

ENERGETICS AND ECONOMICS OF BLUE-GREEN ALGAL CONTRIBUTION TO RICE CROP SYSTEM

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RICE is apparently the only major crop to whose nitrogen economy, non-symbiotic nitrogen-fixing blue-green algae make a significant contribution and crop yields provide an indirect measure of their agronomic role⁴⁻⁷. In a cropping system it is necessary to determine the efficiency of the inputs in generating the output products. The present communication is an attempt to evaluate the blue-green algal contribution in a rice crop system by using the economics and energetics approaches³.

Monetary quantification was done in terms of grain output *vis-a-vis* the cost of the network of all inputs. Since all the input energy sources, except the algal and added fertilizer nitrogen, are the same both for the algalized and non-algalized series, calorific quantification was done in terms of added nitrogen and grain yield. The data used for computations were drawn from 463 field trials conducted in eight States. For calculations, the calorific value for the rice grains was taken as 4.4 Mcal/TDN (total digestible nutrients)² and the energy equivalent for nitrogen as 12.34 Mcal/kg¹.

Table I summarizes the algal contribution in terms of monetary quantification in twenty farmers' holdings indicating an average net profit of Rs. 518/ha and the economic efficiency works out to 1:25.9 in terms of the cost of algal input. The economics approach is, however, subject to fluctuations in the market systems.

Table II shows the energy output in terms of grain yield in the absence of added nitrogen input. On an average, algal input generated about 7,453 Mcal/ha,

TABLE I

Monetary quantification of algal contribution to the grain yield of rice (values mean of 20 farmers; P:K 50:50) (cost of BGA Rs. 20/ha)

| Nitrogen (Kg/ha) | Grain yield (Kg/ha) | % increase | Net profit* (Rs./ha) | Economic efficiency |
|------------------|---------------------|------------|----------------------|---------------------|
| 100 | 4,222 | | | |
| 100+BGA | 4,766 | 12.8 | 518.25 | 25.9 |

* Net profit calculated after deducting the cost of all the network of inputs like land preparation, labour, irrigation, fertilizers, seeds, pesticides, BGA, etc.

TABLE II

Estimated energy output due to algal application (10 Kg/ha) (values mean of 160 trials; P:K 40:15)

| Nitrogen (Kg/ha) | Grain yield (kg/ha) | Mcal for rice grain/ha | Additional energy output (Mcal/ha) | % increase |
|------------------|---------------------|------------------------|------------------------------------|------------|
| 0 | 2,079 | 6,098.4 | | |
| 0+BGA | 2,541 | 7,453.6 | 1,355.2 | 22.2 |

which was 22.2% more than that obtained in the absence of algae. This capacity of algal resource to generate additional energy was clearly reflected even in presence of high levels of energy input in the form of chemical nitrogen. A 14% increase in the energy output was observed when an input of 1,234 Mcal was supplemented with algae (Table IV). Precise quantification of algal activity in terms of nitrogen is not possible, although their contribution is in the range of 20-30 kg N/ha as obtained by acetylene-reduction assays.

Table III summarizes the extent of energy compensation through algal input at different levels of chemical nitrogen input, indicating that on an average about 320 Mcal energy in the form of fertilizer nitrogen could be saved without significantly affecting the energy output in terms of grain yield. Although these analyses are based on a 'single-resource-use', these may be used in three ways in a rice cropping system. Firstly, in the absence of any added energy input in the form of chemical nitrogen algal input could generate about 1,350 Mcal of net yield for rice grains alone. This is particularly important for areas lacking in economic viability for investment in costly energy inputs. Secondly, to obtain, for example, an output of 14,921 Mcal/ha, an input of

TABLE III

Estimated energy output due to algal application at reduced chemical energy input levels
(Values mean of 185 trials; P: K 50:50)

| Nitrogen (kg/ha) | Input energy equivalent (Mcal/ha) | Input energy saving (Mcal/ha) | Grain yield* (kg/ha) | Mcal for rice grain per ha | Energy efficiency† |
|------------------|-----------------------------------|-------------------------------|----------------------|----------------------------|--------------------|
| 60 | 740.4 | | 3,496 | 10,254.93 | 13.85 |
| 40 + BGA | 493.6 | 246.8 | 3,630 | 10,648.00 | 21.57 |
| 75 | 925.6 | | 4,342 | 12,736.53 | 13.76 |
| 50 + BGA | 617.9 | 308.5 | 4,273 | 12,534.13 | 20.31 |
| 90 | 1,110.6 | | 4,585 | 13,448.53 | 12.10 |
| 60 + BGA | 740.4 | 370.2 | 4,520 | 13,258.13 | 17.90 |
| 100 | 1,234.0 | | 5,087 | 14,921.33 | 12.09 |
| 75 + BGA | 925.6 | 308.5 | 5,090 | 14,930.13 | 16.13 |
| 120 | 1,480.8 | | 5,833 | 17,110.13 | 11.55 |
| 90 + BGA | 1,110.6 | 370.2 | 5,761 | 16,898.93 | 15.22 |

* Grain yields between the respective full and reduced nitrogen levels non-significant

† In relation to chemical nitrogen energy input.

TABLE IV

Estimated energy output due to algal application at high energy input level
(Values mean of 118 trials; P: K 50:50)

| Nitrogen (kg/ha) | Input energy equivalent (Mcal/ha) | Grain yield (kg/ha) | Mcal for rice grain/ha | Additional energy output (Mcal/ha) | % increase |
|------------------|-----------------------------------|---------------------|------------------------|------------------------------------|------------|
| 100 | 1,234 | 5,112 | 14,995.2 | | |
| 100 + BGA | | 5,826 | 17,089.3 | 2,094.1 | 13.96 |

1,234 Mcal is required in the form of chemical nitrogen. The same output can be obtained with an input of only 925.6 Mcal, if supplemented with algal input under conditions where all other network of inputs are the same. Thirdly, even with high levels of energy input, about 14% additional energy yield could be obtained by algal complementation.

The blue-green algal contribution to rice crop system thus appears to be energy intensive. For developed countries this may perhaps be unimportant so long as fertilizer energy is available. But for developing regions increased energy inflow through such biological systems is an important factor, for energy in the form of nitrogenous fertilizer forms a substantial portion of the national energy budget. The implications of Table III are that renewable and regenerative sources of energy input could help reap higher energy harvests in the cropping system with lesser non-renewable sources of energy input.

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1. Blcuin, G. M., *Rep. TVA Natl. Dev. Centre, USA, 1970*.
2. Castillo, L. S. and Gerpacio, A. L., *UPLB Tech. Bull., 1976, No. 21*.
3. Librere, F., In *IRRI Symp. Cropping Systems Research and Development for the Asian Rice Farmer*, Los Banos Philippines, 1977, p. 261.
4. Venkataraman, G. S., In *Nitrogen Fixation by Free-living Microorganisms*, ed. W. D. P. Stewart, Camb. Univ. Press, 1975, p. 207.
5. —, *Algal Biofertilizer and Rice Cultivation, Today and Tomorrow*, New Delhi, 1972.
6. —, *Algal Biofertilizer for Rice*, IARI, New Delhi, 1977.
7. — In *International Rice Research Institute Nitrogen and Rice*, Los Banos, Laguna, Philippines, 1979, p. 311.

A NEW FRUIT ROT DISEASE OF PAPAYA**A. K. SAXENA AND S. K. JAIN**

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AN undescribed fruit rot of papaya (*Carica papaya* L.) at pre- and post-harvest stage was observed at Gwalior, during February and March, 1980. The isolations from the diseased fruits consistently yielded colonies of *Trichothecium roseum* (Pers.) Link ex Fries.

At pre-harvest stage the diseased area became wrinkled and pink in colour. The fungus was isolated in pure culture by single spore isolation method.

The pathogenicity of the fungus on papaya fruits was confirmed under laboratory as well as in field conditions. The disease appeared within 10 days on all inoculated fruits in both the conditions. The pathogen was found to attack through wounds. The pathogen was re-isolated from artificially infected fruits and found to resemble the original isolate. This fruit rot due to *T. roseum* had not been reported earlier from India.

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