzzling to me why biotechnology has found such a small place in the two papers. Moreover, the Conference paper by Fishel and Kenny[4] and the Poster Paper no. 63 by L. D. Hill and W. Florkowski[5], both on biotechnology, make no reference at all to possible relief of pressures on natural resources by the new technology.

(3) Do *people* and *villages* matter? Implied in both papers, and explicitly stated in numerous contributions at the Conference sessions, as well as in the 'poster' presentations, we find the *leitmotiv* of how important the main actors, the people in the countryside, are. Agriculture has the unique quality of being a highly location-specific human activity. This concerns the natural conditions (soils, topography, climate, altitude) as well as the man-made organisations and institutions in their history, religion and social structure. An overall consensus seems to prevail that narrowly defined economic analysis is fading into the history of our profession.

(4) Some *more questions* listed:

Poverty and environmental degradation;
Role of organic farming;
Olson's theory on collective action;
Relative impacts of on-farm and off-farm pollution, e.g. of soil and water;
Tourism as a factor of preservation and degradation;
The UNESCO-approach 'Man and Biosphere' (MAB).

I wish to conclude my brief contribution with reference to the Presidential Address by Glenn Johnson. Our profession can make an important contribution to the solution of the problems of natural resources as they relate to the feeding of mankind. A necessary condition for achievement is to widen the 'Scope of Agricultural Economics'[6] and to apply the appropriate mix to theory:

in a multidisciplinary approach
with proper problem solving activities, and
sufficient information about our quantifiable and unquantifiable values', (i.e. the normative and ethical base).

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5. Lowell D. Hill and Wojciech Florkowski, 'Economic Consequences of Biotechnology on International Corn Production and Marketing', (Poster Session Paper no. 64).
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DISCUSSION OPENING II – JEAN-PIERRE BERTRAND

The two papers which have been presented focus on the same topic: Does the intensive model of agricultural development exert tremendous pressure on the natural resources?

In the case of the US Susan Capalbo and Kenneth Farrell argue that the increase in the productivity in agriculture has occurred without taking into account the natural resources and environmental quality, as the process of erosion and degradation of water quality created by the use of huge amounts of pesticides and fertilizers show. The main hypothesis of the authors is that there does exist an inverse relation between an increase in productivity and the maintenance of environmental quality. They think, however, that this relation could be reversed and they propose to take into account the costs of protecting the environment. They then suggest a new approach to measure the productivity.

Agricultural productivity growth at the expense of environment would be made more costly. How, we may ask, could we measure this economically? How to take into account the loss of diversity of systems which are more and more specialised and concentrated? One example of this loss could be found in the case of the soybean system in the United States and of the soybean-wheat system in Brazil. They are very simple, and, without doubt, agronomically balanced, but are they able to resist a biological, climatic or economic shock?

Susan Capalbo and Kenneth Farrell argue that trade-offs between high rates of productivity growth in favour of greater protection of the natural resources and reduced levels of pollution could mean higher real costs of food. They suggest that the magnitude of this cost increase will depend on the difference between the rhythm of development of technologies to maintain production and attempts to reduce the degradation of the quality of natural resources.

In this evolution the price policy will be very important. We could also ask if in the international situation, there should exist a new relation between the movement of prices and the mobilisation of natural resources? Do we have a succession of agricultural booms which put more

pressure on national resources and agricultural busts which, paradoxically, favour conservation practices and policies? Can the acceleration of erosion in the United States during the 1970s be attributed to cultivation of marginal land? On the contrary, what will be the consequences of the present overproduction crisis upon the protection of the environment?

The paper of Achmad Birowo and Dibyo Prabowo raises also the question of the pressure on the natural resources as a consequence of the choice of an intensive model of agricultural production. The authors have shown very well how Indonesia has combined rice self-sufficiency strategy and a vigorous agro-export wood and products policy. The import substitution of rice was obtained thanks to small producers who have adopted new packages of inputs. The rice yield has doubled in the last 20 years which is quite remarkable. What I would like to know is what has happened to the income distribution and if there was not a disruption, or at least deep changes, in the social structure.

In the lumber industry the results have been remarkable too but the effects on environment were more dramatic. On the international demand side, after the 1975–7 boom with high lumber prices, prices have dropped. Indonesia has tried to develop a more complex strategy and has begun to export more processed products, but the country has faced the interests of the developed countries and has suffered from its own lack of managerial skill.

I think it would be very interesting to discuss a little more the specific difficulties of excessive dependence of a strategic sector in very unstable and turbulent international markets.

GENERAL DISCUSSION – RAPPORTEUR: MAURIZIO MERLO

Comments and questions mainly concerned the general analysis of pressure on natural resources as presented by the two papers and the problems of evaluating externalities which have 'non-monetary, intangible' values. Contributions to the discussion also concerned agricultural-environmental policies and special attention was devoted to the environmental impact of foreseeable development in biotechnology.

With regard to the general analysis the opinion was expressed that more attention should have been given to welfare economics, especially Pigou analysis, quite neglected by the Farrell and Capalbo paper. Also multi-objective analysis in its dynamic version was advocated as a more appropriate tool for optimising the trade-offs between farmers' profits (first objective) and 'ecological sustainability' (second objective). Other discussants supported the importance of ecosystems analysis which should be able to give a more comprehensive view of agriculture in the context of the environment and its role in natural resource development and depletion. It was also pointed out that agriculture, besides being a polluter, was very much affected by the pollution created by other activities. Farmers were usually very sensitive to ecological problems and to natural resource conservation but they were under such economic

pressure they were obliged to use the more sophisticated techniques even if polluting.

Several discussants posed the more practical (as well as theoretical) question of how to evaluate costs and benefits of various agricultural techniques. It was observed that various items can often be evaluated in an incorrect way or even ignored. The case of soil overexploitation was raised, underlining its consequences, not only in terms of erosion (as shown by Birowo and Prabowo's paper) but also in terms of more general environmental and social degradation.

Several discussants felt that even when the best theoretical solution of the trade-off between productivity and conservation was found, the crucial problem would remain of evaluating the shadow prices of non-monetary externalities.

It was observed that the modified aggregate production functions proposed by Farrell-Capalbo seemed to be only a first step which needs further sound and consistent evaluations. In this context the problem of intertemporal relationships was also raised; that is, consideration of future generations' welfare. It was pointed out that in various cases solutions to apparent problems are generating more serious problems for the future. Others observed that we are passing the bill to the next generation because we are too selfish on environmental issues. In other words, what really matters is the willingness to pay which seems to be lacking in our societies. It was then felt that this crucial issue was missing in the papers as well in the discussion.

Coming to more political considerations, the free market, and its distortions, was blamed as the main reason for environmental degradation. A 'stick and carrot' policy was then called for to cope with externalities. A supra-national authority at regional level should supervise the policy in order to achieve a better quality of the environment and a more balanced economic growth.

Political issues concerning biotechnology development were also raised with reference to the papers and to the openers' remarks. The modified aggregate agricultural production functions proposed in the Farrell-Capalbo paper were considered a step forward in order to broaden the traditional analysis by taking account of environmental quality as a separate outcome of the production process. However it was observed that what really counted was the attitude of the administration of research stations and the behaviour of farmers. It was pointed out that there should be some implications for environmental policy of a situation of market surplus and a highly intensive use of land in agriculture.

In their replies the authors of the two papers largely agreed with most comments. Birowo and Prabowo particularly stressed the fact that unfortunately many questions up to now had no answers. To a very large extent the demographic pressure, the growing food needs, the development of new technologies were a vicious circle. However, environmental and social problems were constantly in the focus of political intervention.

Farrell and Capalbo first underlined the fact that linkages between productivity analysis and applied welfare economics were unclear. This was an area for further research. Second, with reference to several objections regarding shadow values they agreed about the difficulty of measurement. However, this should not prevent further enquiry into possible adjustments to the familiar production functions. They observed that agricultural economists were famous or maybe 'notorious', depending on one's point of view, for pushing ahead in relatively unexplored frontiers of research and applied empirical work. They also agreed that the suggested modifications were only one of the possible means of incorporating and evaluating the environmental/productivity trade-off; of course other methodologies could be employed.

With reference to questions concerning biotechnologies and the impact of agricultural policies on natural resources, Farrell and Capalbo pointed out the possibility that new biotechnologies might simultaneously increase agricultural productivity and enhance environmental quality. However this possible outcome was dependent on many variables about which we now know very little. These variables included technical characteristics of the technologies themselves, substitution possibilities with more conventional production inputs, and economic variables which affected the rate of adoption and the returns to agricultural producers. This implied a unique opportunity and need for agricultural economists to collaborate with other scientists from other disciplines to assess the potential effects and the environmental impact of the new biotechnologies. This assessment was needed for shaping the future course of development and defining the more appropriate public policies able to encourage the most desirable outcomes.

With respect to agricultural policies, Farrell and Capalbo expressed the opinion that price, income and other policies exerted strong effects on producers' choices and thereby on environmental quality. Consequently there was an obvious need to explicitly incorporate agricultural policy variables in models designed to explore the trade-offs between productivity and environmental quality.

Participants in the discussion included J. Berthelot, F. de Casa Bianca, T. Dams, V. Iakimets, E. K. Ireri, A. Kahan, E. Rabinowicz, P. Söderbaum and G. Weinschenk.