

SUMMARIES OF GROUP DISCUSSION

Subject I

Valuation of Natural and Environmental Resources: Methodology and Estimation

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Resource valuation is in its infancy posing challenges to resource economists as each resource is unique and has discernible features, which complicates standardising the methodology of valuation. In the classical school, price is derived from value. Thus value of any commodity or service has to be priced. In National Resource Economics (NRE), it is crucial to distinguish between 'value' and 'price' since value of commodity is a complex entity based on 'utility' theory, philosophy of existence [as natural resources (NRs) have a concept of existence, while a production function is based on the theory of use]; and a rational of 'equity'. Economic theory is poor in dealing with 'equity'. Pareto optimality, for instance, has no equity concern. In NRs, inter-spatial and inter-temporal equity are crucial. Every NR, however abundant or scarce, is valued. 'Price' is thus a narrow - superficial - way of treating NRs. This is precisely the case of missing market. If there is no market, valuation is tough. Even if a market exists in a rudimentary manner (as in the case of 'groundwater' or 'water' market), it may not be effective. Distortions in market not necessarily signal competitive price. In addition, as NRs have multitude of uses, they correspondingly have multitude of values. The degree of uncertainty is enormous in NRs due to complex chain reactions, mutualism and synergies (which are apparent, for instance, due to destruction of natural forests). Thus revival of natural systems sometimes may take hundreds or thousands of years or may not take place at all due to 'irreversibility'. Thus the valuation of NRs is the crucial and vital part of NRE.

Valuation of Mutualism

For a welfare state, to measure the importance of NRs, computation of green gross national product (GNP) is vital. Nature, *inter alia*, has tremendous power of

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The assistance of G.B. Lokesh, B.T. Srinivas, Senior Research Fellows, National Agricultural Technology Project (NATP), and M. Prakash Kumar, Junior Research Fellow, Ford Foundation Project, Department of Agricultural Economics, University of Agricultural Sciences, Bangalore in the preparation of this summary is gratefully acknowledged.

regeneration, micro-climatic conditioning, waste accumulation capacity, microbial decomposition of natural and generated waste, pollination and biodiversity services, carbon sequestration capacity, accumulative power of soils, nutrient recycling functions (as in Devara Kadu - sacred groves). Similarly, value of known and unknown services of known and unknown natural resources is crucial. A decade ago, in one of the South-East Asian countries, it was reported that the yield of Durian fruits (similar to Jack fruit) declined dramatically, when lime stone caves were permitted to be exploited for use by a local cement factory. Later it was realised that the bats inhabited in the limestone caves were responsible for pollination of durian trees and after the limestone caves were used up for the sake of limestone for manufacture of cement, the bat habitat was destructed resulting in lower fruit yields. Forests are the best lungs in the world providing for carbon sequestration. Several examples of mutualism are being reported in different countries and myopic policies undermine the valuation of natural resources and natural resource services.

Taxation - Weak Instrument

Pigou's neoclassical economic solution to treat externality is through polluter pays principle or taxing the polluter or to handle issues outside the purview of demand and supply like the punitive fines. However, taxation in pollution is a weak instrument in India due to weak institutions and colossal transaction costs of policy administration.

Double Accounting in Valuation

Regarding inter-generational valuation, economics has no theory of valuing the future. This leads to complex fundamental questions regarding preservation and development values. The stated preference method is used in contingent valuation method (CVM) developed by psychologists where a person states his/her preferences regarding natural resource preservation values in a hypothetical market. There is no clear ranking of valuation methods, as each technique has a variety of assumptions. It is crucial to appreciate the problems involved in addition to values obtained from different methods. Double accounting must be avoided. For instance, timber is carbon too. We should not again count for timber. In addition, in the total economic valuation, from the 'market' timber is valued, and from 'CVM' existence value is obtained. How to add these two values obtained from different methods is still a challenge to resource economists. Another challenge is summation of value of utilities of individuals with asymmetric behaviour with regard to public goods. In addition, while estimating the existence value, how to take into account the contribution of 'tradition' that has motivated in preservation from historic times is another challenge.

Thus it is crucial to note that in any valuation exercise, the possibility of double accounting should be avoided. For instance, an ecologist might value timber as a

carbon sequestering entity and assign a functional value, while a forest economist might value the timber alone. The right method is to arrange in the descending order of magnitude of all values and pick the maximum value, but not add the different values.

Valuation of Short-Term and Long-Term Effect

Regarding soil degradation, how to value the immediate loss in productivity and how to value the long-term loss, which has impact on the future generation/s are the challenges. Such valuations raise complicated issues due to utter lack of quality data. Robert Repetto made the first attempt to incorporate such values in his green GNP estimation for Indonesia.

Orthogonality in Individual and Collective Response in CVM

It was reiterated that while interpreting the results in contingent valuation method, the respondents to contingent valuation studies generally offered about four times the annual payment for preservation as they offered for a once for all payment (Mitchell and Carson, 1989). In the CVM, an individual's value to CVM survey is different from a collective response to the same question. For instance, while an individual may indicate a positive willingness to pay (WTP) for preservation (of sacred grove, for instance), in a group, collectively, he may join with others to say that his WTP for preservation is zero! These are other challenges.

Methods of Valuation

During discussion, a major question raised was regarding what methods of valuation would be appropriate to address specific natural resources and specific questions (Table 1).

Existence Value

In addressing the estimation of existence value (of sacred groves, for instance), it was recognised that the real valid measure of existence value is the WTP of non-users. This arises because there is no objective way to specify that portion of the users' WTP that is attributable to existence value (Mitchell and Carson, 1989).

Estimation of Negative Externality due to Pest Resurgence

In the estimation of negative externalities arising from pest resurgence due to indiscriminate use of agro-chemicals, the Group felt that the *ceteris paribus* conditions will have to be met for focusing on measurement of negative externality. Specifically focusing on the studies by Arunakumara (1995) and Poornima (1999) on estimation of negative externalities in cabbage and grapes respectively in the University of Agricultural Sciences, Bangalore, it was opined that it is necessary for

TABLE 1. APPROACHES IN VALUATION OF NATURAL RESOURCES

Question (1)	Valuation (2)	Approach (3)	Resource (4)
1. Willingness to pay for preservation of Devara Kadu (scared grove)	(i) Total value (ii) Existence value: Based on notion of 'access' = WTP of non-users of the resource (iii) Use value=(i)-(ii)	Contingent valuation Contingent valuation (ex-ante method)	Sacred groves (Devara Kadu of Kodagu district, Karnataka)
2. Willingness to pay for recreation in a national park	(i) Use value (ii) Total value Existence value: based on notion of weak complementarity: (ii)-(i)	Travel cost (ex-post method) Contingent valuation	National Park
3. WTP for a contract which guarantees purchase of an environmental good for a specified price at a specified point in future	Option value exists due to uncertainty on the 'demand' side and 'supply side'. For instance, people may not be certain whether they want to use an unused and uncontaminated aquifer. A sewage plant may or may not meet its goals. Destruction of a forest may have irreversible consequences.	'Timeless' approach (similar to insurance policy, which once bought cannot be changed over time) is the risk premium to compensate for uncertainty about future taste, income or supply.	Hunting rights
4. Value of a plant in the wild	Quasi-option value (QOV) = risk premium paid to delay an activity which if undertaken might foreclose making a better-informed decision at a later time. For instance <i>Garcinia cambogia</i> , in Uttara Kannada district of Karnataka fetched Rs. 5 per kg in 1990. During 1997 it fetched Rs. 50 extra, due to research information that it would reduce obesity due to isolation of an alkaloid and its commercial exploitation.	Time-sequenced approach. QOV = f of (information generated). This assumes that consumer knows what s/he wants. But s/he knows that the outcome of a given action is uncertain. S/he knows that more information will be available in future to permit a better decision.	Medicinal plant
5. Property value	Hedonic pricing	Environmental values are reflected in property values	Land valuation

factors, *inter alia*, variety, active chemical in the pesticide, method, dose and time of application, alternate hosts planted and the consumer market be kept uniform for comparison over time. Here the farmers' practice need to be compared with the latest 'package of practice' recommended. It is desirable that the time lag between the farmers' practice and the latest 'package of practice' is kept to the minimum. During discussion, a comparable base of negative externality on cabbage and grapes at the farm level and the price premium offered at the consumer level was developed (Table 2).

TABLE 2. COMPARABLE NEGATIVE EXTERNALITY AT THE FARM LEVEL AND CONSUMER LEVEL

Produce (1)	Negative externality at farm level (2)	Negative externality appreciated through price premium for quality produce at consumer level (3)	Percentage of farm level negative externality to the consumer recognition of externality (4)
1. Cabbage	Rs. 7.00 per kg ¹	Rs. 1.60 per kg	1.6/7 = 23
2. Grapes	Rs. 17.60 per kg ²	Rs. 1.03 per kg	1.03/17.6 = 6

1. The negative externality in cabbage is Rs. 2.31 per rupee of cost of production (Arunakumara, 1995). Considering the price of pesticide-affected cabbage as Rs. 3 per kg, 0.33 kg of cabbage is for one rupee. Thus the negative externality is $2.31/0.33 = \text{Rs. } 7.00$ per kg.
2. The negative externality in grapes is Re. 0.88 per rupee of cost of production (Poornima, 1999). Considering the price of pesticide-affected grapes as Rs. 20 per kg, 0.05 kg of grapes is for one rupee. Thus the negative externality is $0.88/0.05 = \text{Rs. } 17.6$ per kg.

Thus according to the studies, cabbage consumer is ready to internalise 23 per cent of negative externality by offering a price premium for pesticide free cabbage and the grape consumer is ready to internalise 6 per cent of negative externality by offering a price premium for pesticide free grapes. This shows that there is a greater cognition of the perception of negative externality in cabbage while compared with grapes.

Estimation of Negative Externality due to Salinity/Waterlogging

For the estimation of negative externality due to salinity/waterlogging, it is necessary to explore all plausible alternatives such as salt tolerant crops and crop varieties which can sustain the predicament, and then value the negative externality after taking care of the problem through soil amendment methods and crop varieties. Else, the value of negative externality would get over-estimated. For instance, in Gangavathi, Raichur district (Karnataka), salt tolerant agro-forestry recommendations were suggested.

Valuation of Groundwater in Scarcity Area

Regarding estimation of value of groundwater resource in an area of scarcity, the negative externality due to cumulative interference of irrigation wells needs to be considered (Shivakumaraswamy and Chandrakanth, 1997). For the estimation of negative externality, the data on both stock and flow of groundwater needs to be considered. These are only estimates and caution needs to be exercised in interpretation of the values. Thus generalisation of groundwater value, externalities and transaction costs is not possible as the boundaries of aquifers (unconfined or confined) are difficult to be established and they cannot also conform to the terrestrial boundaries.

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Valuation of Water in Watershed

Valuation of water in the watershed needs to consider, *inter alia*, value of additional biomass, additional income from dairy-livestock and the augmented carrying capacity due to improved water regime. In addition to *with and without/ before and after* approaches, continuous data regarding watershed improvement need to be used. Regarding the negative externality of watershed programme on the irrigation tanks in the chain, if the reduced biomass in the chain of irrigation tanks is compensated by the additional biomass generated in the watershed, the externality is internalised. However, the emerging equity implications need to be addressed. These are topical researchable issues in NRE of watershed and tank irrigation.

Valuation of Non-marketed Forest Product

To a question regarding the total economic value in watershed, a study conducted by Gopal Kadekodi, in Yamuna basin covering Yamunothri to Allahabad, provided the following method of valuation:

Value of i-th forest product per hectare =

$$\text{Value of timber per hectare} \times \frac{\text{(Rank assigned by villagers for the i-th forest product)}}{\text{(Rank assigned by villagers for timber)}}$$

Here, as the i-th forest product is not marketed, but needs to be valued, the value of the i-th forest product is given by the product of the value of 'timber' weighted by the relative rank of the i-th forest product to the rank assigned for timber. This value is added across all forest products. Similar concept can be used in valuation of watershed also. However, for evolving the ranks, the sample should be sufficiently large and representative.

Choice of Discount Rate

It has been a practice to compare the cost of surface water projects (provided by the public/canal irrigation) with the cost of groundwater projects (private irrigation), by indicating for instance, that to provide one acre of irrigation by surface water, it costs Rs. 60,000 to Rs. 75,000, while it costs Rs. 25,000 to provide one acre of irrigation by groundwater. Such a naïve comparison is improper without due consideration of the involvement of the 'time dynamics' in the construction and the stream of benefit flows. A surface water project usually involves at least 30 years and the benefits last say for 75 to 100 years, a groundwater (bore) well, on the other hand, can be drilled in a few hours and the benefits may last for about 10 years. Thus comparison needs to weigh for the time involved in construction and the flow of benefits. Here as 'time' dimension is involved, the choice of interest rate needs to be made with sound economic rationale. Thus the investment in a surface water project made in the first year needs to be compounded for 30 years, investment in the second

year needs to be compounded for 29 years and investment in the 30th year needs to be compounded for the last one year. If this can be compared with groundwater project, which may cost Rs. 25,000 to provide irrigation for one year, correspondingly the cost in both surface and groundwater projects needs to be weighed by the number of years of benefit flows. A suitable method of comparison needs to be evolved since this is akin to comparison of a compounded value of investments in an irrigation project providing surface irrigation with benefits lasting for 100 years, with the present (current) value of providing irrigation by groundwater with benefits lasting say for ten years. In a recent study sponsored by National Agricultural Technology Project (NATP) at University of Agricultural Sciences (Ravi, 2001) on valuation of surface water provided by Bhadra irrigation project in Karnataka, it was found that it would cost Rs. 10,884 to provide irrigation for one acre (at an interest rate of 4 per cent), while the amortised cost of irrigation would be Rs. 531 per acre at an interest rate of 4 per cent and the time of benefit flows assumed as 100 years. Obviously, these costs would blow up exponentially with the increase in rate of interest and it was found to yield unrealistic estimates of cost estimates. The choice of lower rate of interest is justified especially for projects which involve long time period for construction (like irrigation dam). Similarly, the choice of lower rate of interest is justified for projects which yield benefits for large number of years (like dug wells in some situations). This can be appreciated by plotting the value of e^{it} (on Y axis) for different values of t in years on X-axis. For instance, if $t = 30$ years, at 4 per cent, one rupee grows to Rs. 3.32, while at 12 per cent, one rupee grows to Rs. 36.6, i.e., for a 200 per cent increase in rate of interest, the future value increased by a whopping 1002 per cent. Thus choice of discount rate is the most crucial in the valuation of natural resources.

Researchable Issues in the Valuation of Natural Resources

1. How best the Geographic Information System (GIS) information from National Remote Sensing Agency (NRSA) can be used in association with the 'ground truth' in the valuation of natural resources, considering economy in data procurement and processing.
2. Natural resource economics research needs to be linked with 'health economics' for a meaningful policy implication indicating the ways and means of internalising the negative externalities.
3. Valuation of medicinal plants currently being used in pharmaceuticals and in essential oil extraction with emphasis on quasi-option value.
4. Optimal extraction path of renewable natural resources like groundwater, forests and fishery using the 'optimal control theory'.
5. Estimation and internalisation of negative externalities in groundwater volume and quality considering areas irrigated by wells, tanks and canals.
6. Total economic valuation of watershed development programmes in different agro-climatic regions.

7. Estimation of existence value of Devara Kadu - sacred groves - in different regions.
8. Valuation of surface water for irrigation in normal, saline and water-logged soil conditions measuring and internalising externalities.
9. Optimal rate of extraction of marine and inland fishery for bio-economically sustainable harvest of different species.
10. Institutional economics of land markets for agriculture.
11. Effective institutions for bringing about sustainable use of natural resources.
12. Economics of value addition from inland and marine pearl culture.
13. Externalities arising from effluents degrading land, surface water and groundwater resources.
14. Valuation of mutualism among flora-fauna, fauna-fauna, flora-flora and fauna-flora relationships in agriculture and forestry (involves valuation of interdependency, synergy, uniqueness, indispensability, irreversibility, uncertainty components of NRE).
15. Valuation of biotechnological innovations on sustainability of bio-diversity services.
16. Valuation of biodiversity benefits and services.
17. Valuation of organically grown agricultural produce.
18. Valuation of indigenous knowledge systems with special reference to benefit sharing arrangements from past and current generation in accordance with Convention on Bio Diversity (CBD).
19. How and by how much the cost of cultivation and net returns of crops differ when the natural resources (like water, pollination services, predator services) are valued and included in the cost of cultivation.
20. Impact of pricing natural resources (like surface water, groundwater, forestry) on their conservation and management with equity and policy implications.
21. Evolving a base to compare the cost of providing irrigation through surface water and groundwater irrigation considering the time involved in construction, time involved in distribution of benefit flows and the choice of interest/discount rate.

REFERENCES

- Arunakumara, V.K. (1995), *Externalities in the Use of Pesticides - An Economic Analysis in a Cole Crop*, M.Sc. (Agri.) Thesis, Department of Agricultural Economics, University of Agricultural Sciences, Bangalore (Unpublished).
- Mitchell, R.C. and R.T. Carson (1989), *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, Washington, D.C., U.S.A.
- Poomima, K. (1999), *Agrochemicals and Their Use in Grape Cultivation - An Environmental Economic Analysis*, M.Sc.(Agri.) Thesis, Department of Agricultural Economics, University of Agricultural Sciences, Bangalore (Unpublished).
- Ravi, B.M. (2001), *Pricing of Surface Water in Bhadra Command: A Resource Economics Study*, M.Sc. (Agri.) Thesis, Department of Agricultural Economics, University of Agricultural Sciences, Bangalore (Unpublished).
- Shivakumaraswamy, B. and M.G. Chandrakanth (1997), "Well Interference and Aftermath: An Economic Analysis of Well Irrigation in Hard Rock Areas of Karnataka", *Artha Vijnana*, Vol. 39, No. 3, September, pp. 341-359.