CONTENTS

CHAPTER	Page no
List of Tables	ii
List of Figures	iii
List of symbols and abbreviations	iv
I INTRODUCTION	1
II REVIEW OF LITERATURE	3
2.1 Post harvest paddy handling	3
2.2 Conventional practice of paddy drying	3
2.3 Drying injury in paddy	5
2.4 Drying at low and ambient temperature	5
2.5 Two stage drying	5-6
2.6 Conventional practice of paddy storage	7
2.7 In-bin drying	8-9
III THEORITICAL CONSIDERATION	10
3.1 Drying models	10-11
3.1.1 Diffusion and activation energy model	12
3.2 Physical properties of paddy	13
3.2.1 Sorption isotherm of paddy	13
3.2.1.1 ANN modeling of sorption isotherm	14-15
3.2.1.2 Neural network models	16
3.2.1.3 Neural network analysis	16
3.2.2 Heat of desorption	17
3.2.3 Specific heat	17
3.3 Non-equilibrium deep bed drying model	19
3.4 Scheme of numerical solution	15
IV METHODS AND MATERIALS	20
4.1 Paddy sample	20
4.1.1 Paddy moisture content determination	21
4.2 Drying experiments	21
4.2.1 Fluidized bed dryer	22
4.2.1.1 Materials and equipment	22
4.2.1.2 Experimental condition	23
4.2.1.3 Drying procedure	23
4.2.2 Sorption isotherm analysis of paddy	23
4.2.3 In-bin dryer	24
4.2.3.1 Materials and equipment	24
4.2.3.2 Design of experiments	27
4.2.3.3 Drying procedure	27-28
4.4 Measurement of physical property parameter	28-29

V RESULTS AND DISCUSSIONS 30
5.1 Drying curves 30-31
5.1.1 Selection of best mathematical model 31-36
5.1.2 Generalization of drying model parameters and global drying rate Constant 36
5.1.3 Generalization based on shift factor using master curve 37
5.1.4 Comparison of thin layer drying behaviour of different varieties Paddy on the basis of page model 37-38
5.1.5 Effect of initial moisture content on the drying rate of paddy 38
5.1.6 Effective diffusivity 39
5.1.7 Activation energy 40
5.2 Sorption isotherm analysis of paddy 40
5.2.1 Experimental moisture sorption isotherms of paddy 40
5.2.2 Curve fitting of sorption isotherm models 41
5.2.3 ANN modeling for the moisture sorption isotherm of the paddy 41
5.2.3.1 Selection of ANN architecture 41
5.2.3.2 Experimental validation of the ANN modeling 42-43
5.2.4 Generalization of moisture sorption isotherm at high and low Ambient temperature conditions 44
5.2.5 Generalized algorithm for emc of the paddy obtained from the ANN modeling 45
5.3 Physical properties of paddy 46
5.4 In bed drying system 46
5.4.1 Temperature profile of the drying 46
5.4.2 Simulation of the in bed drying system 47-48
5.4.3 Validation of the developed model for the in bed drying system 49
VI SUMMARY AND CONCLUSION 50
VII REFERENCES 52

List of Tables

Figures	Description	Page
3.1	Thin layer Drying Models	10
3.2	In-store Drying Models	11
3.3	Sorption isotherm models	13
4.1	Experimental Condition for Thin layer Drying	23
4.2	Experimental Condition for In-bin drying	27
5.1	Statistical results obtained from the selected models for the paddy having 16% IMC	32
5.2	Statistical results obtained from the selected models for the paddy having 20% IMC	33
5.3	Statistical results obtained from the selected models for the paddy having 24% IMC	34
5.4	Values of the drying constant and coefficients of the best model for the paddy having 16% IMC	35
5.5	Values of the drying constant and coefficients of the best model for the paddy having 20% IMC	35
5.6	Values of the drying constant and coefficients of the best model for the paddy having 24% IMC	35
5.7	Drying parameters of the page model for different paddy varieties	37
5.8	Statistical results for the mathematical models fitted for the sorption isotherm analysis of the paddy	41
5.9	Results of optimum ANN architecture for sorption isotherm analysis of paddy	42
5.10	Physical properties of paddy	45

List of Figures

Figures	Description	Page
3.1	Natural neuron	14
3.2	Artificial neuron	14
3.3	Configuration of neural network	15
3.4	Schematic representation of i^{th} thin layer in deep bed dryer	19
4.1	Raw paddy sample Aijong	20
4.2	Weighing balance and oven dryer	21
4.3	Fluidized bed dryer	22
4.4	Water activity meter	24
4.5	Anemometer, temperature se and relative humidity sensor	25
4.6	Design and experimental set up of in bed dryer	25-26
4.7	Schematic view of the dryer	27
5.1	Variation of moisture ratio of paddy (IMC-16%)	30
5.2	Variation of moisture ratio of paddy (IMC-20%)	30
5.3	Variation of moisture ratio of paddy (IMC-24%)	31
5.4	Thin layer drying behaviour of paddy varieties-Wells and Aijong	38
5.5	Effect of intial moisture content on the drying rate of paddy	39
5.6	Effective diffusivity variation with drying temperature	39
5.7	Sorption isotherms of paddt at different temperatures	40
5.8	Selection of ANN architecture according to average MSE	42
5.9	Experimental and ANN predicted values of emc as a function Temperature	44
5.10	Generalization of moisture sorption isotherms of paddy at high And low temperatures	44
5.11	Temperature profile of the inlet air and different levels of the In bed drying system	45
5.12	Predicted moisture profile of the in bed drying of paddy at different levels	46
5.13	Predicted temperature profile of the in bed drying of paddy at different levels	47
5.14	Experimental validation of the final moisture content of the paddy	48
5.15	Experimental validation of the temperature profile for the middle layer	48

List of symbols and abbreviations

Symbol	Description	Page
MR	Moisture ratio	10
RH	Relative Humidity	11
MC	Moisture constant	12
D_{eff}	Diffusivity	12
R	Radius of paddy	12
M_e	Equilibrium moisture content	13
a_w	Water activity	13
MSE	Mean square error	16
R^2	Regression coefficient	16
C_s	Specific heat	17
ASAE	American society of agricultural engineers	21
d_e	Equivalent diameter	29
ψ	Sphericity	29
SSE	Sum of square error	31
RMSE	Root mean square error	31
imc	Initial moisture content	35-37
emc	Equilibrium moisture content	37
a_T	Temperature shifting factor	37
db	Dry basis	37-39
ANN	Artificial neural network	41
PDE	Partial differential equation	46
fmc	Final moisture content	49