Valuation of rice agro-ecosystems: Phase One, Pilot Study for TEEB

Executive Summary

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Background
The UNEP TEEB Office has recently begun to undertake a study on 'TEEB for Agriculture and Food'. This study is designed to provide a comprehensive economic evaluation of the 'eco-agri-food systems' complex, and to demonstrate that the economic environment in which farmers operate is distorted by **significant externalities**, both negative and positive, and a lack of market, policy and societal awareness and appreciation of human **dependency on natural capital**.

The Food and Agriculture Organization of the United Nations (FAO) together with its partners, the International Rice Research Institute and Bioversity International as well as Trucost has applied the TEEB approach to the rice farming sector. Rice (*Oryza sativa* from Asia *or Oryza glaberrima* from Africa) is the most widely consumed stable food for a large proportion of the world's human population, particularly in Asia. It is the agricultural commodity with the third highest worldwide production, after sugarcane and maize. Given that sugarcane does not contribute to food security and that a large proportion of maize production is allocated to both livestock feed and biofuels, rice can be considered to be the most important grain contributing to food security, providing at least one-fifth of the calories consumed worldwide. On more local levels for rice producres themselves, rice production is essential to the food security and livelihoods of around 140 million rice farming households and provides a range of ecosystem services beyond food production (i.e. cereal grain) alone.

At the same time, rice production has been linked to a range of different environmental impacts such as high GHG emissions, air and water pollution as well as an increase in water consumption. Policy makers need to make decisions on how to manage and mitigate these impacts while providing affordable, nutritious, equitably accessible and safe food for a growing global population with changing patterns of consumption.

Study objectives
As these challenges are not independent, but rather interlinked, reaching them is likely to require **trade-offs,** or the development of alternative production systems that may deliver multiple functions, with respect to both production and ecosystem services. Where possible, one should identify **synergies** that allow for a maximization of benefits (which can also be termed positive externalities), while minimizing costs to society and the environment, (i.e. negative externalities), and the wellbeing of the farmer him or herself through the degradation of natural capital from rice production. It is therefore crucial to know which types of farm management practices or systems offer the best options to reach these synergies, and reduce trade-offs.

The specific objectives of this study were three-fold:

1. To identify visible and invisible costs and benefits of rice agro-ecosystems; i.e. externalities

2. To identify and assess those rice management practises which reduce trade-offs and increase synergies

3. To make these trade-offs and synergies visible by assigning biophysical or monetary values to the different options

The approach
1. Scope and framework setting

In a first step, five case study countries were selected which cover rice farming globally and which represent a gradient from low intensified to high intensified production systems. Countries selected were: the Philippines and Cambodia in Asia, Senegal in Africa, Costa Rica in Latin America and California/The United States in North America. According to FAOstat (2013), Cambodia was, on average, the lowest yielding country with 3.3 tons/ha and the USA had the highest yielding production with 9.5 tons/ha.

In a second step, a rice production system typology was developed. The extent of these typologies have will have utility in calculating the geographic extent in which practices based on ecosystem services can be applied.

On a second level, the rice production systems were further categorized by rice management practices. Twenty- three practice category comparisons were identified, starting with land preparation and finishing at harvest.

The study has set out to identify those **farm management practices** that offer the best options to reach synergies, and reduce trade-offs between different management objectives.

In a third step, the project team identified pertinent policy and management issues related to the selected rice management systems and practices. These constituted the basis for the development of the analytical framework, which was built around a set of relevant costs and benefits related to rice production.

2. Biophysical quantification and monetary valuation

TEEB-AF has unique challenges in developing a means of analysis of the positive and negative externalities of agriculture; negative externalities align well with standard valuations of environmental pollution, but positive externalities – such as ecological resilience, or dietary diversity – are not well captured by standard monetary valuations methods. Positive externalities are not simply reflected in the concept of "costs avoided" –such as costs avoided of having to buy pesticides or fertilizers. The reality of biological systems, that TEEB seeks to capture, is that there are many intermediate factors and products in agricultural production systems, generated by biodiversity and ecosystem services. For example, ecological alternatives to pest control are not simply a matter of not applying pesticides, and thus avoiding such costs; it is an intricate process (on the part of nature, when not impeded by humans) of building a natural enemy community, through a management that encourages such ecological processes. This form of management has some value in an initial year and place, but adds value as it is allowed to flourish over time and space,; thus not reflected adequately in a simple calculation of pesticide costs avoided.

In this first phase, so that the gaps and needs can be better understood, a conventional process was followed to attribute monetary values to the costs and benefits of the negative externalities,. We recognize the severe limitations of such an approach, in that it ignores synergistic effects and positive externalities; in the first phase of this study there were no methodologies available to include these. We will return to these important gaps at a later point.

Placing monetary values on the costs or benefits that arise due to different management practices takes place in three distinct steps. This process is guided at all times by an overarching research question, which outlines the aim of the monetary valuation, why the valuation is needed, and who the target audience is.

The first step, which measures the changes in physical conditions, has been performed in the academic literature used for this study. This includes the identification of the drivers for change, such as fertiliser or pesticide inputs. Additional to extracting this data in a standardized way across all five case study countries, a vote counting analysis was done to synthesize these results.

It should be noted that the academic literature that could be accessed for this study, in large part posed questions that correspond to conventional agriculture: i.e., what it the difference from applying this input, versus not applying the input, or applying in various levels? Thus the answers, while scientifically accurate, do not illustrate the full range of alternatives. For example, a number of studies compare the impacts on yields of applying herbicides, versus reduced or no application. In such a binomial study, without consideration of alternative management practices, the yield loss resulting from no application of herbicides may be up to 95% of the control, and virtually no cost for the environmental impacts of herbicides could offset the benefits in such a study. Yet we recognize that this is not an adequate representation of alternative production systems.

The second step requires the biophysical modelling of the impact, or impacts, that are caused by changing physical conditions. This includes identifying factors such as the endpoint of nutrient run-off, which may be adjacent freshwater ecosystems for example, and quantifying the change in the biophysical indicator that is to be valued, such as the change in the quality of human health, measured in disability adjusted life years (DALYs) (see below for more details).

The final step involves the economic modelling component of the valuation. This includes the identification of the final recipient of the impact, such as the local populations who experience the negative effects of eutrophication, and then selecting an appropriate valuation technique to monetize the change in biophysical conditions.

Conclusions

The development of a solid typology that disaggregates data into specific farming systems and practices is key to valuing externalities from the agriculture and food sector. Farming is very diverse, and so are the environmental impacts and ecosystem services that are linked to each type of production. Typologies therefore need to zoom in on management practices as much as possible to reflect the reality of (rice) farming and the diversity of its values. It would be illusionary to think that there is ONE type of production that leads to ONE specific set of positive and negative externalities.

This requires that experimental studies provide a comprehensive data set that goes beyond food production alone as is typically done in agronomic studies. Likewise, ecological and environmental studies need to record agronomic values, including yields, and widen their often restricted focus on natural resources and biodiversity alone. Furthermore, there is a need to enhance models that can mimic agro-ecological processes where specific data points are missing, and where field studies are not feasible.

However, by focusing on management practices and their impacts we come quickly up to the limitations of the current academic literature, which rarely considers practices in the context of whole management systems.

While the data collected in Phase One of the Rice Feeder study is rich and quite complex, its value as the source of estimated negative externalities, much less positive externalities, is insufficient. We believe that a better starting point, one that we should have used had we known the gaps in the literature, would be to develop a sound conceptual model of rice crop production, under a diversity of management practices. Once these practices are integrated and linked within a model, the available data can be put into a proper context. Some of the data- comparing use of inputs versus no use of inputs- should not be included if it genuinely fails to provide insights on the impacts of conventional versus alternative management practices.

Alternatively, farmers themselves are carrying out just such experiments, varying their practices to attain multiple benefits. Instead of relying on the scientific data alone, where experimental protocols generally require that most aspects are held constant while one or a few variable are manipulated, there may be large scope for applying a TEEB-type analysis to specific farms, and making greater use of on-farm, farmer-led research.

There is also a need to improve current valuation methodologies, as there is a clear lack of those that can value agroecosystem benefits as opposed to costs, as noted above. There is a need to link economic valuations to market costs, and avoided costs for the farmer. Methods are urgently needed to be able to assess and compare multi-dimensional values, as monetary analysis is not appropriate for all positive and negative externalities of agriculture. Furthermore, one needs to better adapt current models for valuation to the realities of developing countries.

Recognising that national assets extend well beyond GDP, or gross domestic product, there is an initiative underway to bring in methods to account for other forms of capital including natural capital, to national statistical accounts, through the UN initiative on Systems. Of Environmental-Economic Accounting. TEEB-AF, in addressing the current challenges to develop multi-dimensional valuation, also may provide and share important insights with the System of Environmental-Economic Accounting for Agriculture (SEEA-AGRI). While ecosystem valuations usually focus on the local level, ecosystem accounting methods aim to aggregate information to produce statistical results at the national level. Since both areas of expertise are still in its infancy, it is timely to join forces now in order to follow a coherent approach in the future.