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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 role[4–7]. 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 approaches[3].

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/kg[1].

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 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

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, 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 viabiity 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	617·0	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 crop ing system with lesser non-renewable sources of energy input.

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