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Farm- Energy Balances of Small Farm Management in India: A Socio-ecological and Techno-managerial Analysis

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Abstract

Energy is the driving force in the ecology, which changes its forms while transferring from one trophic level to another and from one component of ecosystem to another component i.e. in between animate and inmate forms of life. While transferring from one component of ecosystem there is loss of some energy, which is termed as entropy in thermodynamics. Keeping this energy and the energy losses in view the present study "Estimation of Farm Energy Balances of Small Farm Management: A Socio-ecological and Techno-managerial Analysis" has been selected to study the energy balances i.e., consumption and production in crop enterprises as well as in households and its overall impact on social, economic, ecological spheres of ecosystem. Farm Energy Balance (y) is defined as the difference between the energy equivalents of feed taken by the cattle and the energy equivalents of the output from cattle in the form of dung and milk per day per cattle. The variable Crop Energy Balance (y) is the dependent variable being predicted by a set of 14 independent variables. Study was conducted at Saharpara village of Haringhata,in district Nadia of West Bengal. The factors, Farm Economy Index, Personal Capacity, Family Resources, Family Motivation have led to consciousness about the energy balances in social ecology and impact of these energy balances on the ecosystem as whole. The Multiple correlation results shows, Age (X_1) has positive significant correlation with Farm Energy Balance (y) ,whereas the variables Education (X_2), Homestead Land Size (X_9) and Age (X_1) have had significant impact on farm energy balance. A comparative study can be adopted to conclude whether agriculture or fishery or cattle or poultry enterprises can be comparable with each other or all these enterprises can well be complemented to develop a complex model for farm energy management.

Keywords: Crop Energy Balance, Social ecology, Social system theory, Entropy, Farm Economy, Trophic Level.

1. Introduction

The energy consumption pattern in India especially in the agro-ecosystem followed by small *and marginal farm holdings around 85% of total 130 million farm families in India generating* 259 million tonnes of food grain that include a record production of 106 million tonnes of rice, 95 million tonnes of wheat, 22 million tonnes of maize, 17 million tonnes of pulses, about 30 million tonnes of oilseeds, 210 million tonnes of horticultural production, 180 million tonnes of milk and 8.7 million tonnes of fish (2011-12) has got tremendous implication and need to be added against total volume of energy consumed is in a positive balance or a negative balance either.

The model on energy in social ecology has got three basic considerations –

1. Flow of energy from one small niche and in between can be called social metabolism.
2. The flow of capital into this system of entrepreneurship intensity of rotation to ultimately characterize enterprise product and outcome.
3. Conservation of energy through considering the renewability level of different energy forms entering the system.

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2. Objectives

1. To generate a conceptual frame work on Crop Energy Balance in a given social ecology i.e. the research locale.
2. To identify and customize independent variables that interact with the dependent variable i.e Crop Energy Balance to study their interactive relationships.
3. To estimate the effect and causal contribution of a set of agro economic and socio-personal variables on the energy consumption pattern of rural respondents.

3. Research Methodology

3.1 Locale of Research

Fatehpur Gram Panchayat of the Haringhata block of Nadia district in West Bengal was purposively selected for the study. The village namely Sahapara was selected by random sampling.

3.2 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 climate change 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.

3.3 Variables

The predictors used in this study are Age (X_1), Education (X_2), Family Education Status (X_3), Family Size (X_4), Gender (X_5), Occupation (X_6), Cropping Intensity (X_7), Farm Size (X_8), Homstead Land Size (X_9), Expenditure (X_{10}), Annual Income (X_{11}), Irrigation Index (X_{12}), Economic Motivation (X_{13}), Market Orientation (X_{14})to predict the variable Crop Energy Balance (y_2).

3.4 Techniques of Data Collection

The respondents were personally interviewed using structured Interview schedule.

3.5 Statistical Tools used for Analysis of Data

The statistical methods used for analysis and interpretation of raw data were – Mean ,Standard deviation , Coefficient of Variance, Correlation of coefficient ,Multiple regression analysis ,Path analysis , Factor analysis.

4. Results and Discussion

4.1 Multiple Correlations

Table 1: Coefficient of correlation (‘r’) between Crop Energy Balance (y) and 14 independent variables (X_1-X_{14})

S. No	Variables	‘r’ value
1	Age (X1)	0.4178**
2	Education (X2)	-0.5759
3	Family education status (X3)	-0.0661
4	Family size (X4)	-0.062
5	Gender (X5)	0.0376
6	Occupation (X6)	0.0634
7	Cropping intensity (X7)	-0.2162
8	Farm size (X8)	0.2380

9	Homstead Land Size (X9)	-0.3656
10	Expenditure allotment (X10)	0.0146
11	Annual income (X11)	0.0559
12	Irrigation index (X12)	-0.0043
13	Economic motivation (X13)	-0.0104
14	Market orientation (X14)	0.0736

r>0.267 *(5% level of significance)
r>0.360**(1% level of significance)

Results:-It has been found that the variable **Age (X_1)** has recorded a **positive** significant correlation with Crop Energy Balance (y_2).

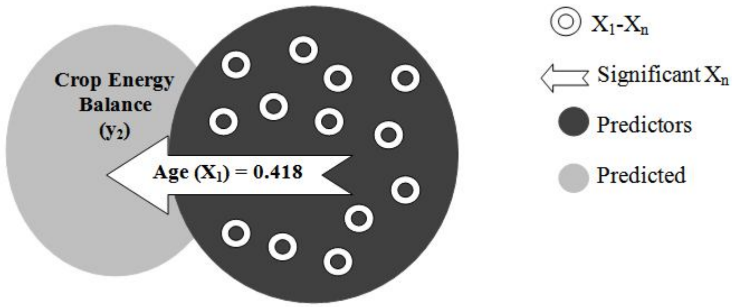

Figure 1: Multiple Correlations between the variable y_2 and 14 independent variables.

Revelation: Chronological age provides the experience factor which is very much needed for the better management of resources and eventually helps to maintain the balance in the crop i.e, helps to increase the output per unit of the input used, otherwise if output would not be more, no person will make agriculture his lifelong occupation.

5. Factor Analysis

Table 2: Factor Analysis of 14 Predictors.

Factors	Variables	% of Variance	Cumulative %	Factor Rename
1.	Age (X1) Farm size (X6) Expenditure allotment (X10) Annual Income (X11) Irrigation Index(X12)	24.774	24.774	Farm Economy Index

2.	Education (X2) Occupation (X6)	15.814	40.558	Personal Capacity
3.	Family size (X4) Cropping Intensity(X7) Homestead Land Size(X9)	9.361	63.680	Family Resources
4.	Family Education Status (X3) Gender (X5) Economic Motivation(x13)	13.731	54.319	Family Motivation

Results:

The factor analysis shows that the 14 variables contributing to and characterizing with the energy consumption pattern can be conglomerated into four factors (1-4)

The **Factor 1** has included following 5 number of variables i.e. Age (X_1) Farm size (X_6),Expenditure allotment (X_{10}), Annual income (X_9),and Irrigation index(X_{12}) which have contributed 24.774% of variance and has been renamed as **Farm Economy Index**.

The **Factor 2** has included 2 numbers of variables i.e. Education(X_2) and Occupation(X_6) that have contributed 15.814% of variance has been renamed as **Personal capacity**.

The **Factor 3** has included 3 numbers of variables i.e. Family size (X_4), Cropping intensity (X_7) and Homestead land size(X_9) which have contributed 9.361% of variance and has been renamed as **Family resources**.

Factor 4 has **3** numbers of variables i.e. Family education status (X_3), Gender(X_5) and Economic motivation(X_{13}) which have contributed 13.731% of variance and has been renamed as **Family motivation.**

6. Revelations

1. Family economy indicates and influences that energy consumption specifically for the communities passing through upcoming modernization process. It is also discernable that the agricultural modernization, invariably and integratedly needs a higher level of energy consumption to support the elements of modernization for transforming farm ecology.
2. Factor 2 indicates that consumption of energy invariably needs capacity building at the personnel level; the capacity involves infrastructural, operational and occupational capacities, in a manner while integrated and orchestered.
3. For any kind of energy consumption family resources extend the support system and at the same time can play a catalytic role in answering the farm modernization process through higher and calculated energy consumption level.

7. Multiple Regressions

Table 3: Regression analysis Crop Energy Balance (y) vs 14 causal variables (X_1-X_{14})

S. No	Variables	β	β×R	S,Error B	't' Value	Rank
1	Age (X1)	0.213	18.078	6163.511	1.087	III
2	Education (X2)	-0.508	59.502	6302.832	2.724	I
3	Family education status(X3)	-0.088	1.184	11333.114	0.596	VII
4	Family size(X4)	-0.290	0.366	35121.789	0.892	XI
5	Gender (X5)	-0.154	-1.174	23643.306	0.967	VIII
6	Occupation(X6)	0.144	1.851	31546.997	1.039	VI
7	Crop intensity(X7)	-0.133	5.585	461.716	0.720	V
8	Farm size(X8)	-0.161	-7.787	102091.742	0.441	IV
9	Homestead Land Size (X9)	-0.293	21.779		1.188	II
10	Expenditure allotment(X10)	-0.189	-0.561	5109.319	1.061	X
11	Annual income(X11)	0.091	1.035	2.421	0.415	IX
12	Irrigation index(X12)	-0.071	0.062	650157.177	0.195	XIII
13	Economic motivation(X13)	-0.007	0.015	34472.475	0.047	XIV
14	Market orientation(X14)	-0.014	-0.209	35901.656	0.095	XII

R^2 =0.2001 F value =5.88 at 2 and 47 DFS.

Results: The Multiple Regression Analysis reveals that the following three variables viz; **Education (X_2), Homestead land size(X_9)** and **Age(X_1)** have exerted substantive impact on the consequent variable Crop Energy Balance(y).

Revelation: The variable Education has recorded the highest percentile contribution to the total R^2 value. It indicates that the higher education level of farmers leads to higher understanding of the energy use in different farming operation i.e, they are able to increase the efficiency and management of different farm inputs like fertilizer, water, electricity etc. This variable has been followed by the **Homestead land size (X_9)** and **Age (X_1)** i.e, if the homestead size would be in a manageable sphere more efficient management of energy would be mantained and comparatively output would be more, also Age(x_1) chronological age provides the experience of handling different farm operations in a better way which leads to a very good equity status in maintaining Crop Energy Balance.

The R^2 value being 0.2001, it is to conclude that 20.01 percent of variance have been explained with the contribution of the 14 causal variables(X_1-X_{14}).

Table-3 a

Variable	β	t	Significant
1.Education (X2)	-0.576	4.881	

Table-3 b

Model	R	R2	Adjusted R2	Standard Error of the estimate
1	0.5759	0.3317	0.3178	3986.370

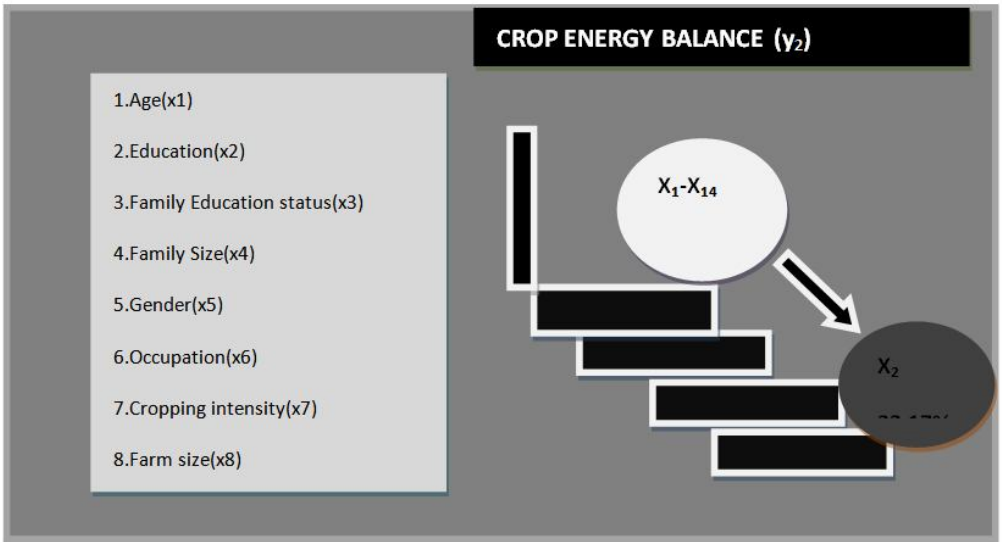

Figure 2: Multiple Regression between y and 14 independent variables.

Results: The step down regression analysis forward) has retained one prominent causal variables viz. **Education (X_2)** at the last step. So, this variable has got substantive strategic and operational impact on Crop Energy Balance.

Revelation: The step down regression presents that at last step of step down analysis variable, **Education(X_2)** has contributed the most to Crop Energy Balance. The knowledge of farmers about new techniques of crop growing, weather, government policies are positively related to the better crop output sources which again is impacted by Education. Only Education(X_2) has been retained at the last stage of Step-down Regression Analysis which has got solitary contribution of **33.17 percent** to the total R^2 value i.e, to say that Education deserve to earn a special attention while we intend to make a serious intervention in the domain of Crop Energy Balance.

8. Path Analysis

Table 4

Path Analysis: Direct, Indirect and Residual effect; Crop Energy Balance (y) Vs 14 Exogenous Variables(X_1 to X_{14})

S. No.	Variables	Total Effect (r)	Direct Effect (DE)	Indirect Effect (IE)=r-DE	Highest Indirect Effect
1.	Education (X2)	-0.5759	-0.5082	-0.0677	-0.1372 (X1)
2.	Farm Size (X8)	0.2380	-0.1610	0.399	0.1772 (X4)

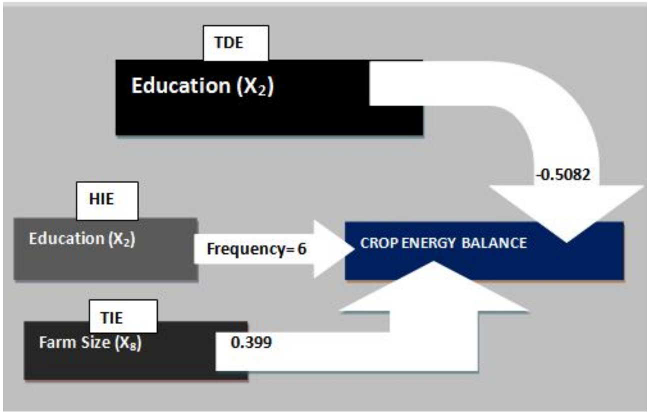

Figure 3: Path Analysis showing TDE, HIE,TIE and frequency.

Results: Table-4 presents the Path Analysis where in the total effect of exogenous variables on consequent variable has been decomposed into Direct, Indirect and Residual effects. It has been evinced that variable **Education(X_2)** has exerted highest direct effect (-0.5082) and **Farm size(X_8)** as highest total indirect effect (0.399)

Revelation: Education (X_2) has recorded the substantive direct effect on Crop Energy Balance (y) although with a negative value to suggest that **Crop Energy Balance (y)** has been better for the farmers having lesser 'Education value'.

The other variable **Farm size(X_8)** has exerted the highest total indirect effect to elicit that in Crop Energy Balance (y), the role of **Farm size(X_8)** is extremely associative and can characterize the entire energy balance to discernible extent.

The variable **Education (X_2)** has rented the highest indirect effect as many as six exogenous variables to evince that education of a farmer has been key cognitive and functional capacity to characterize Crop Energy Balance.

9. Conclusion

Today we all have some basic knowledge about the uses and application of energy especially when we are managing a farming system for sustainable productivity. We know that by burning petrol or diesel we get energy to run scooters, cars, trucks, etc., and we also know that many of our homes need coal, kerosene, oil and gas for the supply for energy for cooking food and similar other domestic activities. For many of us, the awareness of energy has also come about through day-to-day inconveniences caused by power cuts, shortage of kerosene and diesel; fuel rationing, and the increasing cost of obtaining energy. For scientists, energy is in fact another form of matter and interchangeable with it. We live a world with energy all around us.

It is discernible to note that the energy balances for cowdung output has been negative ,while that for crop output has been positive, perhaps this is the most important observation to apparently infer that organic farming does not ensure always an efficient energy conservation or metabolism. The total calorie output from is less than the green fodder.

Energy consumption pattern aims to explain the transfer of energy from one form to another in between the social system, ecological system, animate system as well as inanimate system and provide a deep insight into the domain of entropy generated during this transfer in nature between different trophic levels.

References

[1] Abdi, R.; Hematian, A.; Shahamat, E.Z. and Bakhtiari, A.A. (2012). Optimization of energy consumption pattern in the maize production system in Kermanshah province of Iran. *Research-Journal-of-Applied-Sciences,-Engineering-and-Technology*. **4**(15): 2548-2554.

[2] Asakereh, A.; Keyhani, A.; Safaienejad, H.A.M. and Garavand, A.T. (2019). Energy consumption pattern and economic efficiency of dry farming chickpea in Koohdasht county, Iran. Proceedings-of-the-10th-International-Agricultural-Engineering-Conference,-Bangkok,-Thailand,-7-10-December,-2009-Role-of-agricultural-engineering-in-advent-of-changing-global-landscape. 2009; unpaginated.

[3] Bassi, A.M. (2011). A context-inclusive approach to support energy policy formulation and evaluation. *Regional-Environmental-Change*. **11**(2): 285-295.

[4] Bianchi, F.J.J.A.; Werf, W.van.der. and Honek, A. (2009). Modelling effects of land use on spatial ecology, energy budgets and population viability in the ladybeetle Coccinella septempunctata. *Bulletin-OILB/SROP*. **29**(6): 9-11.

[5] Couvreur, J.P. (2006)Some ideas for the control of energy consumption and for the optimization of farm mechanization. *Fourrages*. (187): 301-310.

[6] Neena, V.; Jatinder. K.; Aprajita, K. and Aruna, R. (2011). Rural farm households energy consumption pattern in district Kangra of Himachal Pradesh. *Advance-Research-Journal-of-Social-Science*. **2**(1): 76-79.