Farm Energy Management: The Perceived Impact on Social Ecology at the Community Level

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Abstract—*In Agriculture, energy is the most important input that promotes sustains and directs both production and productivity but Indian farmers are more input literate and less energy educated. The indiscriminate consumption of energy, as has been reflected in water management, soil and nutrient management even in part of processing agriculture, will lead to a catastrophic ecology in Indian farming. The agricultural productivity is declining at a faster rate, when the need of food security cropped up as the most belligerent issue. The huge pull up of ground water, burning of crop residues and indiscriminate mechanization of farmer may be held responsible for a negative energy balance. Keeping this energy and the energy entropy in view, the present study "Farm Energy Management : The perceived Impact on Social Ecology at the Community Level" has been selected to study the energy balances i.e., consumption and production in cattle and crop enterprises as well as in households and its overall impact on social, economic, ecological spheres of ecosystem .The Study was conducted at Swarnachalida village of Bhatar ,in district Burdwan of West Bengal. It includes a set of dependent variables i.e. Domestic energy consumption ,Crop energy Balance , cattle Energy Balance , and Total energy balance, to be estimated through a set of 13 exogenous variable i.e. Age , Education , Family size , Gender Ratio, Per capita Annual Income , Farm size , Occupation , No. of Fragments , Cropping intensity, Total no. of livestock , Amount of Cow dung applied in farm, Stubble Height , and Irrigation index ,The respondents have been 70 by count and have been selected through both purposive and random sampling approaches to ultimately derive and elicit their behavioural traits in characterizing the energy balances of social, economic, physical and ecological setup. The results show that following factors, Age, Family and Farm size, Per capita annual income, Total number of livestock and Amount of cow dung applied in farm have led to consciousness about the energy balances in social ecology and impact of these energy balances on the ecosystem as whole. All these analytical outcomes can be replicated to other enterprises as well to calculate energy balances. The principle component analysis has isolated 6 factors through an operationally conglomeration of 13 explanatory variables responsible for farm energy balances. All these analytical tools can be replicated to other enterprises as well to calculate energy balances.*

Keywords*: Farm energy, Social ecology, Crop Energy Balance, Cattle Energy Balance, Social ecology, Farm metabolism, Entropy.*

1. INTRODUCTION

Energy is the basic driver for any kind of ecological entity, big or small, medium or humongous. Energy in Agricultural Ecology has certainly characterized its two basic functions-

i) The Production Function

ii) The System Function

While contributing to the production function, energy has certainly been conceived in input forms and functionally attuned to the output character and quantity. By the term 'Farm Energy' we mean and understand, not only the total amount of energy is being applied from external sources, It also helps us estimate the characteristics of system behavior, in which the capsule of energy is functioning as well. It characterizes the system as well. Indian farmers no doubt is enough literate about fertilizer, seed or water input and are equally 'obscured' about energy functioning of the farm. It focuses on the energy commitment and literacy of the farmers and we need to go deeper into the process of agricultural modernization vis-viz its multidimensional functioning including that of energy consumption behaviour.

So the new age extension science will increasingly be aimed at energy auditing, energy designing and energy management. Even with plenty of fertilizer and fertility status of genomes cannot usher in the productivity unless the energy backup has been properly maintained.

Agriculture consumes significant quantities of energy, especially in industrialized countries. Farmers use energy directly to heat and cool buildings, operate equipment, pump irrigation water, and transport products to market. Agriculture also consumes large quantities of fossil fuel indirectly as inputs for fertilizer (a prime ingredient of which is natural gas) and pesticides (made from petroleum and natural gas). Food processing and long-distance shipment consume additional energy.

India has more arable land than china. Indeed it has the second- most arable land in the world. But it has very low productivity of crops per acre. When one takes paddy, as one example, and on comparing with china, India remains far behind. This is so for other crops as well and as compared to most Southeast Asian countries. A good reason for the low productivity is the growing fragmentation of holdings and their decline in size. The high population pressure on small land holdings is on account of high rural poverty. Alleviation requires consolidation of land holding by leasing, urbanization and the acquisition of rural lands for the purpose with adequate compensation. This will also reduce this Pressure.

The present study has got a theoretical structure where in the psycho motivational factor of behavior have well been predicted through its energy consumption behavior.

In agriculture energy is the most important input that promotes, sustained and directs both production and productivity but Indian farmers are more input literate and less energy educated. The ramped consumption of energy as has been reflected in water management, soil and nutrient management even in part of processing agriculture that will lead to a catastrophic ecology in Indian farming.

2. OBJECTIVES:-

- To develop concept on farm energy metabolism and management.
- To isolate the variables and factor responsible for farm energy metabolism.
- To estimate the interaction among and between the variable both intra and inter level.
- To generate a micro level policy for efficient metabolism management.

3. REVIEW OF LITERATURE

Channabasavanna A S, Biradar D P, Mahabhaleshwar Hegde and Prabhudev K N (2010) To study the production efficiency energy input management and its efficiencies as influenced by rice- fish-poultry integrated farming system models.

Bookchin Murray (1964) This study indicates that the complexity relationship between people and nature is emphasized.

Bhoumick Kumar Sharit (1980) This study indicate that the tea plantation has been assumed to have a distinct form of production organization which gives rise to Social relations.

Singh V P (2010) The entropy theory permits a probabilistic characterization of the rating curve and hence the probability density functions underlying the curve. It also permits a quantitative assessment of the uncertainty of the rating curve. The derived rating curves are tested using field data and are found to be in agreement with the curves obtained by the least square method.

4. RESEARCH METHODOLOGY

Locale of research

Sahebghanj-1 Gram Panchayat of the Bhatar block of burdwan district in West Bengal was purposively selected for the study. The village namely Swarnachalida was selected by random sampling.

Sampling Design

Purposive as well as simple random sampling techniques were adopted for the study. For selection of state, district, block and gram panchayat purposive sampling techniques was adopted because the area was ideal for Energy Management study, convenient for researcher and having the infrastructural facilities and in case of selection of villages and respondents simple random sampling technique was taken up.

5. RESULT DISCUSSION

Table 1: Coefficient of correlation (r) between Domestic Energy Consumption (Y_1) and 13 independent variables (X1-X13).

Independent Variables	**" r "** value	**significance** (2-tailed)
1. Age(X_1)	0.009	
2. Education(X_2)	0.063	
3. Family size(X_3)	-0.653**	0.000
4. Gender Ratio(X_4)	-0.068	
5.Per capita Annual Income (X_5)	0.800**	0.000
6. Farm size(X_6)	0.993**	0.000
7. Occupation(X_7)	-0.071	
8. No. of Fragments(X_8)	-0.038	
9. Cropping Intensity(X_9)	-0.095	
10. Total no. Of Livestock(X_{10})	0.049	
11. Amount of Cow dung applied in farm(X_{11})	0.247*	0.039
12. Stubble height (X_{12})	-0.041	
13. Irrigation Index(X_{13})	0.041	

****** Correlation is significant at the 0.01 level (2 tailed)
*****Correlation is significant at the 0.05 level (2 tailed)

Results: - Table 1 presents the Coefficient of Correlation between Domestic Energy Consumption (Y_1) with 13 Independent Variables. It has been found that the Variable Per capita Annual Income (**X_5**), Farm size **(X_6),** Amount of Cow dung applied in farm **(X_{11})** have recorded positive and significant Correlation with Domestic Energy Consumption **(Y_1),** While Family Size **(X_3)** has recorded a significant but negative correlation with Domestic Energy Consumption **(Y_1)**.

Revelation:-Interestingly the variable Family Size(**X_3**) has recorded significant but negative correlation with Domestic Energy Consumption (**Y_1**). This generates the logic that for a bigger Family Size the cost of energy Consumption is evenly share by the family members to justify the egalitarian Consumption pattern in a bigger size family.

With an increase in Annual Income Energy Consumption has gone up. To suggest that better annual income among the farm families has driven them for an energy intensive lifestyle. So also have been reflected for a bigger farm size where larger holding size invites need for intensive mechanization, irrigation intervention, wider mobility etc. which have amounted to a higher consumption of energy. Amount of cow dung applied in farm has contributed highest domesticated Energy consumption (Y1) may be due to its modernization, integration with existing farming and disposition of earning higher level of income through Livestock enterprises.

Table 2: Coefficient of correlation (r) between Crop Energy Balance (Y_2) and 13 independent variables (X1-X13).

Independent Variables	" r " value	significance (2-tailed)
1. Age (X_1)	-0.048	
2. Education (X_2)	-0.022	
3. Family size (X_3)	-0.005	
4. Gender Ratio (X_4)	0.124	
5.Per capita Annual Income (X_5)	-0.315**	0.008
6. Farm size (X_6)	-0.316**	0.008
7. Occupation (X_7)	0.192	
8. No. of Fragments (X_8)	-0.107	
9. Cropping Intensity (X_9)	-0.063	
10. Total no. of Livestock (X_{10})	0.026	
11. Amount of Cow dung applied in farm (X_{11})	-0.048	
12. Stubble height (X_{12})	0.107	
13. Irrigation Index (X_{13})	-0.110	

** Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2 tailed)

Results: - Table 2 presents the Coefficient of Correlation between Crop Energy Balance (y2) with 13 Independent Variables. It has been found that the Variable Per capita Annual Income (X5), Farm size (X6), have recorded negative and significant Correlation with Domestic Energy Consumption (Y1).

Revelation: The result show that with the increase in Crop Energy Balance(y2),the per capita annual income have gone down .It merits a further inquiry whether economic prospects of a farm family has been negatively poised with the aspect of energy use efficiency.

It has also been desirable that the smaller farm size has got higher crop energy balances. This may be due to high intensity management and human efficiency has insulated the prodigal nature of energy use.

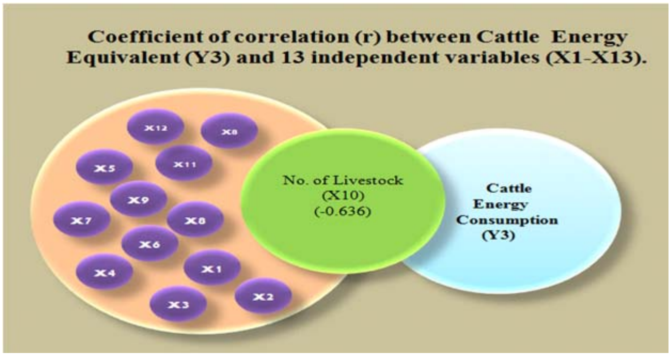
Table 3: Coefficient of correlation (r) between Cattle Energy Balance (Y_3) and 13 independent variables (X1-X13).

Independent Variables	" r " value	significance (2-tailed)
1. Age (X_1)	-0.068	
2. Education (X_2)	-0.033	
3. Family size (X_3)	-0.040	
4. Gender Ratio (X_4)	0.135	
5.Per capita Annual Income (X_5)	-0.062	
6. Farm size (X_6)	-0.028	
7. Occupation (X_7)	-0.179	
8. No. of Fragments (X_8)	-0.057	
9. Cropping Intensity (X_9)	0.000	
10. Total no. Of Livestock (X_{10})	-0.636**	0.000
11. Amount of Cow dung applied in farm (X_{11})	-0.163	
12. Stubble height (X_{12})	-0.014	
13. Irrigation Index (X_{13})	0.049	

** Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2 tailed)

Results:-It has been found that the variable Total no. of Livestock (x10) has recorded a negative significant correlation with Cattle Energy Balance (y_3).

Revelation: It is interesting to note that Cattle Energy Balance (y_3) has been found better where the no. of livestock is less. It has got the same analogy as found in the small farm energy management, Here in this case the lesser no. of livestock amounted to better energy use efficiency.



Model 1

Table 4: Factor analysis conglomeration of 13 independent variables(X_1-X13) into 6 factors

Factors	variables	% of variance	Cumulative %	Rename
I.	Per capita Annual Income (**X5**) Farm size (**X6**)	18.279	18.279	**Resource Factor**

II	No. of Fragments (**X8**) Total no. Of Livestock (**X10**) Amount of Cow dung applied in farm (**X11**)	13.176	31.455	**Farm Management**
III	Age (**X1**) Family size (**X3**)	11.498	42.953	**Family Factor**
IV	Gender Ratio (**X4**) Cropping Intensity (**X9**)	9.947	52.900	**Capacity Factor**
V	Education (**X2**) Occupation (**X7**)	8.868	61.768	**Avocation Factor**
VI	Stubble height (**X12**) Irrigation Index (**X13**)	8.510	70.278	**Farm Ecology**

Results: The factor analysis shows that the 13 variables contributing to and characterizing with the energy consumption pattern can be conglomerated into six factors (1-6). The total 13 exogenous Variables have been put up with Factor Analysis to identify the important factor in state of variables, which has been responsible for contributing the Variance in the process of conglomeration. The Factor 1 has included following 2 variables i.e. Per capita Annual Income(X5) and Farm size (X6) which have contributed 18.28 % of variance and has been renamed as **Resource Factor**.

The Factor 2 has included 3 numbers of variables i.e. No. of Fragments(X8), Total no. of Livestock(X10) and Amount of cow dung applied in Farm(X_{11}) that have contributed 13.18% of variance has been renamed as **Farm Management**.

The Factor 3 has included 2 numbers of variables i.e. Age(X_1) and Family size (X3) which have contributed 11.50% of variance and has been renamed as **Family Factor.**

Factor 4 has 2 numbers of variables i.e. Gender Ratio(x4) and Cropping Intensity (X_9) which have contributed 9.947% of variance and has been renamed as **Capacity Factor.**

Factor 5 has 2 numbers of variables i.e. Education(X2) and Occupation which have contributed 8.868% of variance and has been renamed as **Avocation Factor.**

Factor 6 has 2 numbers of variables i.e. Stubble height (X12) and Irrigation index which have contributed 8.510% of variance and has been renamed as **Farm Ecology.**

So, this factor already isolated are presenting important tactical and strategic dimensions for better Crop energy balances and capacity building of practising farmers in Farm Energy Management as a whole.

Model on Factor Analysis: Conglomeration of homogeneous Variables based on factor loading into factor

Factor 1 ---) Resource Factor

Model – 2

Factor 2 ---) Family Factor

Model –3

Factor 3 ---) Capacity Factor

Model –4

Factor 4 ---) Avocation Factor

Model-5

Factor 6 ---) Farm Ecology

Model-6

6. CONCLUSION

Farm energy has been the prime mover for agricultural productivity and its intrinsic transformation of transferable matter into metabolic energy. Our farmers are more input literate and, at the same time remains energy illerate. Having energy losses from sub soil region in place, the soil will look like soil but certainly turns unproductive. The present paper has highlighted the important predictors and correlates characterizing the farm energy management status. A simple variable, the stubble height left after harvesting of crops, would go a long way to retrieve the energy balances and at higher energy resilience for a well calibrated come back of factor production towards sustainable agriculture.

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