Response to section B

P.S. TENG, M. HOSSAIN and M.J. KROPFF
International Rice Research Institute (IRRI), P.O. Box 933, Manila, Philippines

Response to paper by Van Latesteijn

In general, the author is to be commended for clearly explaining a complex but innovative approach to explore land use options. The results offer options for different desired scenarios, without specific recommendation of one. This is closer to the real world situation, where ultimately, many political decisions are made with consultation and weighing the pros or cons of each available option. The advantage of the approach over more conventional economic approaches appears to be its ability to not stipulate an optimal solution. The author puts this succinctly when he stated "the focus of research is no longer on developments that might be expected, but on developments that might be feasible". In short, the approach explores, and does not choose.

The paper devotes much space to explaining the procedures used for the analyses and not enough is devoted to discussion on findings. The usefulness of the paper could be enhanced by explaining why the different scenarios were selected and how to formulate other scenarios of interest.

The LP procedure, even though it is multiple goal, is nevertheless a 'static modelling' technique. Its limitations include pre-setting assumptions and constraints. For example, high yields are assumed to be those obtained by the best technical means and it would be very cumbersome to incorporate the influence of changing technology to accommodate several yield scenarios. Also, the price – production relationship remains the same while the influence of external demand or supply of commodities (such as may occur with GATT) is set and not allowed to change. In essence, the entire EC region is treated as one big farm divided into *n* regions. Farmer behavioral response, or politician behavioral response to individual goals as affected by the results of other goals, is not included in the analysis.

The procedure used requires prior analysis of factors that determine agricultural development at the regional level. In a sense, there is a selection of key factors to explore. Thus, results will have to recognize that other factors, not included, could play a role in influencing land use. However, a strength of the approach also appears to be that there is no assumption of exchangeability

J. Bouma et al. (eds.), Eco-regional approaches for sustainable land use and food production, 123–129.

between labour, capital and nutrients and all factors are treated equally. This allows a 'freer' exploration of possibilities.

One point that has to be repeatedly kept in mind is that the approach used by the author is for analysis purposes. The next step is specification of a time path for implementation using an economic model.

Response to paper by Penning de Vries et al.

The authors are to be commended for taking a systematic approach, using empirical data, to make an objective estimate of food demand in relation to the production capacity of different agro-ecological zones for supplying food (measured as grain equivalents). However, like most studies of a global nature, this study was also hampered by availability of data and the scale of aggregation. Given the state of current technology (such as geographical information systems, networking, etc.), global projections should account for as much detail as possible, in particular of local influences on the supply-demand equation. This is what John Naisbett calls the post 'New Age' paradigm of *Think Locally, Act Globally* (Naisbett 1994). The authors have tried to do so in their study, but it still falls short because of the small number of spatial units that were used in the aggregation procedure.

The ERA-meeting organizers must have put this and the paper by Pinstrup-Andersen and Pandya-Lorch together to contrast approaches. The first is very 'technocratic' while the second has a more socio-economic flavour.

Global projecting is a process full of potential pitfalls. One is the need to generalize assumptions or average values. Although the authors are to be commended for noting that "it is better to use all basic data and to aggregate subsequently than to use averages", they nevertheless could not apply this guideline to some of the variables used, such as crop yield and consumption demands. For example, we know that in Asia, which grows $> 90\%$ of the world's rice, even in rainfed environments, there is a big difference between actual yields of the favourable rainfed, the drought susceptible rainfed and the submergence susceptible rainfed. External input is only one source of influence on rice yields in these environments. Hence, a more logical division for calculating rice supply would have been to use water as a first determinant, then external input (HEI or LEI) as a second determinant.

The population scenarios used are very reasonable, i.e. low, medium and high. As population growth is a key factor in the food demand calculation, the authors are to be commended for taking this into account. However, it would have added to the discussion had there been some explanation of the three scenarios used in relation to other projections of population growth. For example, the World Bank (1992) also provided three scenarios for population growth based on a rapid decline in fertility (2040 – 8 billion), a base scenario at present rates of growth (2040 – 10 billion) and a scenario with slow fertility

decline (2040 – 12 billion). These scenarios are highly germane to the question of quantity of food demand and to shifts in the type of food. For example, the authors showed that in eastern, southern, and Southeast Asia, there is likely to be a food deficit. Yet, this part of the world is generally recognized as the most dynamic in terms of economic growth and its accompanying purchasing power. Any statement on food sufficiency for these regions will have to deal with (i) the purposeful reduction in actual production capacity, as has happened in Malaysia where the government has set a goal of 65% self-sufficiency in rice; (ii) the substitution of cereal demand for meat and vegetables, a phenomenon that accompanies increased affluence, and (iii) the ability to import from areas such as North America and Australia, which have in recent years developed crop varieties closer to Asian tastes.

As an addendum, the role of GATT and APEC in influencing food production and prices has yet to be factored in and will likely affect food production.

The authors take a rather arduous route to come to the same conclusion that was arrived at by Smits (1986), "that if all food were equally distributed, no one would go hungry". If this was taken as a given, and it appears to be supported by at least one sector of protagonists in the global food supply-demand debate (see Avery 1994), then a more appropriate hypothesis to be explored in the paper should have been whether this can be done without degradation of the natural resource base. The authors define the natural resource base as soil, climate, plant genetic properties and surface water. A more encompassing definition could have been soil, water, biodata and climate. Degradation of the natural resource base will be a key factor in determining the production capacity of much of the global agricultural lands. To assume minimal to no degradation is to ignore an important influence on both supply of and demand for food. In tropical Asia, 2.7 million ha are deforested each year, mainly in the uplands (FAO 1991), resulting in extreme erosion. The uplands are an important ecosystem because of their role as watersheds for much of the lowland rice, even though rice is not a major component of the farming systems of the uplands. Degradation of the lowlands in intensively cropped systems may also be exacerbated in the coming years, as exemplified by the phenomenon of 'yield decline' and decline in total factor productivity (Cassman *et al.* 1994) in rice and wheat. In the humid tropical eco-region of Asia, loss of agricultural land to urbanization is another relatively recent phenomenon that is likely to have profound effects on food supply. By 2040 it is estimated that in Asia, more than half the population will live in Megacities, compared to the approximately one-third of urban population in 1990. On the surface, these factors appear at odds with each other and it will take detailed analyses to make even projections at the Asian level look realistic.

Much of the decision on food sufficiency (security) is based on calculating the relative ratio of supply/demand, but the explanation of why the ratio value of 2.0 is selected as the 'break-even' point is not clear. However,

to recap the authors findings, under an HEI scenario with moderate diets and a medium rate of population growth, only southern Asia would have problems meeting demands, while under an LEI scenario with moderate diets and medium population increase, all of Asia would have problems. This perhaps illustrates a weakness in 'closed' system projections that exclude the role of imports. It is unrealistic to expect that in this dynamic region of economic growth there would not be importation. Conversely, that all regions of Africa showed no food security problems under the same scenarios would further suggest a need to re-examine the scenarios. What is more likely to happen in Asia is the occurrence of medium population growth with a shift to affluent diets, while Africa may be anticipated to have medium population growth with moderate diets. A recent article by Avery (1994) pokes fun at the food shortage pronouncements of L. Brown regarding Asia and he argues that economic growth, trade, and high-yield farming will make up for any potential food shortages in the region. Avery (1994) cites in particular the impact of freer trade in mobilizing the production capacity of 20 million ha of farmland set aside in the USA due to current grain surpluses, and the 30 million ha in Argentina diverted to pastures.

The study could also be made more realistic by taking into account availability of key resources to increase yields such as nitrogenous fertilizers. HEI agriculture may not be that sustainable if there is another increase in petroleum prices. For example, to tap the potential of rice plants to yield an average of 12 tons ha^{-1} will require almost doubling of applied nitrogen unless more efficient techniques of application and utilization are found. Thus, instead of a HEI versus LEI scenario, it would have been more useful to apply several scenarios of N availability at different price structures.

The authors refer to the role of new technologies in influencing future cereal grain supply. It would have added greatly to the paper, and to the study, if in fact scenarios had been presented of yield gains to be anticipated from various technologies, such as high end biotechnology and low end Integrated Pest Management (IPM). Using rice as an example, to meet the anticipated increase in demand in 2050 would require that rice yields increase in irrigated areas from 4.9 tons ha^{-1} in 1990 to 9.3 tons ha^{-1} in 2050 (90% increase), and corresponding yields in the rainfed areas increase from 1.9 tons ha^{-1} in 1990 to 4.5 tons ha^{-1} in 2050 (137% increase) (Zeigler *et al.* 1994). If there is to be no increase in rainfed rice yields, then irrigated rice yield would have to increase to 12 tons ha^{-1} in 2050 (145% increase relative to 1990)! These enormous increases in rice yields will be difficult to achieve with conventional breeding to raise the yield plateau, and at the level of the eco-region, decisions may have to be made to mount a concerted effort involving mechanisms such as consortia to accelerate efforts aimed at either reducing current gaps between attainable and actual (which vary from 2–6 t ha^{-1}) yields, or at increasing yield potential. Part of the international dialogue on eco-regional approaches must take into consideration not only analyses but suggestions

for future action to be taken at expanded time and space horizons (borrowing terminology from the Club of Rome). Increasing the potential yield may be difficult to achieve even with biotechnology in the rainfed environments since many of the traits are multigenetic and their inheritances are as yet not well-understood. Conservative estimates of preharvest losses (gap between actual and attainable yield caused by biotic stresses) which have not been reduced through breeding range from 15–30% annually. At the eco-regional level, Asia accounts for over 80% of all pesticides (insecticides, fungicides, herbicides) sold world-wide. Therefore, the situation exists in which substantial losses are being incurred in spite of high inputs of pesticides and presence of host plant resistance in most genotypes. Crop improvement versus natural resource management strategies could assist the scientific community concerned about eco-regional issues such as IPM policy and implementation.

Response to paper by Pinstrup-Andersen and Pandya-Lorch

This is an excellent paper which succinctly reviews recent developments on the production, consumption (nutrition) and distribution of food in the developing world, the future prospects, and their implications for policy regarding research and development. The authors are to be commended for pulling together a lot of material and synthesizing them into a very logical and well-argued format. Many of the points regarding distribution (access) versus availability (production), however, have been articulated by previous writers. The sentence "global availability of food has not yet translated into availability of and access to food by all people", sums it all up. What the authors have missed is the opportunity to explore implications by eco-regions, taking into account projected changes in the parity purchasing power of different countries in the major eco-regions. This would have added greatly to the paper and pointed to some policy possibilities for specific eco-regions. The paper argues that except in Africa, the prospect for food grain production is encouraging, but the gap between production and consumption is expected to widen, because of the problem of distribution and lack of purchasing capacity of the poor.

The paper appears to be optimistic regarding the recent developments and the future prospect of sustaining the growth of food production in Asia. This is mainly because in reviewing the recent growth in grain-food production the authors fail to distinguish between the 'once-for-all' effect of the policy changes introduced in many Asian countries since late 1970s, and the developments of factors that sustain long-term growth. For example, China had a rapid growth in food production during the 1980–84 period, because of the policy changes introduced since 1978, and Vietnam had a rapid growth during the 1987–91 period due to the economic liberalization policies. In both countries the growth has slackened after the initial acceleration. The authors

have used 1979–81 as the base for assessing the recent developments in Asia. China's performance during 1979–84 has influenced the indices since it is a big country. Since 1984, the rice production in China has remained almost unchanged, and that of Asia increased at 1.3% per year, much slower than the growth of population.

The authors have rightly mentioned that since 1989 rice yields have stagnated at around 3–6 tons ha^{-1}. This however gives a misleading impression about a large yield gap that is available for exploitation in the future, since Japan and South Korea achieved a yield of 6.5 tons ha^{-1} and have stagnated at that level. A disaggregation of the rice ecosystem into irrigated and rainfed, and yields achieved by farmers in those ecosystems would have cleared this misunderstanding. Farmers in China where almost all rice area is irrigated, have already achieved an average national yield of 6.0 tons ha^{-1}. In India, where the average yield is less than 3.0 tons ha^{-1}, farmers have already achieved 5.5 tons ha^{-1} in irrigated Punjab and Tamil Nadu. Thus, in the irrigated ecosystem farmers have almost reached the yield plateau. The future growth would be limited unless research makes another breakthrough in shifting the yield potential. In the rainfed ecosystem, the growth in rice yield has been slow, and is around 2.0 tons ha^{-1} because technological progress for this ecosystem has been limited. In countries with a large proportion of area under the rainfed ecosystem, such as in South Asia, the growth may slow down unless there is an acceleration of investment in irrigation, drainage, and flood control for the transformation of the rainfed into irrigated ecosystem, and/or the scientists succeed in developing high yielding varieties resistance to droughts, floods, and problem soils, which are difficult scientific challenges.

A comment on interpretation of macro or national level food production figures is needed. In the Asian region, some countries have purposely reduced area under food crops and total food production in lieu of export income generating activities. Malaysia has a stated goal of 65% self-sufficieny even though productive capacity could be much higher. Other countries are contemplating substitution as land resources have higher economic worth for non-agricultural activities, e.g. Thailand. An added value to the analyses done in this paper would have been to examine actual production rather than potential. What are the food security implications for the world, if divided into eco-regions of different production capacity, if government and multilateral policies could be put in place? Surely, one of the aims of the 'eco-regional paradigm' is to get concerted action, albeit harmonized, on common issues that will benefit the most people in an eco-region.

The authors are to be commended for making the forceful point that food availability is necessary but not a sufficient condition for food security, because of the lack of purchasing capacity for acquisition of the food. They rightly mention that in spite of the remarkable economic progress in Asia, hunger and malnutrition is widely prevalent in many countries which have

declared self-sufficiency in grain-food production at the national level. In fact, poverty is acute in regions which had low yields in grain-food because of the unfavourable production environments. Since production of staple grain-food is the major source of employment and income at the low-levels of economic development, the purchasing capacity of the poor could not be increased without raising the productivity in the grain-food sector. Thus, to help alleviate the food security problem, research must focus on problems of the specific regions where the poor live and work. Hence, the need to move from global to eco-regional approach to research, the theme of their conference. The paper could have made this point more clear.

A key factor that was not addressed in the paper is what it means to expand irrigation to the favourable rainfed areas, and to improve existing irrigation infrastructure. For the humid, tropical Asian eco-region, many irrigation systems date from the post-Second World War era, and are suffering signs of decline and inefficiency in water utilization, with accompanying increases in biotic/abiotic stress effects on potential yield. About 25% of rice area is in the rainfed lowland, with great potential for spectacular yield increases equivalent to the first Green Revolution, if converted to irrigated area. This would require investments in irrigation, which the current price and demand for rice do not appear to justify. Given that only 2–3% of global rice production is traded, food security for the marginal environments of Asia may have to rely on improved infrastructure for water control brought about through new investments.

Acronyms

EC	European Community
GATT	General Agreement on Tariffs and Trade
HEI	High External Input farming
IPM	Integrated Pest Management
LEI	Low External Input farming

References

Avery D T (1994) Feast or Famine? Far Eastern Economic Review 157(48):40.

Cassman K G, De Datta S K, Olk D C, Alcantra J, Samson M, Descalsota J, Dixon M (1994) Yield decline and nitrogen balance in long-term experiments on continuous, irrigated rice systems in the tropics. Advances in Soil Science (in press).

Meadows D H, Meadows D L, Randers J, Behrens III W W (1972) The limits to growth. Pan Books, London, UK.

Naisbett J (1994) Global Paradox. William Morrow & Co., Inc., New York, USA.

Zeigler R S, Hossain M, Teng P S (1994) Sustainable agricultural development of Asian Tropics and Subtropics: emerging trends and potential. In proceedings of IFPRI Eco-regional Workshop, November 1994, 7–11, 1994, Airlie House, VA, USA (in press).