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Artificial Neural Network (ANN) Model for prediction of Human Energy Consumption of women Thresher machine operators

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Abstract:* The objective of the present research paper is to develop Artificial Neural Network Simulation and analysis for prediction of Human Energy Consumption (HE) of women Thresher machine operators as dependent π term and considering Anthropometric, Physiological , Environmental , Crop and machine variables as independent π Terms. The output of this network can be evaluated by comparing it with field data, mathematical data and the predicted ANN simulation. ANN Simulation model developed for can very well be used in Artificial Neural Network Simulation and analysis for prediction of Human Energy Consumption (HE) of women Thresher machine operators.

***Keywords:* ANN model; dependent π Term, independent π Terms, Human Energy Consumption (HE)**

1. INTRODUCTION

To arrive at mathematical model, the process started with development of some preliminary mathematical relations and then arriving at some single generalized equations. The mathematical model to calculate for Human Energy Consumption (HE) of women operators for thresher machine considering Anthropometric, Physiological , Environmental , Crop and machine variables is developed by Kadam .A.D [1]in 2019.Kadam .A.D et.al [2,3] studied for improving the existing condition of thresher machine women operators by field data base modeling and analyzed the effect of various input variables on the response. The final objective of this study is not only developing the models but also to find out the best set of variables. The best set of variables will outcome in maximization and/or minimization of the response variables [4-9]. Human Energy Consumption, HE needs to be minimized is the objective functions corresponding to developed models. The models have been formulated mathematically as well as by using the ANN. Now we have sets of values of independent pi

terms of Thresher operation involving human ergonomics viz. values computed by field data, values computed by mathematical model and values obtained by ANN [10-11].
In this paper an attempt is made to extend the work by developing artificial neural network Simulation and analyze for prediction of Human Energy Consumption (HE) of women Thresher machine operators as dependent π term and considering Anthropometric, Physiological , Environmental , Crop and machine variables as independent π Terms.

1.1 Artificial Neural Network Simulation is developed to calculate for Human Energy Consumption (HE) by using Anthropometric, Physiological , Environmental , Crop and machine variables. For the dependent pi term i.e., Human energy, field data-based modeling was accomplished through mathematical models. The development of artificial neural network (ANN) is also scheduled in such a complicated phenomenon involving non-linear systems. The output of this network can be evaluated by comparing it with observed data and the data calculated from the mathematical models. For development of ANN, the designer has to recognize the inherent pi terms. Once this is accomplished training the network is mostly a fine tuning process [10-11]. It is utmost importance to compare the data generated through mathematical models, field data and ANN data to validate the phenomenon

1.2 Artificial Neural Network Simulation

An artificial neural network (ANN) consists of three layers i.e., the input layer, the hidden layer and the output layer. Its nodes represent neurons of the brain. The specific mapping performed depends upon the architecture and synaptic weight values between the neurons of ANN network. An artificial neural network is highly distributed representation and transformation that works in parallel. The control is distributed by highly interconnected. It is utmost important to compare the data generated through, experimentally observed data and ANN data to validate the phenomenon.

2. PROCEDURE FOR ARTIFICIAL NEURAL NETWORK PHENOMENON

The observed data from the experimentation is separated into two parts viz. input data or the data of independent pi terms and the output data or the data of dependent pi terms. The input data and output data are imported to the program respectively. Through principal component analysis the normalized data is uncorrelated. This is achieved by using “prestd” function. The input and output data is then categorized in three categories viz. testing, validation and training. The common practice is to select initial 75% training, last 75% data for validation and middle overlapping 50% data for testing. This is achieved by developing a proper code.

1. The data is then stored in structures for training, testing and validation.
2. Looking at the pattern of the data feed forward back propagation type neural network is chosen.
3. This network is then trained using the training data. The computational errors in the actual and target data are computed and then the network is simulated.
4. The uncorrelated output data is again transformed on to the original form by using “poststd” function.

5. After simulating the ANN, it is found that experimentally observed values are very close and in good agreement with the ANN predicted values.

Figure 1shows simple multilayer feed forward network for ANN and figure 2 shows the flow diagram of ANN simulation.

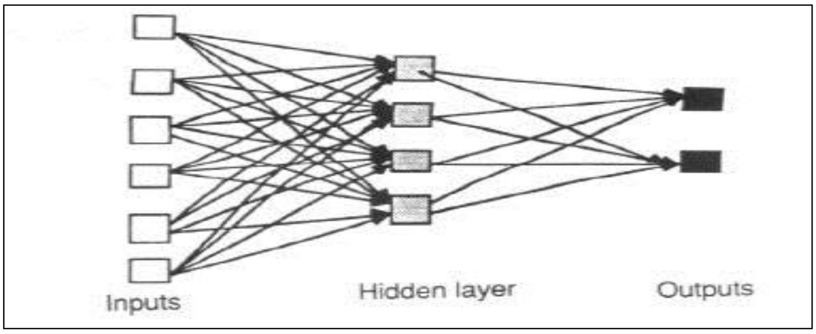


Fig.1 Simple multilayer feed forward network (ANN) [3]

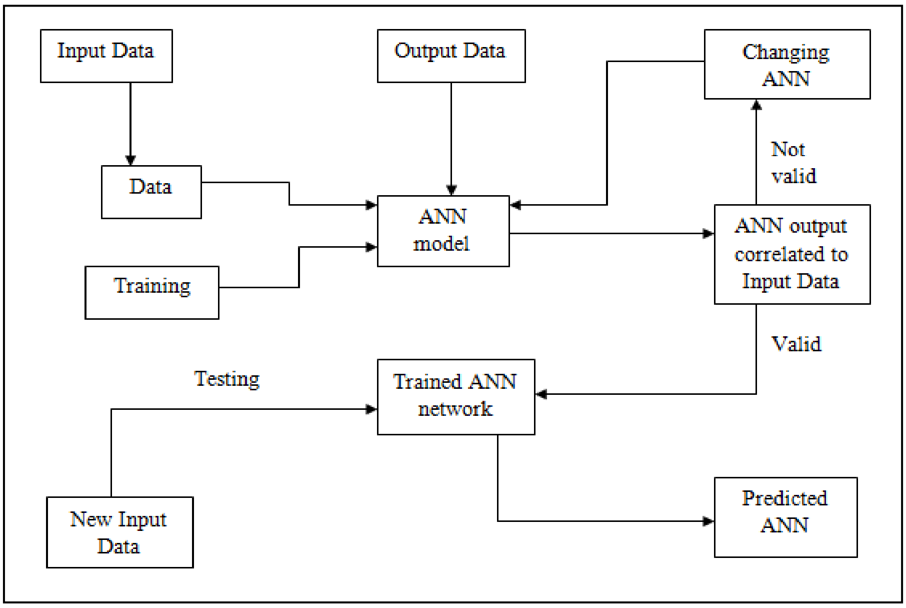
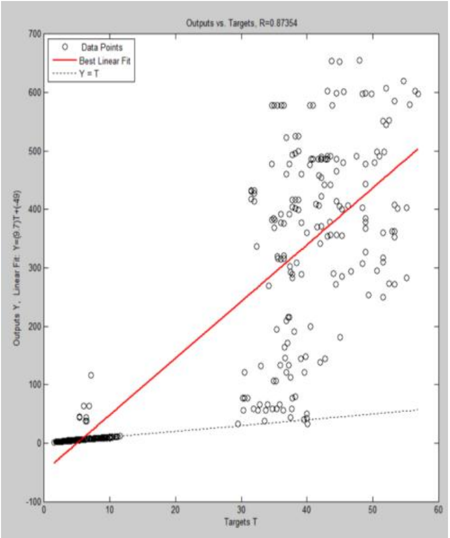


Fig.2 ANN Simulation flow diagram [3]

Table 1shows comparison of the values of dependent pi terms computed by experimentation, and ANN and. The values of R squared error in ANN, number of iterations, values of the regression coefficients for dependent pi terms and the plots of the actual data and target data for the dependent pi terms are shown in Figures for response/ dependent variable.



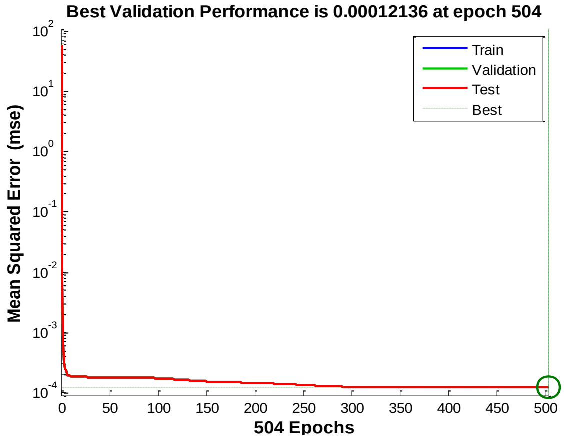


Fig. 3 Target vs output graph (R^2=0.7569) Fig. 4 Shows best validation performance (a)

(a)

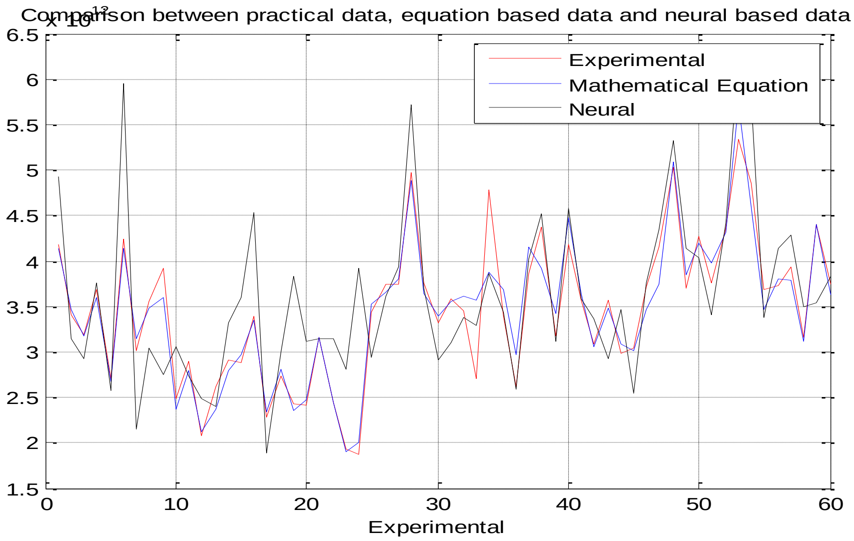


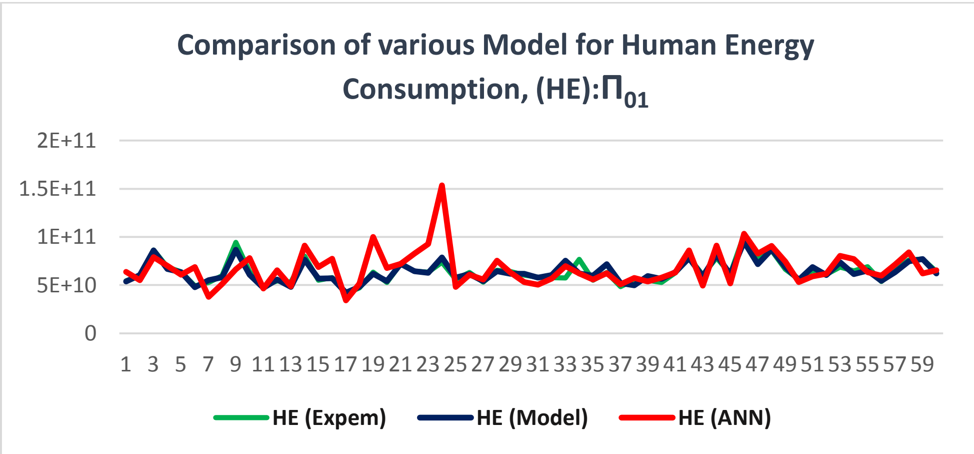
Fig.5Comparisons between experimental data,mathematical and ANN for Human Energy Consumption (HE)

Table 1. Performance analysis of ANN and Comparison of Experimental and field data for Human Energy Consumption, (HE) (out of 60 reading first 10 and last 10 are reported here)

SN	**HE (Field data)**	**HE (Mathematical Model)**	**HE (ANN Simulation)**	**Error between ANN & Field data**	**% Error between ANN & Field data**	**Mean Square Error between ANN & Field data**
1	5.428E+10	5.374E+10	6.386E+10	9.579E+09	17.65	9.175E+19
2	5.951E+10	6.041E+10	5.508E+10	4.431E+09	7.45	1.963E+19
3	8.632E+10	8.588E+10	7.91E+10	7.22E+09	8.36	5.213E+19
4	6.884E+10	6.685E+10	7.009E+10	1.254E+09	1.82	1.573E+18
5	6.385E+10	6.329E+10	6.089E+10	2.965E+09	4.64	8.794E+18
6	4.908E+10	4.785E+10	6.882E+10	1.974E+10	40.22	3.897E+20
7	5.292E+10	5.497E+10	3.773E+10	1.519E+10	28.70	2.307E+20
8	5.968E+10	5.823E+10	5.096E+10	8.729E+09	14.63	7.62E+19
9	9.435E+10	8.673E+10	6.647E+10	2.787E+10	29.54	7.77E+20
10	6.364E+10	6.071E+10	7.808E+10	1.444E+10	22.68	2.084E+20
:	:	:	:	:	:	:
:	:	:	:	:	:	:
51	6.529E+10	6.867E+10	5.901E+10	6.277E+09	9.61	3.94E+19
52	6.108E+10	6.044E+10	6.178E+10	695898000	1.14	4.843E+17
53	6.889E+10	7.363E+10	8.033E+10	1.144E+10	16.61	1.309E+20
54	6.485E+10	6.128E+10	7.698E+10	1.213E+10	18.71	1.472E+20
55	6.911E+10	6.52E+10	6.328E+10	5.836E+09	8.44	3.405E+19
56	5.37E+10	5.46E+10	5.973E+10	6.028E+09	11.22	3.633E+19
57	6.561E+10	6.337E+10	7.153E+10	5.919E+09	9.02	3.504E+19
58	7.596E+10	7.472E+10	8.4E+10	8.033E+09	10.58	6.453E+19

59	7.705E+10	7.7E+10	6.198E+10	1.507E+10	19.56	2.271E+20
60	6.395E+10	6.194E+10	6.528E+10	1.332E+09	2.08	1.775E+18
Sum	**3.819E+12**	**3.812E+12**	**4.045E+12**			**MSE**
AVG	**4.774E+10**	**4.765E+10**	**5.056E+10**	**2.825E+09**	**5.92**	**2.313E+20**

Fig.6 Graphical comparison between ANN Model, field data-based model, Mathematical Model for Human Energy Consumption, (HE)



3. CONCLUSIONS

ANN Simulation model developed for can very well be used in Artificial Neural Network Simulation and analysis for prediction of Human Energy Consumption (HE) of women Thresher machine operators considering Anthropometric, Physiological , Environmental , Crop and machine variables as dependent variables.

The comparison of values of dependent pi term i.e. Human Energy obtained by field data, mathematical models, ANN model are shown in Table 1.The significance of this model can very well be seen from the data presented in column field data, mathematical model values and the predicted ANN simulation strength in Table No1. All these values match very well with each other. From the values, it seems that the mathematical models and the ANN developed can be effectively used for calculation of dependent terms for a assumed set of the independent pi terms

The Fig 6. depicts that the comparison made by Field data, Mathematical model values and ANN gives the response data which is overlapping. The overlapping curves are due to less percentage error among Models. This proves the authenticity of the responses.

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