The Social Physics of Farm Energy Management in India: The Metabolism and Ecology

S. K. Acharya[1], M. Gupta[2], K. Mondol[3]

[1]Professor, [2, 3]Ph.d.scholar
acharya09@sankar@gmail.com, moumi38@gmail.com
Department of Agricultural Extension,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal

Abstract: The sociology of energy consumption and generation, trapping and utilization, has got unique features that again can be configured as the farm metabolism as well as energy ecology in farm management. Most of the Indian farms, as few researches start evincing the fact, are suffering from moderate to high energy imbalances leading to an energy entropy in farm and in farmers psyche. The social physics of farm metabolism also implies the entropy status of the farmers due to imbalances between level of achievement and the quanta of motivation unleashed. This is perhaps a unique situation where in the farms are suffering from energy imbalances and the farmers are from motivational entropy. The new age extension science will keep on focussing to manage and mitigate both the restless farms and the chaotic farmers. The present research encompasses these two aspects in a mega thematic research supported by empirical evidences. The variables under study are discontinuance, rejection, entropy, farm energy consumption, farm energy metabolism and while these are the criterion variables, the causal variables are a score of socio-ecological and input variables. It is interesting to observe that with an increase in entropy, the cropping intensity has also been increase and the irrigated agro-ecosystem bestows more energy chaos than that of a rain fed agro-ecosystem. So, the research evidences drive us to a policy implication where in food security through sustainable production function of a farm need to be estimated as well as relegated to the present status of farm energy metabolism. Since, this is a new goner of research in this sub-continent, more of replication and collaboration of this research will go more effective and comprehensive in terms of both policy and practice.

Keywords: farm energy metabolism, irrigated agro-ecosystem, social-chaos, social ecology, social physics.

1. INTRODUCTION

Energy is the prime mover for any production process and Indian farms have got an evolving profile of energy metabolism and management. Energy metabolism takes care of energy entry and energy exit into and from any system, which again with the most important determinant of production management. This is a new goner of research that helps farmers adopt better energy management practises for their farms and entail the whole spectrum of factor production to perform for a protractile period. This is immensely important in the perspective of climate change. One of the

crises that Indian farming is facing lies in its mismanagement of energy jeopardizing the system behaviour of farms. The incorporation of livestock into farming along with participation of farm women in its management can contribute to a better energy management in farms (Mondal, K and Acharya, S K 2014). It has also been found that even with higher application of organic manure may lead to a negative energy balances in any farm (Khan, G A and Acharya, S K 2013). Thus the social physics of farm energy metabolism implies that the nature and level of farm energy metabolism can be estimated through the dynamics of socio-economic and socio-ecological factors. The proposed research will make an estimation of different variables contributing to energy balances and its metabolism in some selected farms.

Objectives:

- To operationalize the concept of farm energy metabolism and management in empirical terms.
- To isolate the variables contributing to farm energy management and subsequent metabolism.
- To organize participatory data generation process to delineate the time, space, flow and decision characters.
- To elicit the micro level policy on efficient energy management and metabolism so as to achieve a resilient and sustainable farm production.

2. MATERIAL AND METHODS

The deliberation on the methodology has been made to understand the concept, methods and techniques which were utilized to design the study, collection of information, analysis of the data and interpretation of the findings for revelation of truths and formulation of theories. This chapter deals with the method and a procedure used in the study and consists of eight main parts.

A. Locale of Research. B. Pilot Study. C. Sampling Design. D. Empirical Measurement of the Variables. E. Preparation of Interview Schedule. F. Pre-testing of Interview Schedule.

G. Techniques of Data Collection .H. Statistical Tools used for Analysis of Data.

3. CONCEPTUAL INPUTS

According to law of entropy, all matter and energy are constantly and without exception moving from an ordered to a disordered. *(Ibid; p 233)* Technologies after all, are designed to speed up the entropy process by more progressively using up the stock of available matter and energy in the world. *(ibid; p 233)*. This is an analytical framework which is based on the fundamental laws of Thermodynamics. The matter and energy is neither created nor destroyed guarantees a material balance in the economy. That is to say, "Human beings can neither create matter nor energy, only create utilities" (Marshall 1924 in Georgescue; Roegen, 1977). Therefore, this shows limitations or physical restriction that the environment imposes on the expansion of national economies. The second law of thermodynamics or Entropy law highlights the finite character of natural resources and in general, of all materials that are used in economic system. This law establishes that energy is transformed from available energy for the human use to non-available or dissipated energy and never vice-versa: "The degradation of matter-energy goes not only continuously, but also irreversibly" (Georgescu; Roegen 1977: 16). In general terms, we can say that valuable natural resources enter the economic process and waste without value is what leaves the system.

All societies, even the most rudimentary ones, need a physical base, a biophysical infrastructure composed of living and non-living materials (Livestock, buildings, artifacts, machine and road). In addition, all societies depend on the use of materials to grow and increase their welfare. At the same time, the use of material exerts pressure on the environment and in a world characterized by limited availability of resources. It affects future supply prospects. Every product consumed in modern societies has a long material flow story which starts with the extraction of raw materials and continuous with processing, manufacturing, packaging and transportation to markets. It then grows on to final consumption or use, possible reuse and recycling and ends up with final disposal. Each step on this material chain has an impact on the environment either by the extraction of material by the accumulation of material within the socioeconomic system as more land in being used or by the release of emissions and waste.

By producing, consuming and disposing of material into the environment, societies transform nature. At the same time, this modified natural environment determines societies. A co-evolutionary process takes place between nature and societies. The epistemological framework that analyses the interaction between society and its material environment is referred to as social or societal metabolism (Fisher-Kowalski, 1998). According to this approach, each socioeconomic system (or society) has a physical dimension or metabolic profile determined by the quality and characteristics of their material and energy inputs and outputs. This approach recognizes the nature of economies as open systems (Kapp, 1976). That is inevitably connected with the surrounding environment and with other economic systems by means of material flow and energy. There is a continuous and mutual influence between economic process and environment.

Roy, Ankita (2011) has drawn up that the higher the independency, the individuality gets unleashed and the person will start behaving like a free particle in zigzag movements as has been observed by Albert Einstein's in a typical Brownian movement. The education in a person acts as a propeller and drives in out of the customized confinement or defined domain for an individual by tradition and norms. This kind of extraterrestrial behavior can be perceived as entropy per se for an apparently state and unmoved society. The educational pursuit in a family, non integrated, erratic, free flying, non committal, may add a kind of negentropy which is happening in a mundane and depletive farming system. Cropping intensity and distance matrix may experience a marital closeness and proximity through Eigen Roots and can contribute to a new factor called System Factor to substantially characterize the social entropy.

Coefficient of correlation (r)between Crop Energy Balance (y) and 14 independent variables (X1-X14)
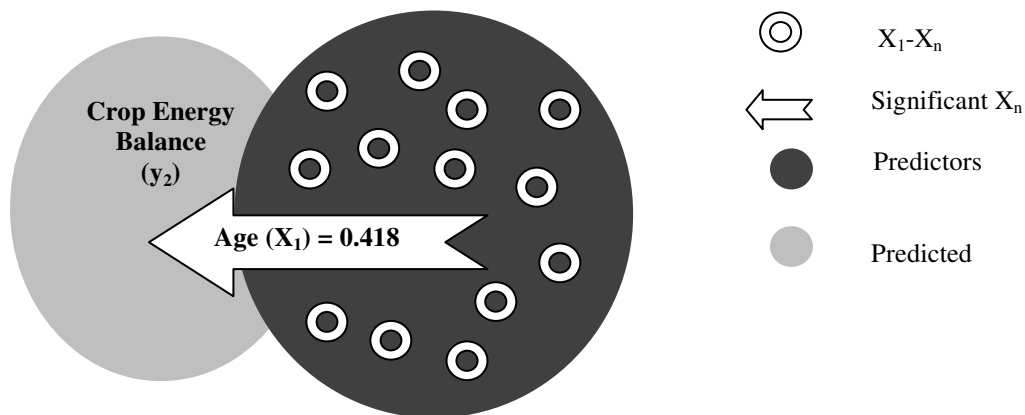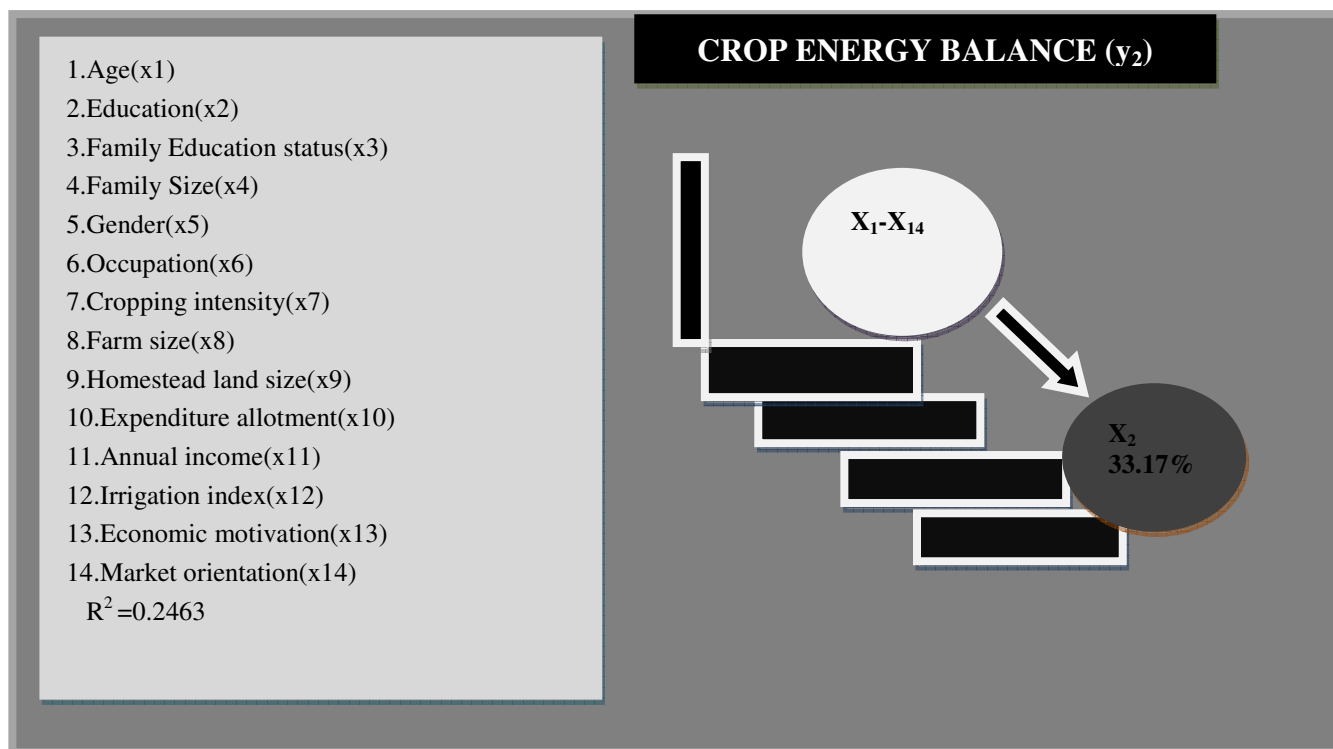
Dutta, T. (2010) Concluded that every chaos and entropy has got a framework to act and make the system somehow operational. They also found that concept of Social entropy would help calculation of residual energy or motivation, estimation of motivation flow mechanism to formulate better scientific and effective training, motivation, leadership, project monitoring, teaching learning program, organizational behavior and objective evaluation mechanism. It would help measure and adopt remedial measure to fight stress, morbidity, neuro-psychosis and psycho-somatic disorder. The concept of entropy would help in combat and redress conflict, intra-group rivalry, leadership, intimidation, shift stress etc. Kenneth, D.

Bailey (1994) presents the concept of entropy theory not as merely a thermodynamic concept whose utility is primarily limited to the study of heat and temperature change, but rather as a generic concept that is inversely related to the amount of work done.

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.

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

CROP ENERGY BALANCE (y_2)

1. Age(x1)
2. Education(x2)
3. Family Education status(x3)
4. Family Size(x4)
5. Gender(x5)
6. Occupation(x6)
7. Cropping intensity(x7)
8. Farm size(x8)
9. Homestead land size(x9)
10. Expenditure allotment(x10)
11. Annual income(x11)
12. Irrigation index(x12)
13. Economic motivation(x13)
14. Market orientation(x14)

$R^2 = 0.2463$

X_1-X_{14}

X_2
33.17%

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.

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

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.
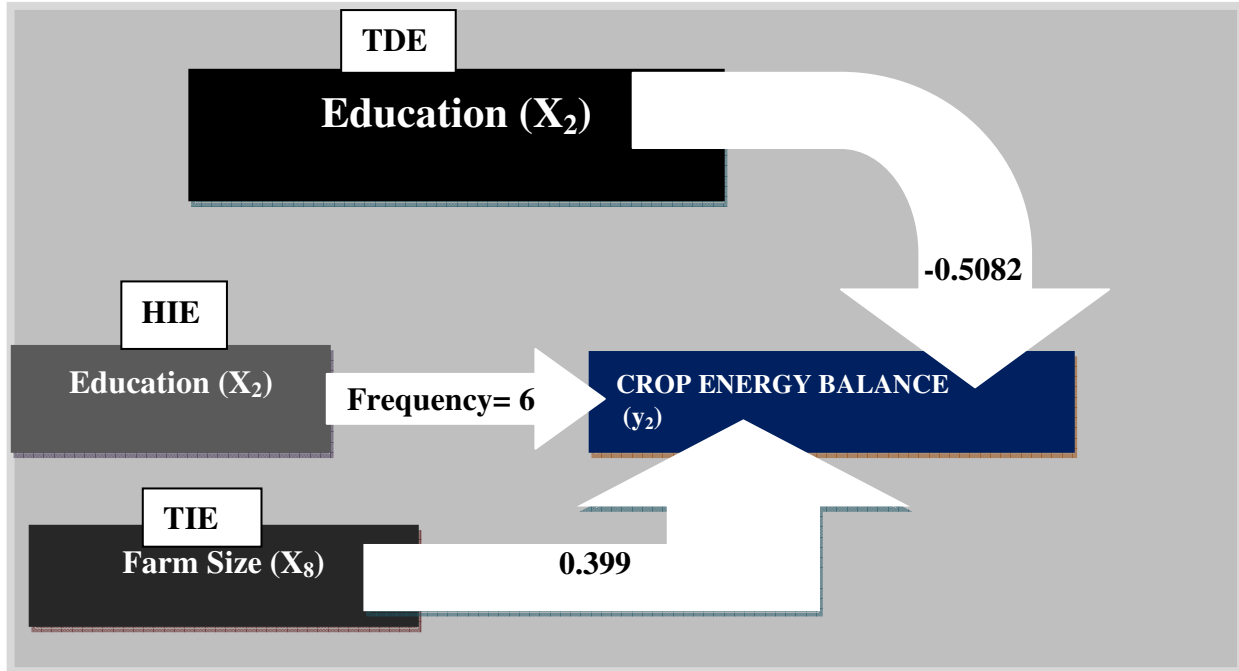
Coefficient of correlation (r) between Cattle Energy Balance (y) and 14 independent variables (x_1-x_{14}).

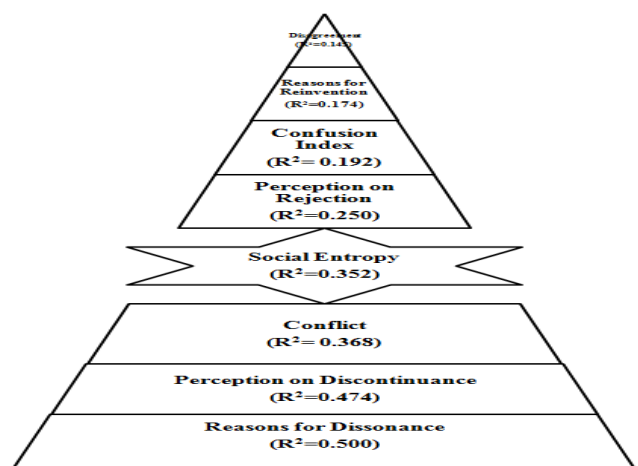| Variables	r value	Remarks
1. Age(x_1)	0.0793	
2. Education(x_2)	-0.1109	
3. Family education status(x_3)	0.1067	
4. Family size(x_4)	0.2166	
5. Gender (x_5)	-0.0936	
6. Occupation(x_6)	0.1538	
7. Cropping intensity(x_7)	0.2212	
8. Farm size(x_8)	-0.0170	
9. Homestead land size(x_9)	-0.0175	
10. Expenditure allotment(x_{10})	**0.3170**	*
11. Annual income(x_{11})	0.0570	
12. Irrigation index(x_{12})	-0.1043	
13. Economic motivation(x_{13})	-0.0541	
14. Market orientation(x_{14})	-0.0563	

Revelation:-Expenditure allotment is an important determinant to decide on what enterprise and at what proportion the expenditure will be incurred by the farmer. The unit output value from unit input cost is proportionally more for agriculture, while it is lower for animal enterprise, that is how and why family allocation has been found as a determinant to decide on number of cattle and the bio energy balances in the form of cow dung, ultimately gone relegated to energy balances in the given farm ecology.

CROP ENERGY BALANCE (y)

X_1-X_{14}

X_4 , X_{10}
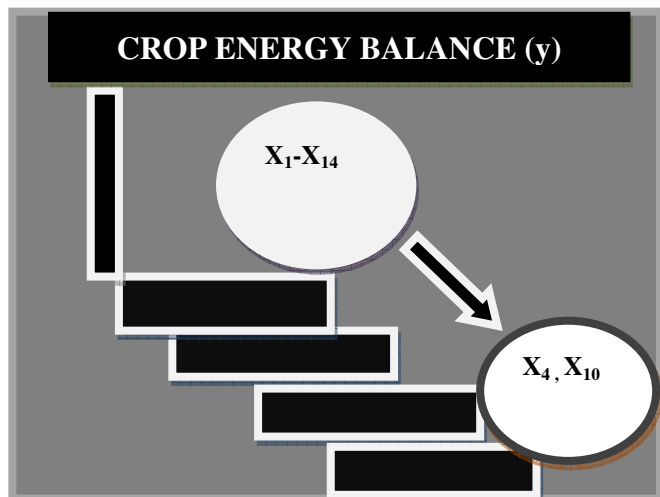
Revelation: The step down regression presents that at last step of step down analysis two variables, Family size(x_4) and Expenditure allotment(x_{10}) have contributed the most to Cattle Energy Balances. The sources of energy are linearly related to family requirement which again is impacted by family size. Only Family size(x_4) and Expenditure allotment 1 (x_{10}) have been retained at the last stage of Step-down Regression Analysis.

Model of Social Entropy

Model of Social Entropy (Fig) was developed arranging all the R^2 values of all the dependent variables. Model of social entropy shows that, the dependent variable Perception on discontinuance has contributed in second order of strength i.e. just after Reasons for dissonance. Social entropy itself contributed with the R^2 value 0.352 which explains its medieval nature among all the dependent variables.

Disagreement (R^2=0.141)
Reasons for Reinvention (R^2=0.174)
Confusion Index (R^2= 0.192)
Perception on Rejection (R^2=0.250)
Social Entropy (R^2=0.352)
Conflict (R^2= 0.368)
Perception on Discontinuance (R^2=0.474)
Reasons for Dissonance (R^2=0.500)

4. CONCLUSION
- The variables having market orientation indicating family education status, electricity consumption and information seeking behavior have recorded increasing propensity to instigate and stimulate the process of social entropy in hastening the technology socialization.
- Stepwise regression has further specified and helps to conclude that market orientations and utilization of cosmopolite source of information have become a diode to fasten the technology socialization through social entropy in farm ecology.
- Hence, it can be concluded that this analytical framework a new paradigm have come up to estimate the 'bulk of negentropies' mostly through a set of socio-psychological, situational and behavioral characters. In a given social ecology the auditing and its negative motivational dispositions can go a long way in driving the farmers' inspiration as well as perspiration to better tomorrow and higher accomplishments.
- Technologies always speed up the process of social entropy or other way energy in a system irreversibly that is why farmers shows negative cognitive behavior in the form of discontinuance, rejection, disagreement, conflict, dissonance, reinvention and confusion. In nature Earth is a closed system as compared to universe. When energy depletes on the earth. Social entropy will go up. To offset the impact of Social entropy Earth takes energy form the sun to maintain life on the biosphere of the earth.

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