Assessing and Modeling of Sustainable Rice Production Systems: A Multi-Stakeholder Perspective

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Introduction

Rice is the staple food for more than half of the world's population and its production is the most important source of employment and income for rural Asians. In Bangladesh, rice is the main crop, covering about 75% of the total cropped area and it employs almost 50% of the country's labor force, and contributes to about 10% of GDP. A substantial number of studies indicate that present rice production is not sustainable in Bangladesh in terms of environmental soundness, economic resilience (or capability) and social development.

The study addresses three issues, namely development a framework for indicator development, assessment of sustainability of rice production systems, and development of a model for sustainable rice production in Bangladesh.

Normalisation

Max-min, $$li = \frac{x - min(x)}{max\,(x) - min(x)}$$

Standardisation, $$li = \frac{(x - \mu)}{\sigma}$$

Aggregation,

Linear, $$Index = \sum_{i=1}^{n} li.wi$$

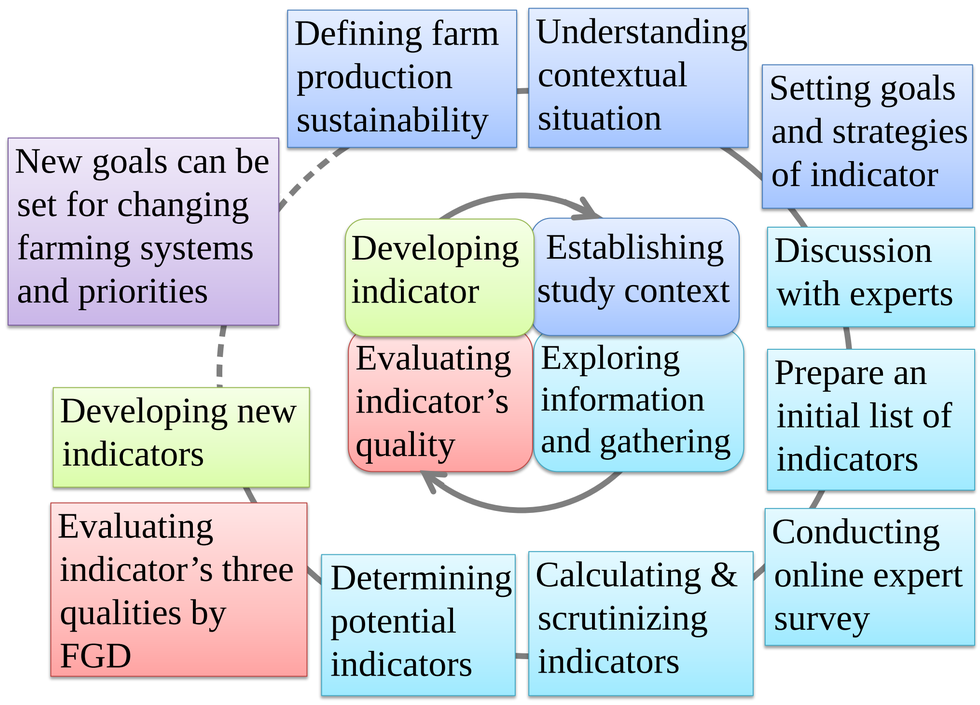
Geometric, $$Index = \prod_{i=1}^{n} li^{wi}$$

Where, *li*, *x*, and *wi* are the normalised, raw value, and weight of indicator. In addition, *max (x)* and *min (x)*, μ, and σ are the maximum and minimum value, mean, and standard deviation of *x*.

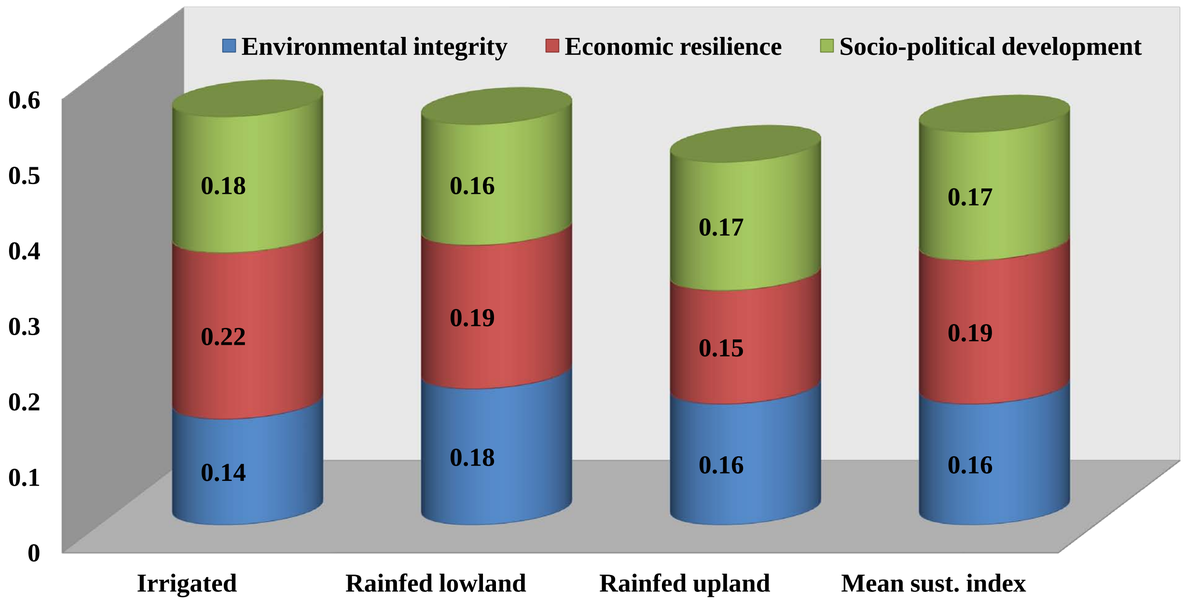
Methodology for composite indicator (CI) construction

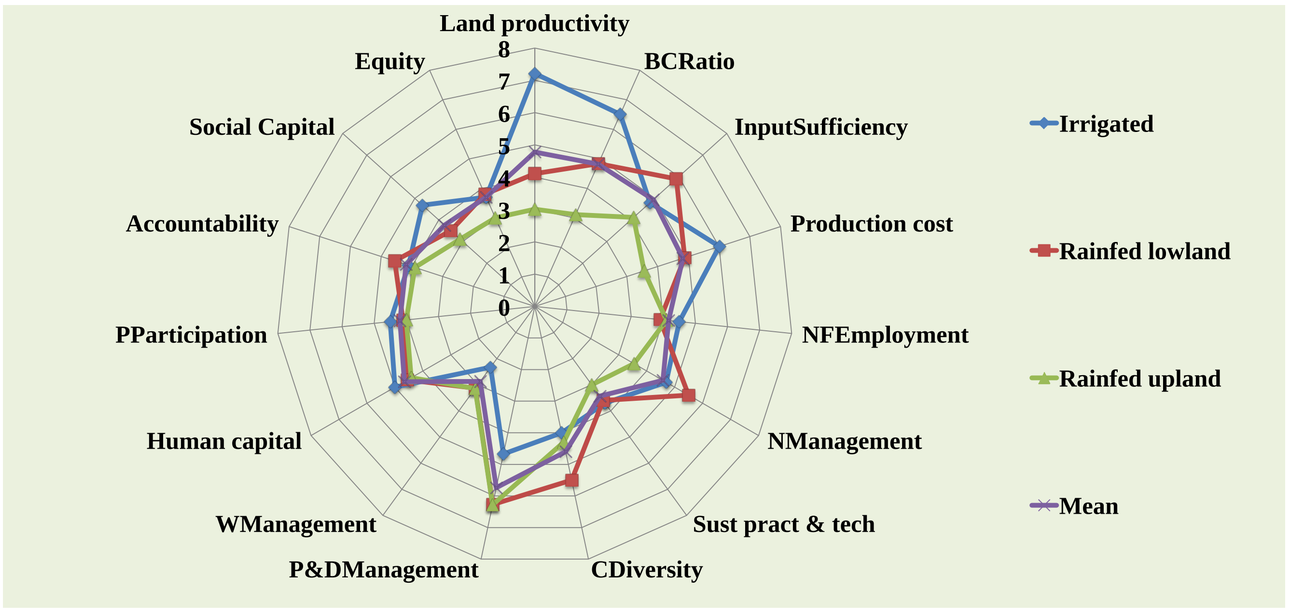
Step and stage	Tools/Method applied	Output
Step 5: Index construction, assessing internal consistency and robustness of CI	Correlation, path and stepwise multiple regression analysis	Developing a meaningful CI and determining policy options
Step 4: Normalisation, weighting, and aggregation	Max-min and standardization method, factor analysis, linear & geometric aggregation	Making data comparable, assessing weight of indicators & aggregating them
Step 3: Data screening, bivariate and multivariate analysis	Skewness, Z-score, correlation and principal component analysis	Ensuring quality and structure of the data set for methods choices
Step 2: Data collection	Survey and key informant interview	Preparing a complete data set
Step 1: Developing theoretical framework and indicator	Top-down and bottom-up approaches	Developing a set of indicators

Result I: Indicator development framework

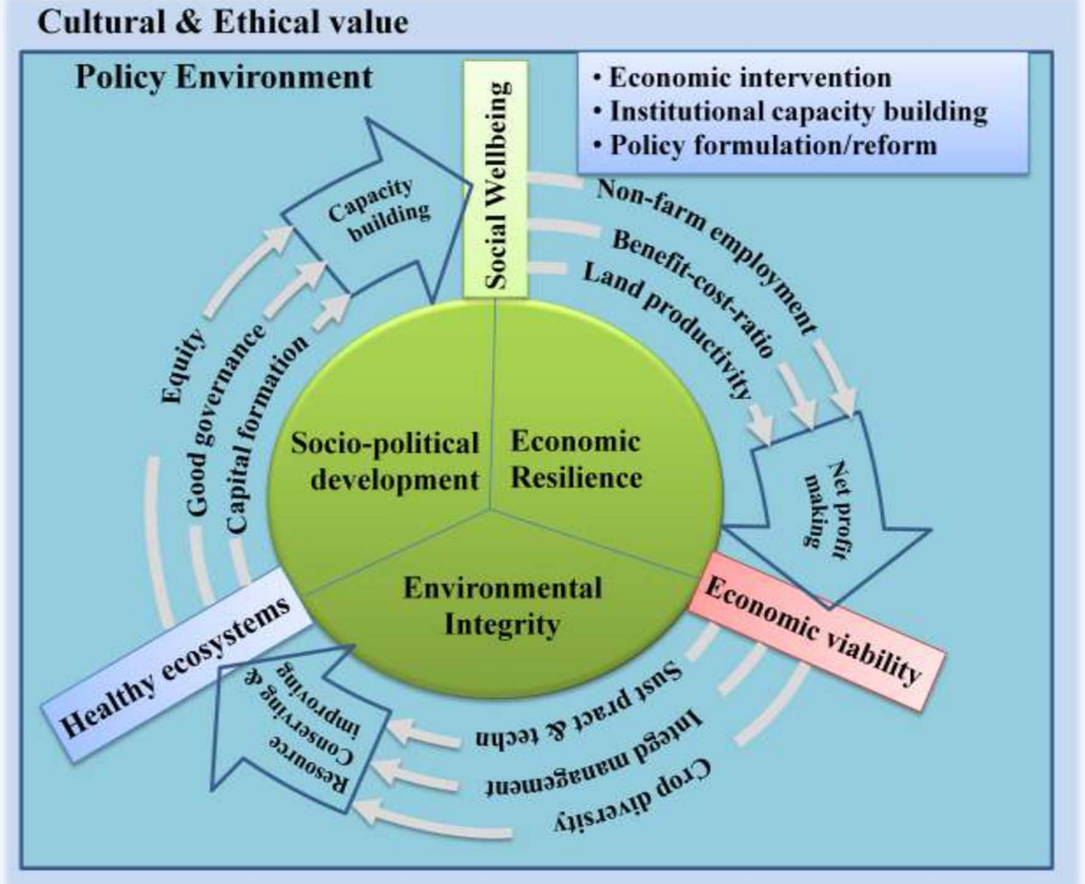


Result II: Assessment of rice production sustainability





Result III: Model of rice production sustainability



Conclusion and policy implications

About half of the growers face several environmental, economic, and socio-political challenges. The irrigated and rainfed upland rice production systems were found to be the most and least sustainable, respectively. The rainfed lowland production system was more environmentally sound, followed by rainfed upland and irrigated rice. The findings of this study are expected to have knock-on effects on "green agriculture and growth", a main strategy for promoting "green economy" in Asia and the Pacific.

Policies should emphasize: increasing land productivity by adopting a multi-pronged approach, pervasively disseminating and utilizing resource conserving practices and technologies, developing grower's human capital, and valuating integrated farming practices and environmental services. Moreover, creating a favourable environment for better policy implementation is imperative for farming sustainability transition.

In terms of the overarching policy implications for sustainable rice production systems, considering major 3 out of 5 rice growing ecosystems is a limitation of this study. Climate policy integration for sustainable management of rice-based production systems is a future research area.

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