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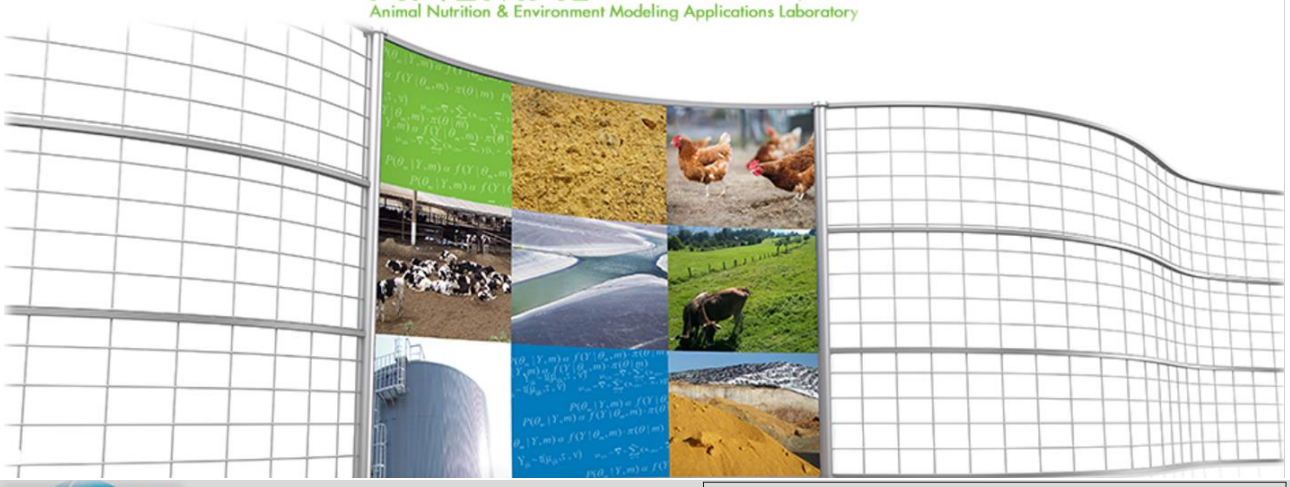
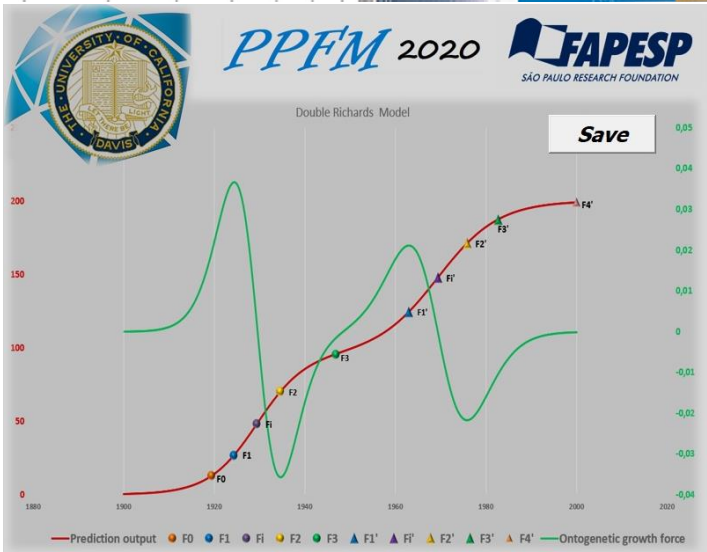
Animal Nutrition & Environment Modeling Applications Laboratory





Practical Program for Forces Modeling

The PPFM worksheet adjusts up to 1000 data for multiple models by the Excel Solver tool

A planilha PPFM ajusta até 1000 dados para vários modelos pela ferramenta Solver do Excel

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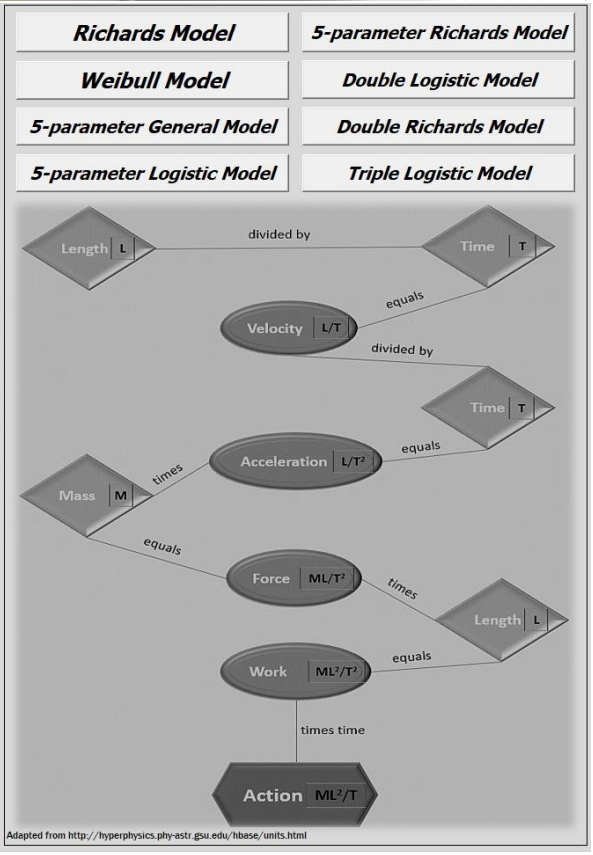
Programa Prático para Modelagem de Forças



PPFM Tutorial

DISCLAIMER AND ASSUMPTION OF RISK

The PPFM spreadsheet presents the objective of data analysis by adjusting models with subsequent force deployments.

There is no guarantee that adequate adjustments will always be made to predict the data provided for analysis (iterative principle), and it is the sole responsibility of the user to decide on the validity of each model chosen.

This spreadsheet is not guaranteed to be free of enhancement needs. Reason for suggestions welcome. Therefore, the risk of any or all unsatisfactory performance of this worksheet is entirely at the user's own risk and accept full responsibility for the accuracy and reliability of the inputs and outputs.

This spreadsheet is not allowed to be marketed, but it is allowed to copy, publish, distribute, publicly perform, provided that authorship is acknowledged.

SUGGESTION CITATION

GARCIA-NETO, M.; KEBREAB, E.; FARIA-JUNIOR, MJA. PPFM: Practical Program for Forces Modeling (2020). In: <https://sites.google.com/view/ppfm-spreadsheet/>. Access in: month / day / year

WHAT IS PPFM?

The Practical Program for Forces Modeling (PPFM) is a spreadsheet for adjusting growth curves with subsequent evaluation and analysis of acting forces. https://sites.google.com/view/ppfm-spreadsheet/

The spreadsheet is use-friendly, with point-and-click tools, being in the public domain.

WHY PPFM?

The PPFM spreadsheet features a completely new approach to growth assessment, with great flexibility and practicality of adjustments, allowing visual and numerical comparison without the need to type command lines, being user-friendly with point-and-click tools based on Excel 2010 or higher.

WHAT CAN PPFM DO?

The main purpose of the spreadsheet is to adjust growth models that subsequently unfold in the analysis and evaluation of forces acting on growth kinetics.

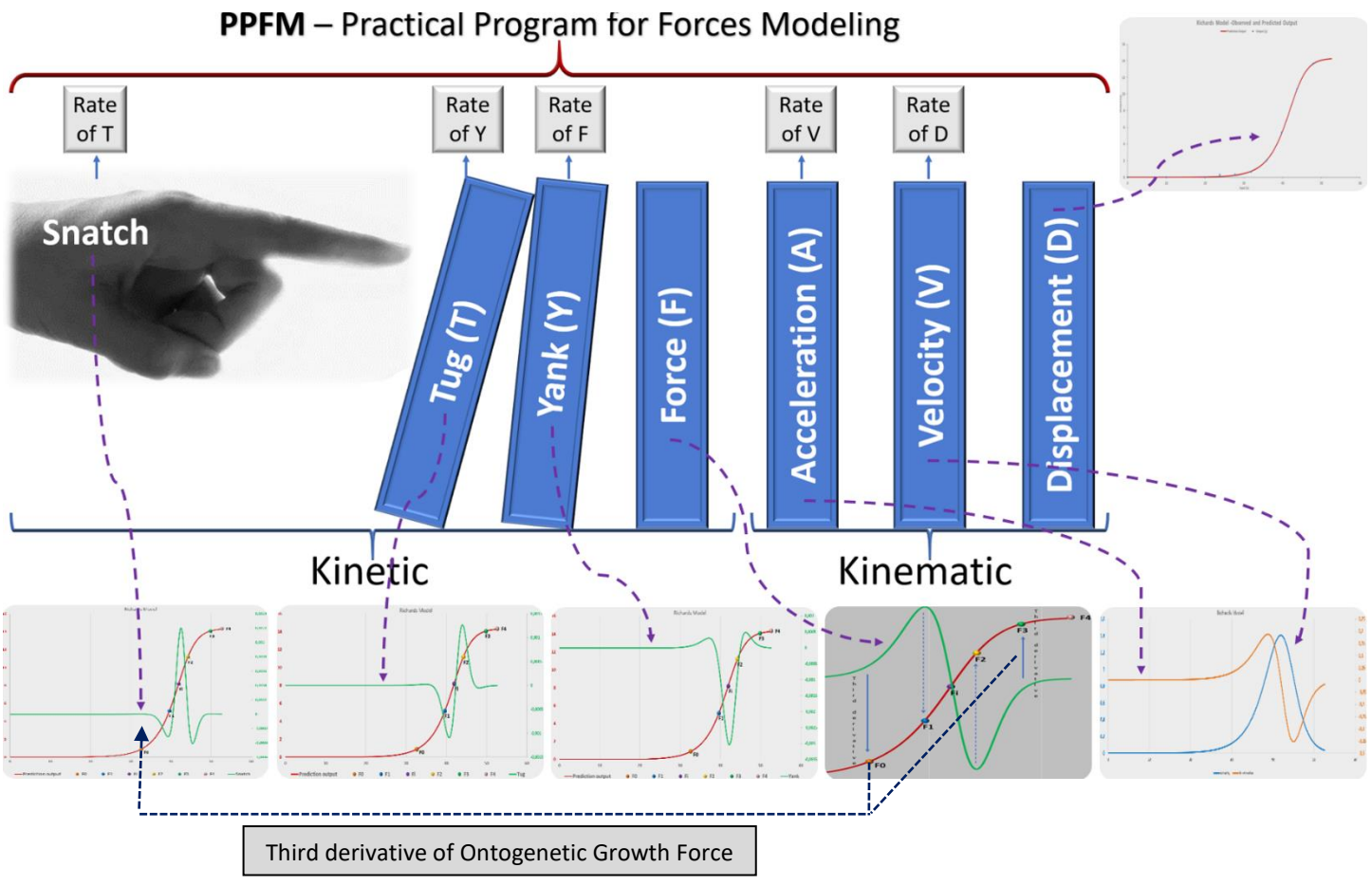
More details:

Growth curve: an intelligent life history described by a mathematical model!
https://drive.google.com/u/0/uc?id=1DyYPsbKZguZq2tkszgU_StjQrt5b5XFT&export=download

Action: numeric metamorphosis of a curve through the PPFM spreadsheet
https://drive.google.com/u/0/uc?id=12nCjySDkkRfbTHBkUp3lWLte9W75H_zl&export=download

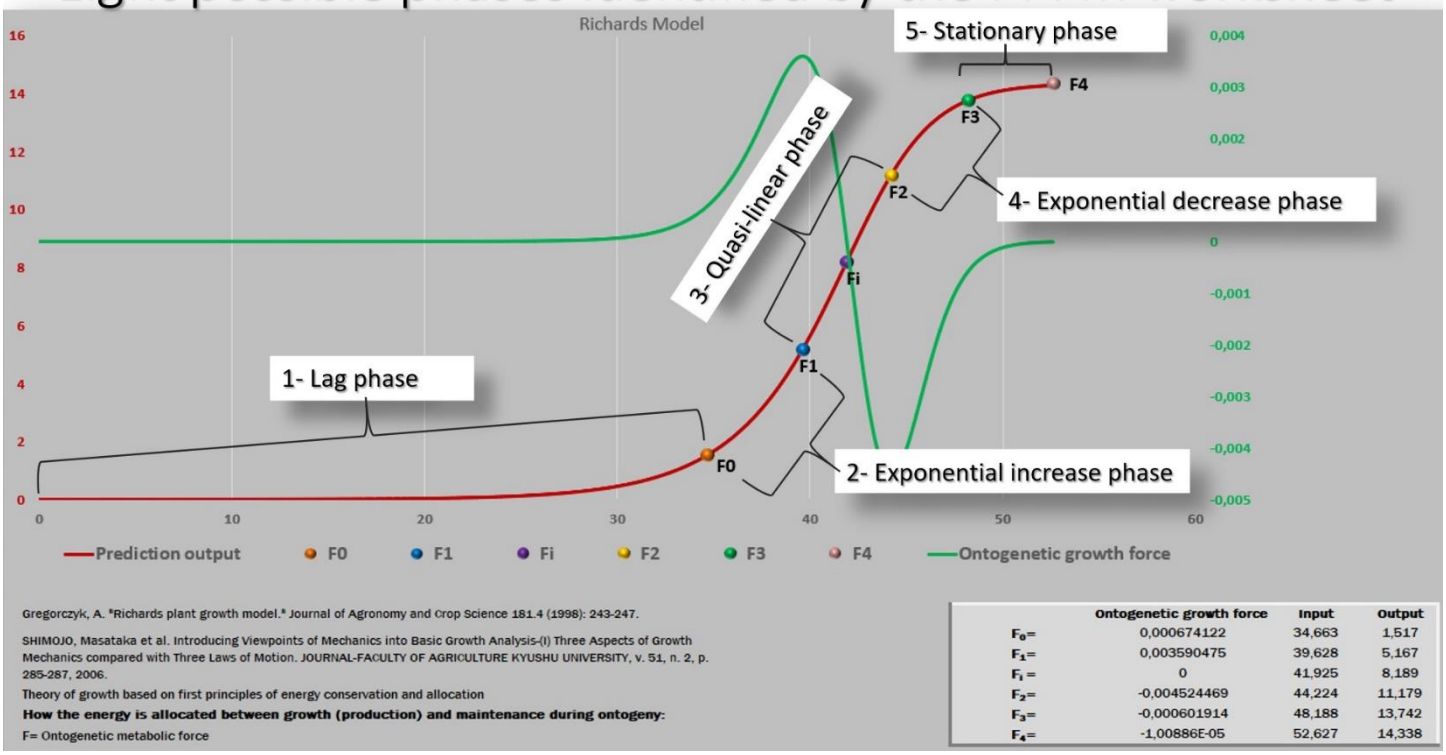
A new paradigm for growth modeling: Action
https://drive.google.com/u/0/uc?id=1PXvsB1dklAApjDtOrSOXlRLZ3zTICsxL&export=download

Growth expansion modeling: kinetic energy tool to measure efficacy, efficiency, economicity and effectiveness
https://drive.google.com/u/0/uc?id=113gXgccIVY_wTVX4Qgw-gwAoOWx8kK1_&export=download



HOW MANY PHASES COULD PPFM IDENTIFY?

Eight possible phases identified by the PPFM worksheet



Gregorczyk, A. "Richards plant growth model." Journal of Agronomy and Crop Science 181.4 (1998): 243-247.

SHIMOJO, Masataka et al. Introducing Viewpoints of Mechanics into Basic Growth Analysis-(I) Three Aspects of Growth Mechanics compared with Three Laws of Motion. JOURNAL-FACULTY OF AGRICULTURE KYUSHU UNIVERSITY, v. 51, n. 2, p. 285-287, 2006.

Theory of growth based on first principles of energy conservation and allocation

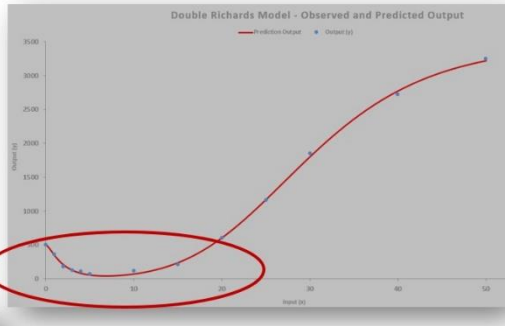
How the energy is allocated between growth (production) and maintenance during ontogeny:

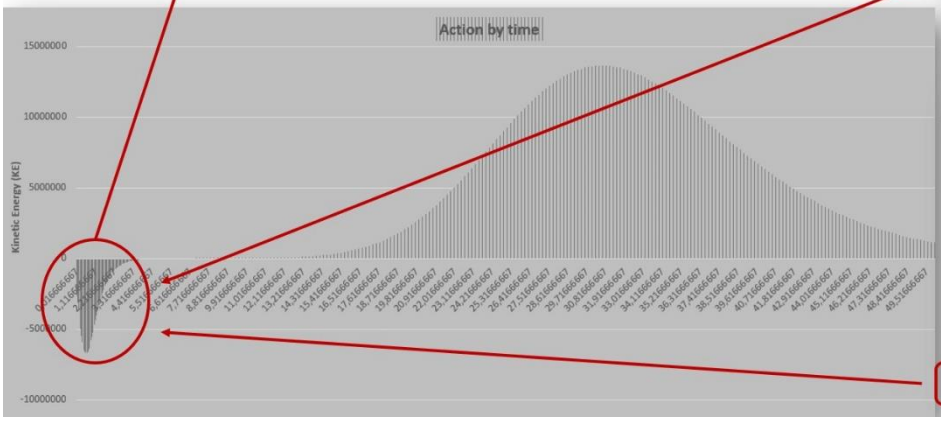
F= Ontogenetic metabolic force

	Ontogenetic growth force	Input	Output
F_0=	0,000674122	34,663	1,517
F_1=	0,003590475	39,628	5,167
F_i =	0	41,925	8,189
F_2=	-0,004524469	44,224	11,179
F_3=	-0,000601914	48,188	13,742
F_4=	-1,00886E-05	52,627	14,338

Eight possible phases identified by the PPFM worksheet

- 6- Resilience or survival phase





	Kinetic Energy (KE)		Input	Output
$KE_{maximum}$ =	13649602,26	1,3650E+07	30,617	1880,768

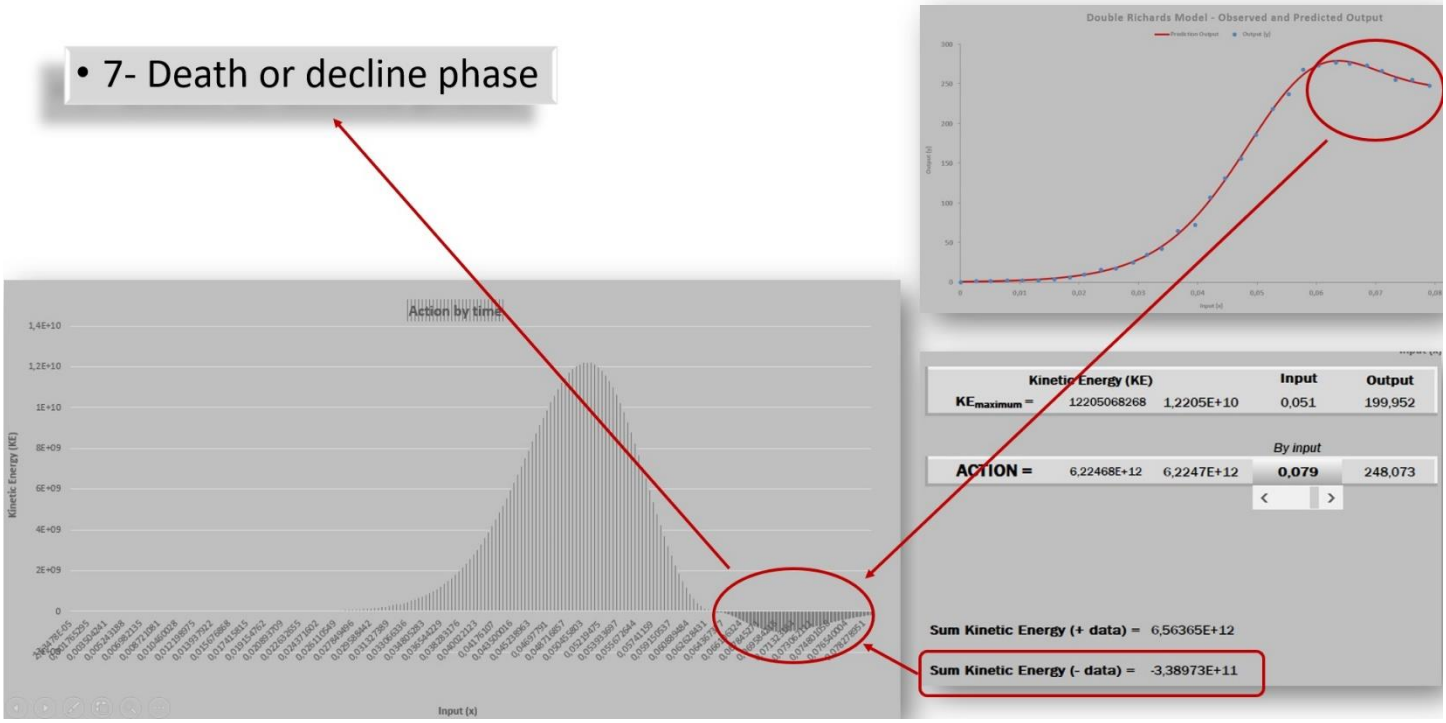
			By input	
ACTION =	13601198288	1,3601E+10	50,017	3221,929

Sum Kinetic Energy (+ data) = 14125797979

Sum Kinetic Energy (- data) = -524599691

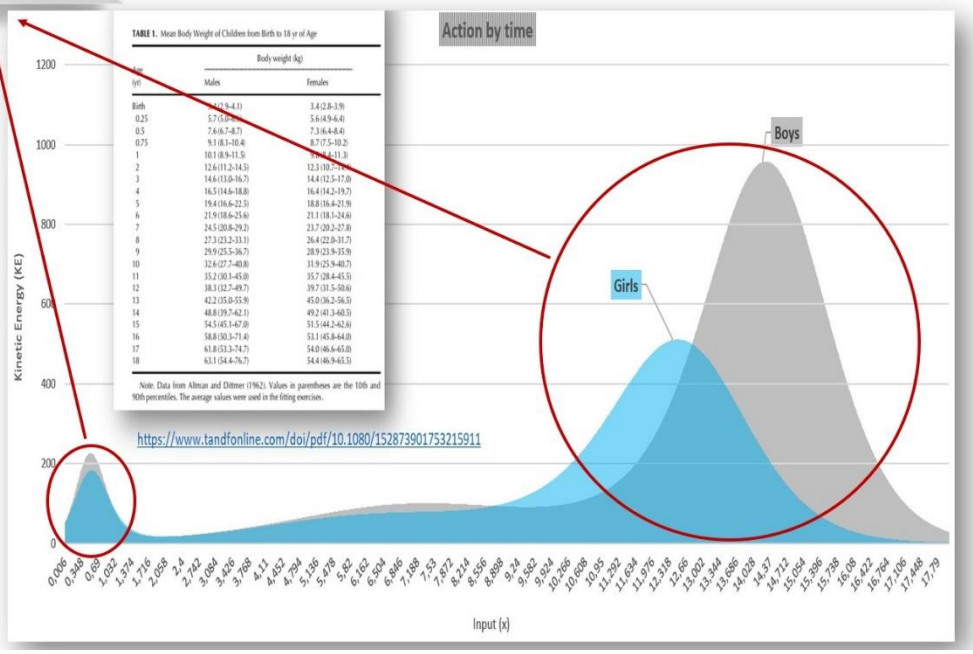
Eight possible phases identified by the PPFM worksheet

- 7- Death or decline phase



Eight possible phases identified by the PPFM worksheet

- 8- Spurts phase

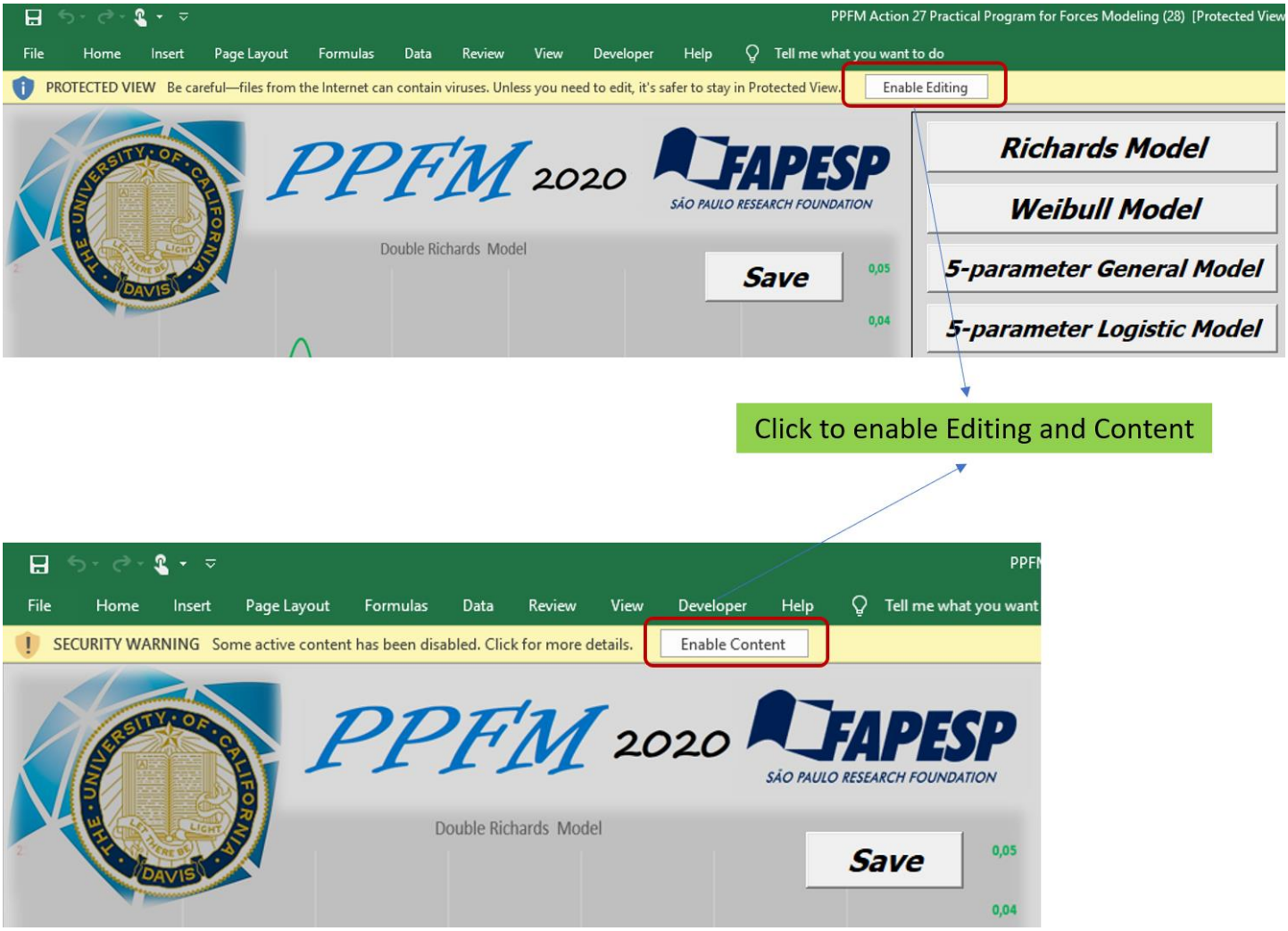


WHAT IS REQUIRED TO USE PPFM?

You must release the requested macros and also enable the Excel 2010 or higher Solver add-in. https://support.office.com/en-us/article/load-the-Solver-add-in-in-Excel-612926fc-d53b-46b4-872c-e24772f078ca

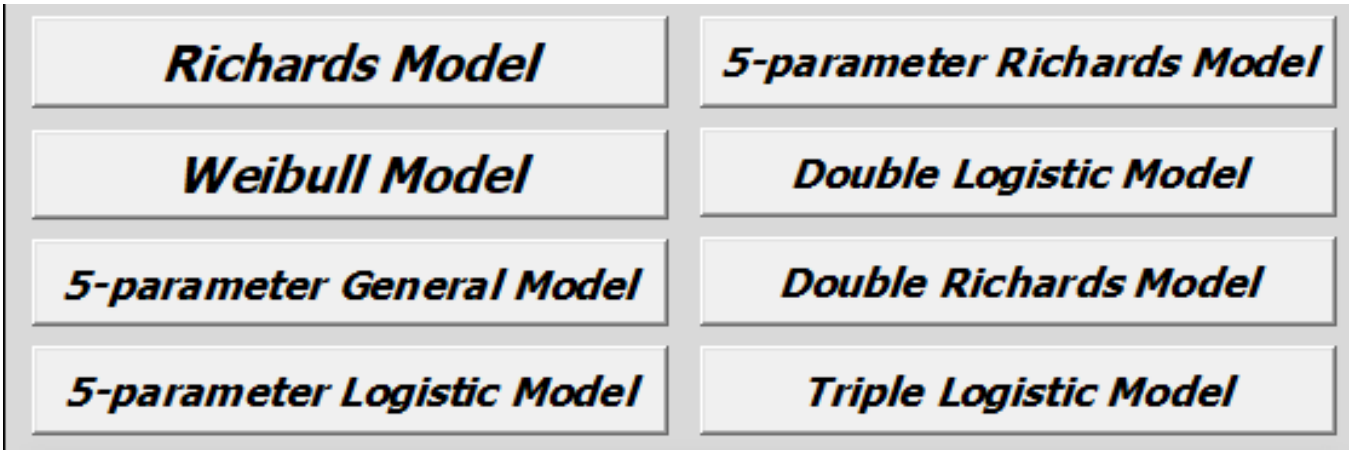
It is up to the user to have the basic knowledge of Excel to be able to supply the data in the correct form (inputs and outputs) and click on the available buttons as desired.

Although no programming knowledge is required, understanding and mastery of the area under study is crucial to judging the relevance and consistency of the results provided after adjusting the PPFM worksheet by the Solver supplement.



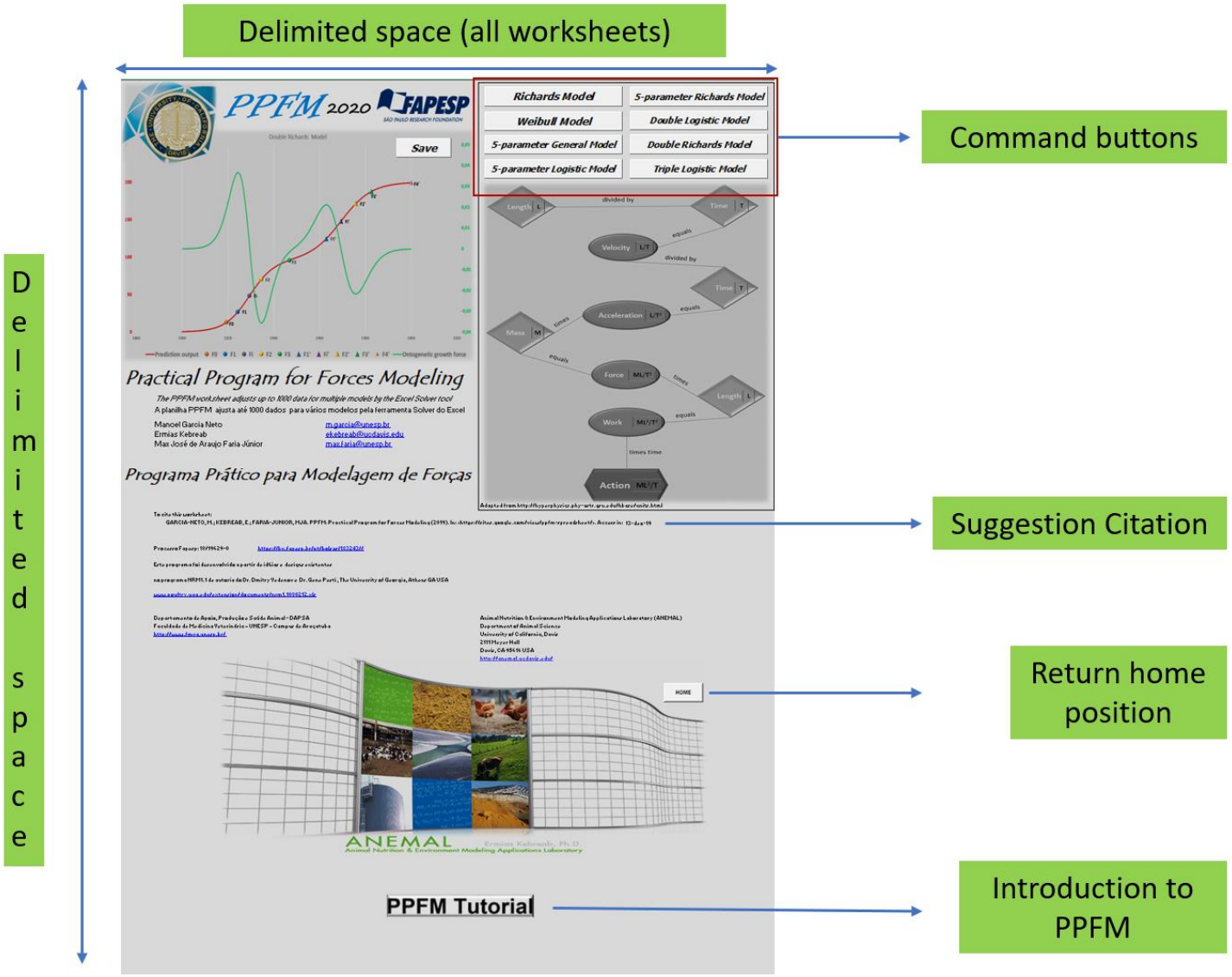
WHAT MODELS ARE INCLUDED IN PPFM?

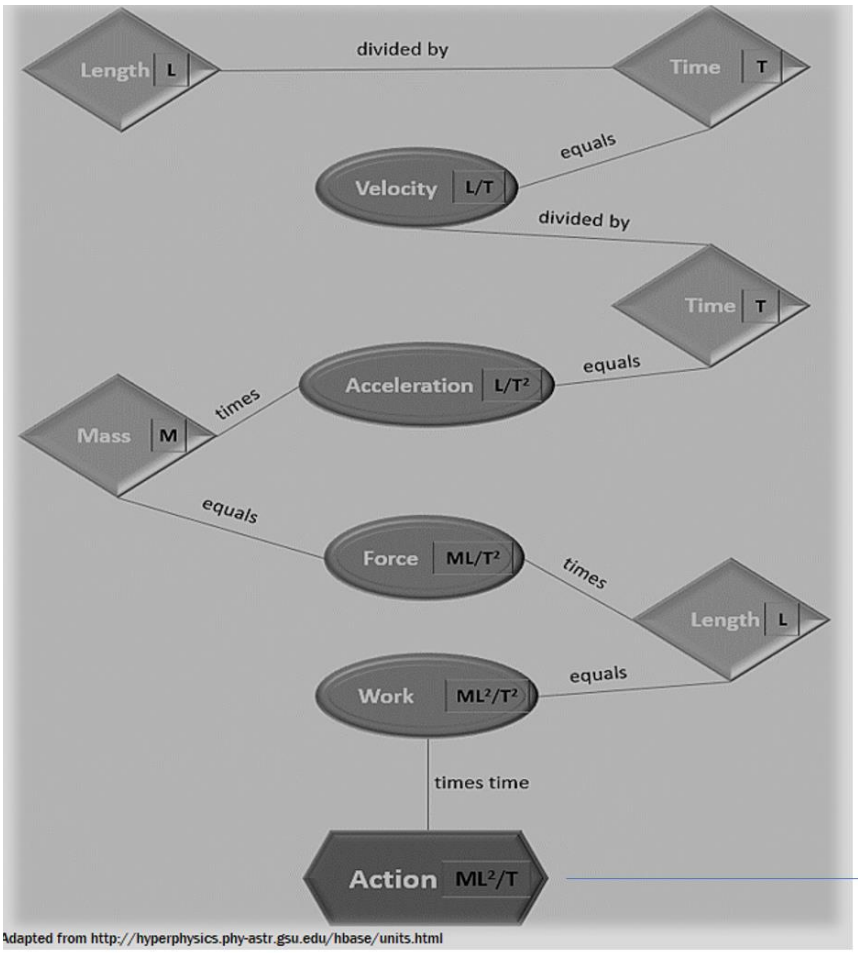
Eight mathematical models are available for adjustments to the PPFM worksheet.



PPFM SPREADSHEET STRUCTURE AND DETAILS

The spreadsheet always opens on the HOME page, which gives a brief explanation of the effect of current forces, ending in action. https://drive.google.com/uc?authuser=0&id=1sOQ18AraG-atqznnhRXxl86w4a5tkDni&export=download

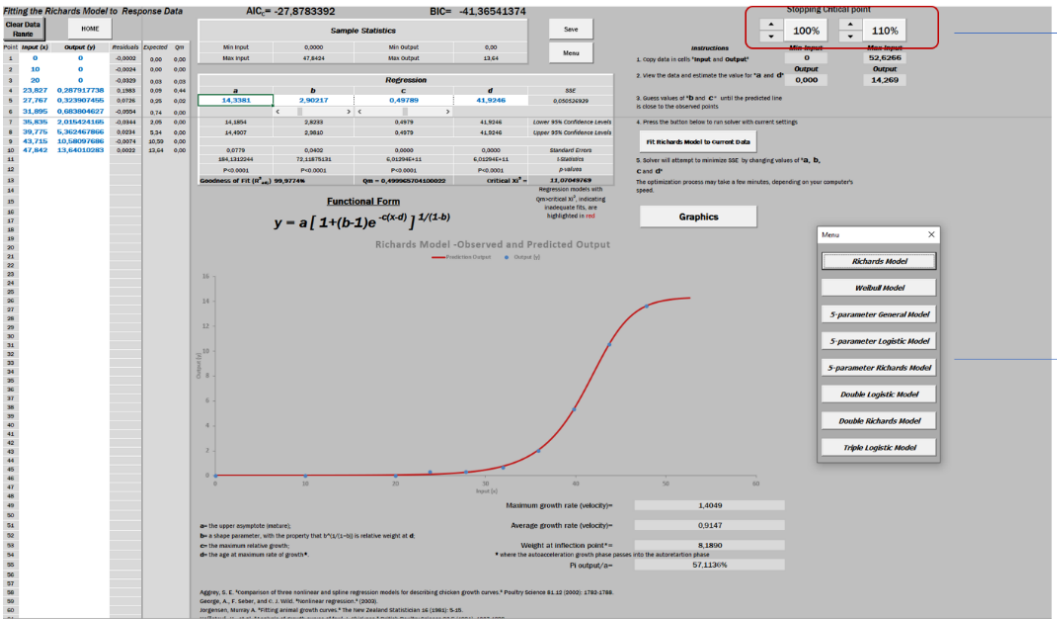




Action (ability to store energy)
"The minimum possible quantity of action is Planck's Constant"

http://wearcam.org/html5/mannkeynotes/Wearable_Computing,_Alethiometric,_and_Actional_Systems.pdf

It presents the options of eight models, the credits due (involved entities and authors) and citation suggestion.



Values always return to default

Fitting the Richards Model to Response Data

AICc= -27,8783392

BIC= -41,36541374

Clear Data Range | HOME | Save | Menu

Sample Statistics

Min Input	0,0000	Min Output	0,00
Max Input	47,8424	Max Output	13,64

Point	Input (x)	Output (y)	Residuals	Expected	Qm
1	0	0	-0,0002	0,00	0,00
2	10	0	-0,0024	0,00	0,00
3	20	0	-0,0329	0,03	0,03
4	23,827	0,287917738	0,1983	0,09	0,44
5	27,767	0,323907455	0,0726	0,25	0,02
6	31,895	0,683804627	-0,0554	0,74	0,00
7	35,835	2,015424165	-0,0344	2,05	0,00
8	39,775	5,362467866	0,0234	5,34	0,00
9	43,715	10,58097686	-0,0074	10,59	0,00
10	47,842	13,64010283	0,0022	13,64	0,00
11					
12					
13					
14					
15					
16					
17					
18					

Regression

a	b	c	d	SSE
14,3381	2,90217	0,49789	41,9246	0,050526929
14,1854	2,8233	0,4979	41,9246	Lower 95% Confidence Levels
14,4907	2,9810	0,4979	41,9246	Upper 95% Confidence Levels
0,0779	0,0402	0,0000	0,0000	Standard Errors
184,1312244	72,11875131	6,01294E+11	6,01294E+11	t-Statistics
P<0.0001	P<0.0001	P<0.0001	P<0.0001	p-values

Goodness of Fit (R^2_{adj}) 99,9774%

Qm = 0,499965704100022

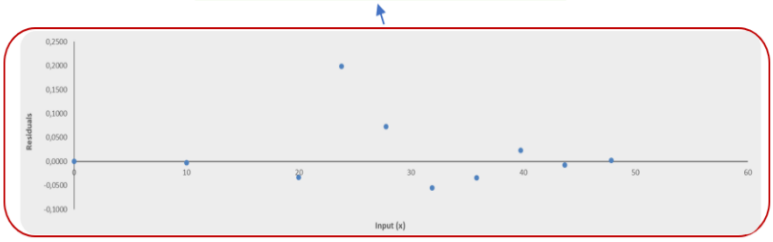
critical Xi^2 = 11,07049769

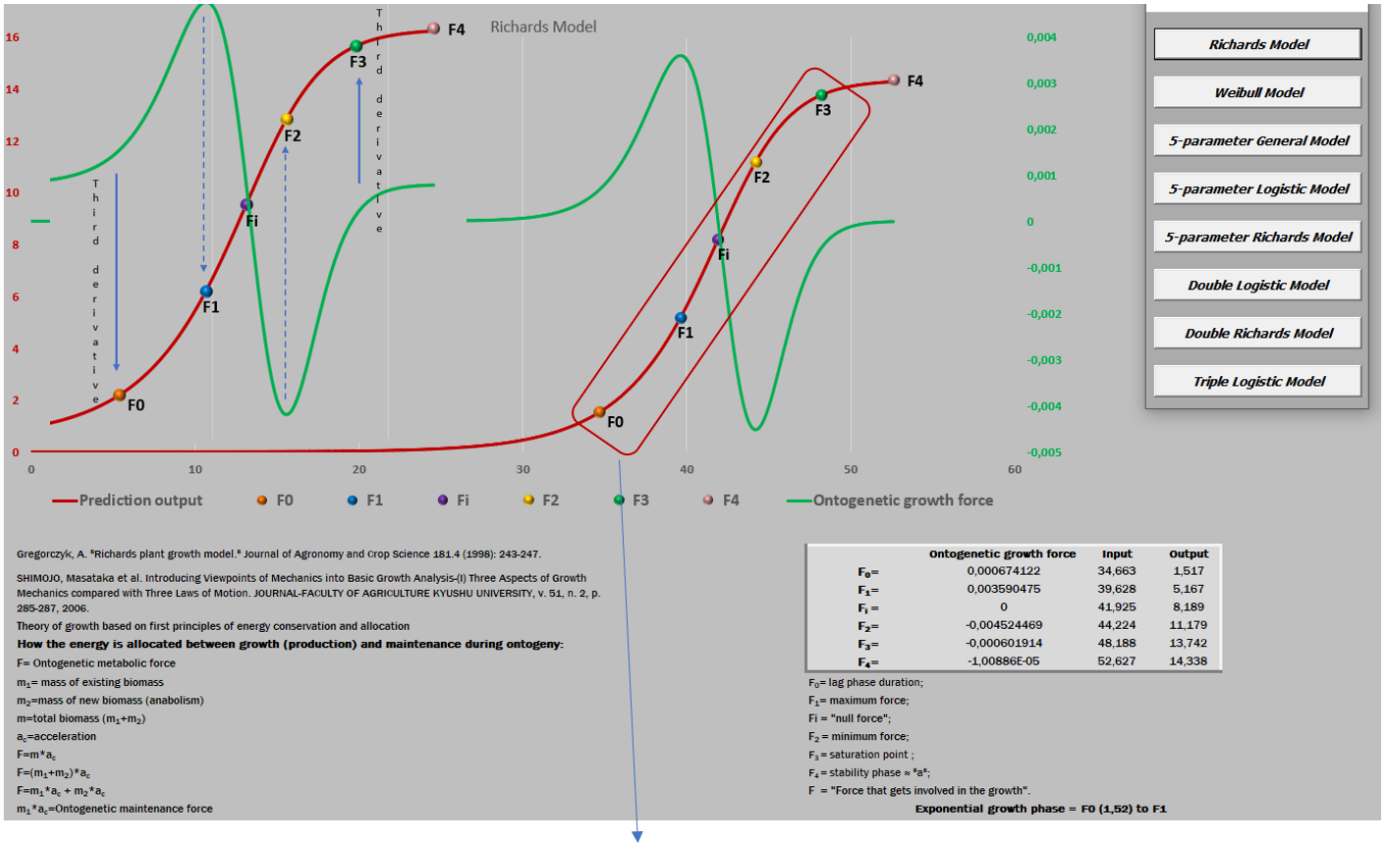
Regression models with Qm>critical Xi^2, indicating inadequate fits, are highlighted in red

Functional Form

$$y = a\,[\,1+(b-1)e^{-c(x-d)}\,]^{1/(1-b)}$$

Five criteria for assessing fit quality



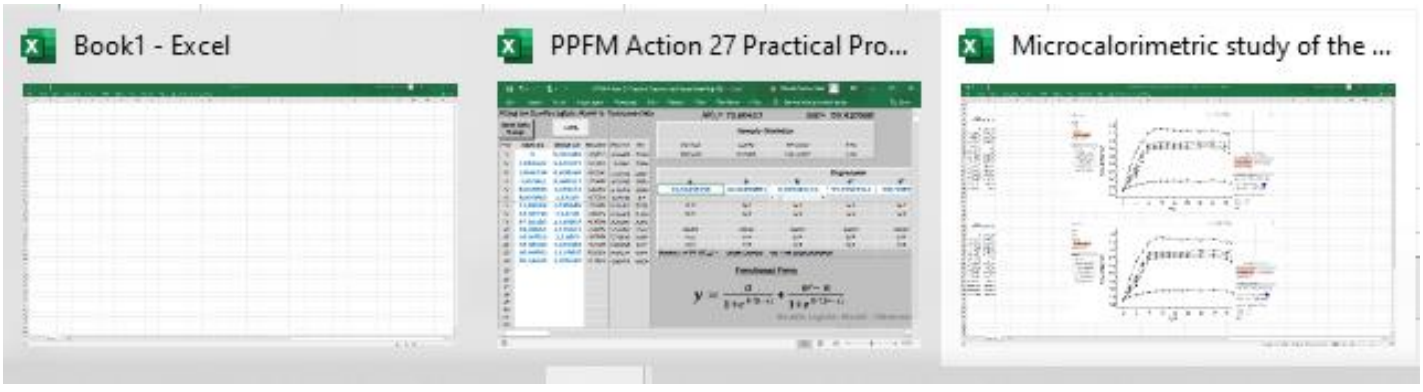


F0, F1, F2 and F3 points calculated based on ontogenetic growth force (better lag phase accuracy)

GENERAL DETAILS AND KEY SPREADSHEET COMPONENTS

Like other Excel spreadsheets, the PPFM spreadsheet can be minimized, maximized, moved from screen to screen.

The "esc" or return button remains active. Thus, if you need to rewind, the previous data can be recovered.



PROVIDING THE DATA TO THE SPREADSHEET

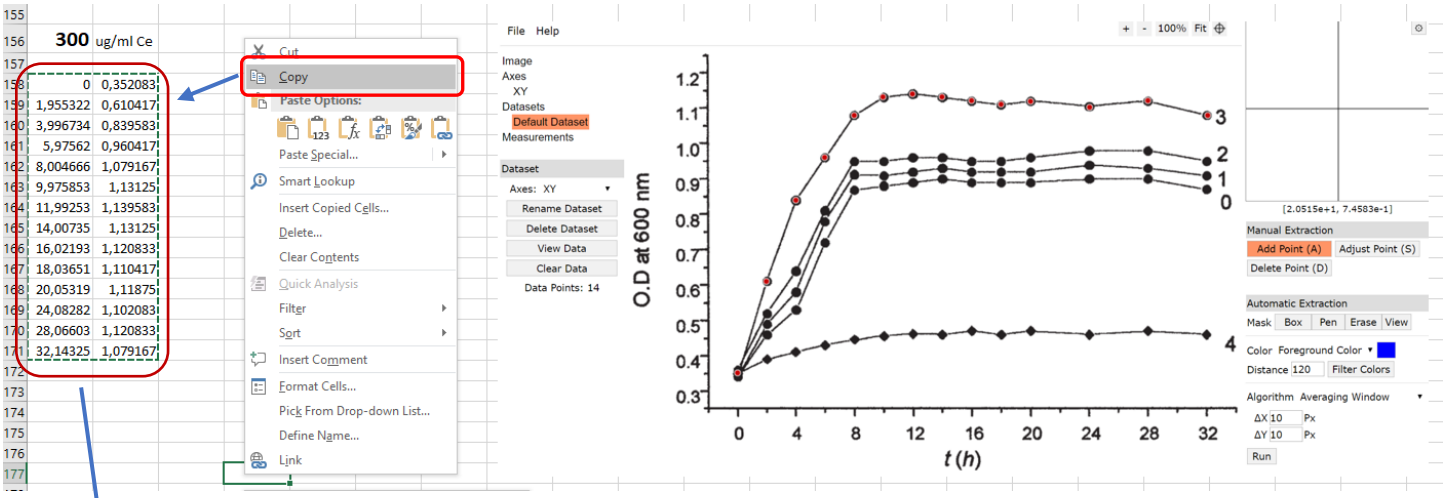
The PPFM spreadsheet allows you to receive up to 1000 rows (inputs and outputs). The data need not be in a numerical sequence, but it is imperative that there is no missing data in both inputs and outputs. Therefore, every input must have its corresponding output.

The sample size (datapoints) to fit a growth curves should be the number of model parameters plus one, but ideally 10 to 12 (Legan et al., 2012).

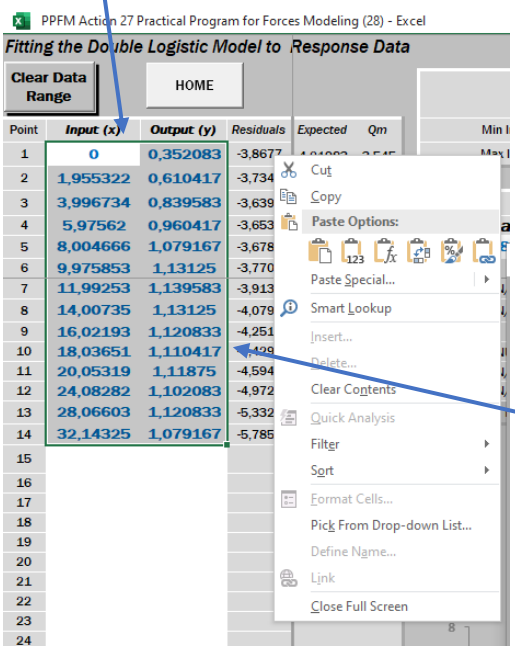
You can export data from other spreadsheets, but be careful to be in the appropriate Excel format.

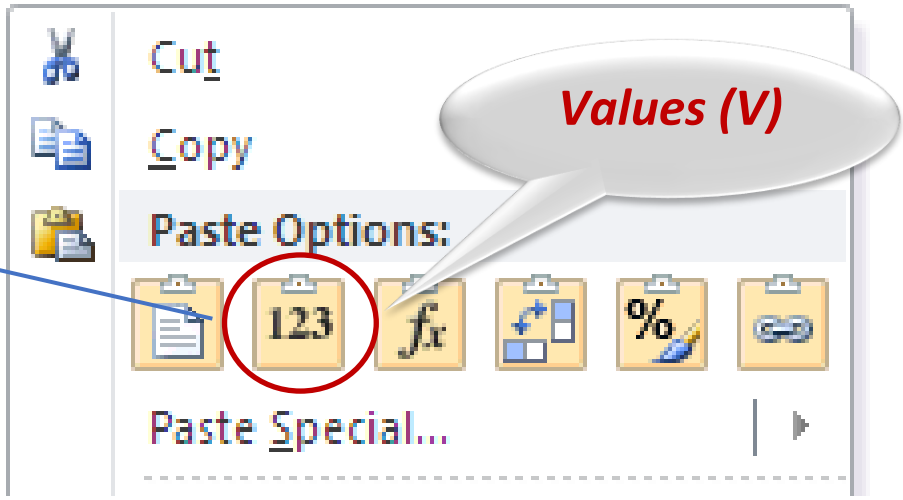
Direct manipulation of copy, paste, cut, and clear is possible, and if necessary enable the return.

The “Clear Data Range” button should be used whenever new data is provided, especially when its proportion is numerically smaller than the current one (total overlap of values). This procedure ensures the correct entry of data by avoiding improper overlap.



https://link.springer.com/content/pdf/10.1385/BTER:86:2:167.pdf
https://apps.automeris.io/wpd/





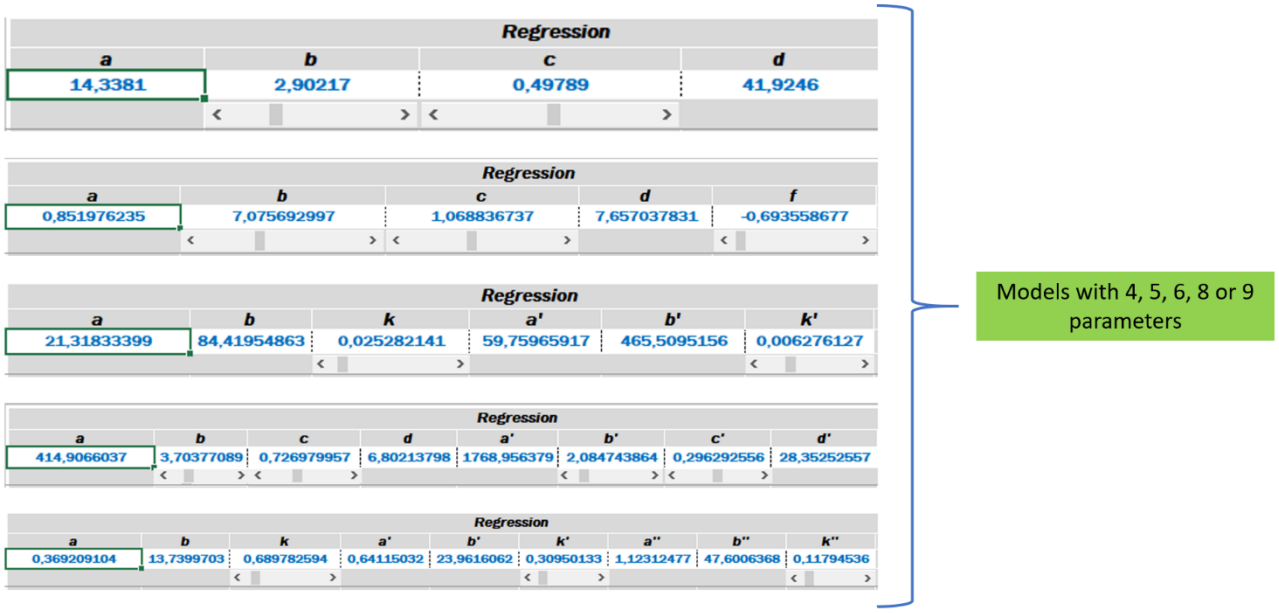
MATHEMATICAL MODEL ADJUSTMENT

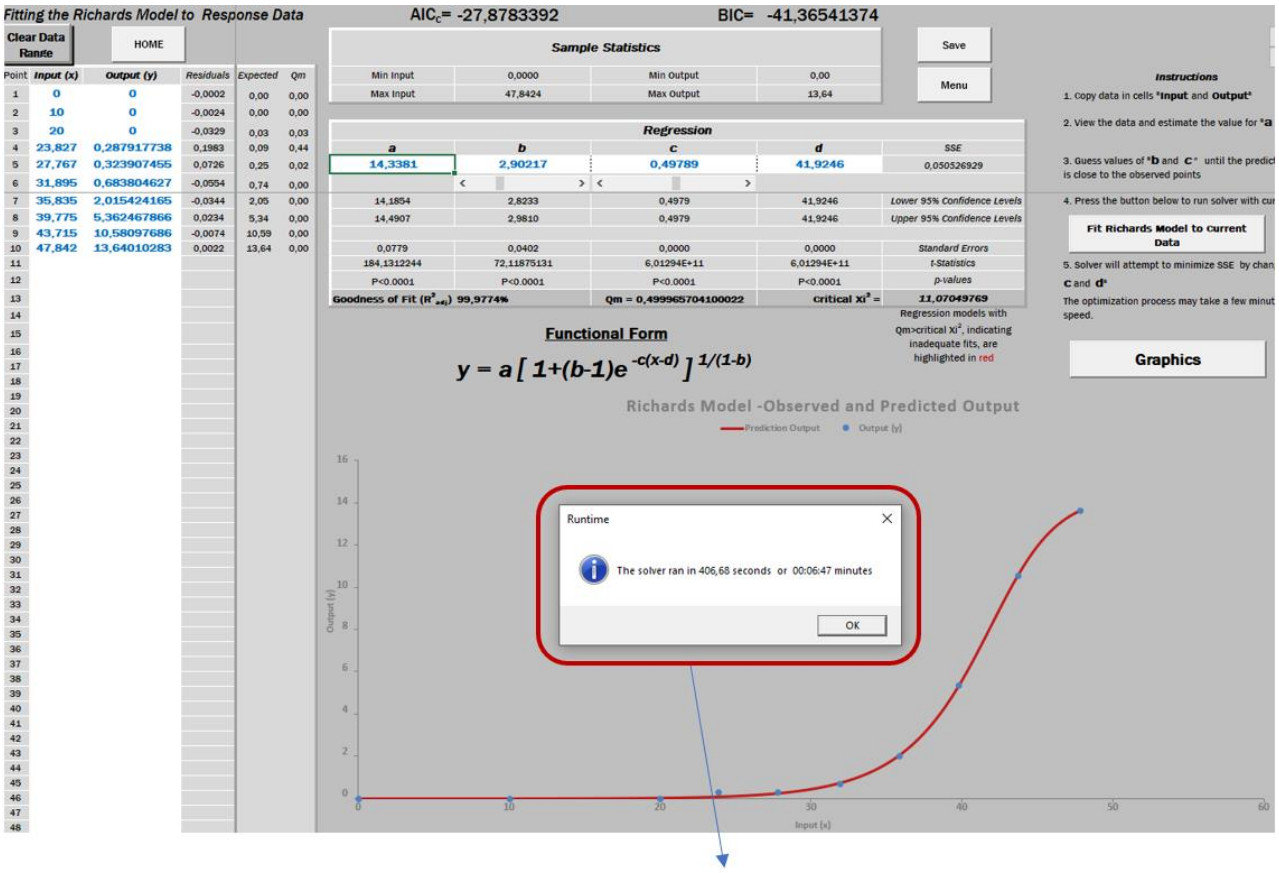
It is up to the user to decide on the best and most appropriate model. Most of the time the visualization of the curve is already a strong indicator for a coherent decision.

Each model has different parameters (4 to 9 parameters).

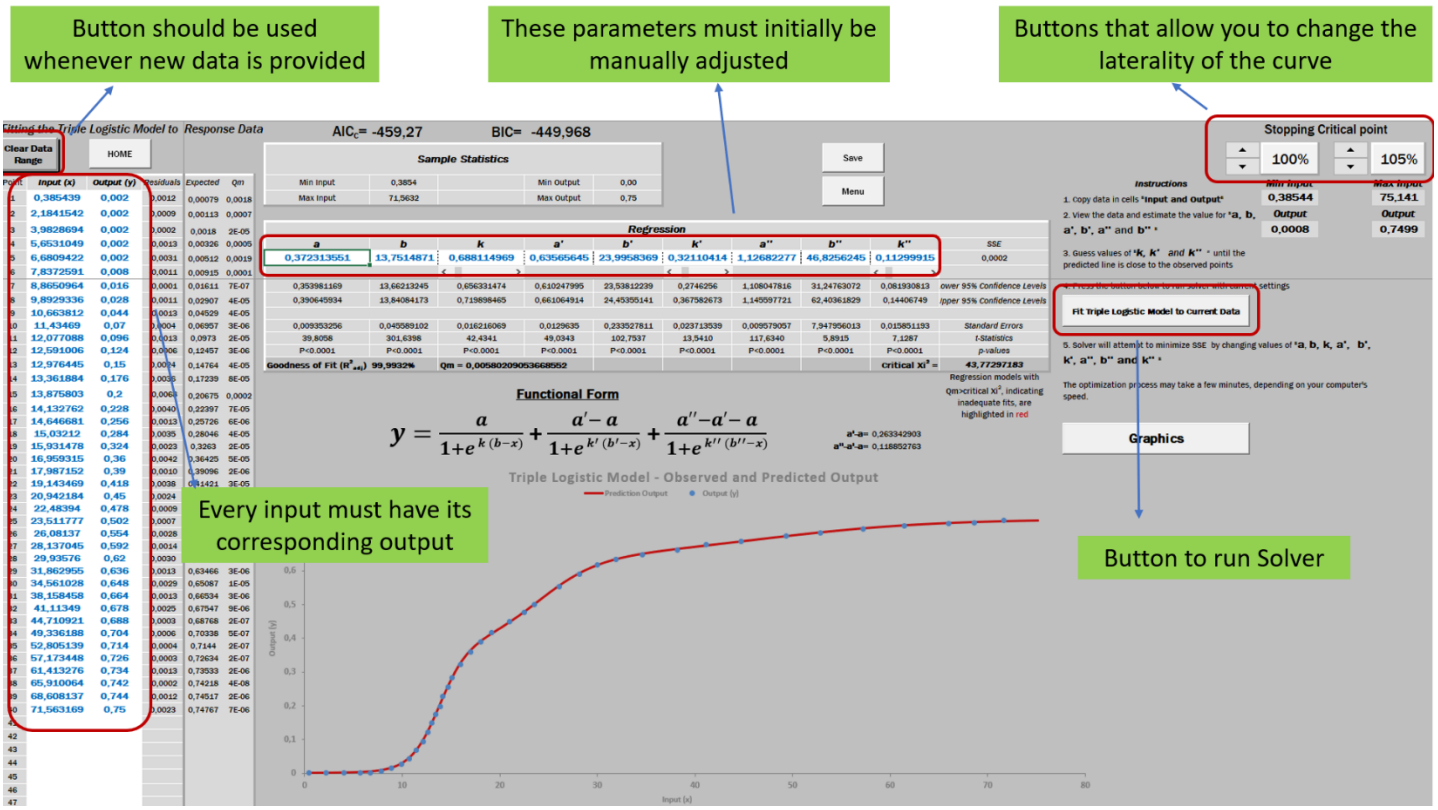
These parameters must initially be manually coherently adjusted and the result immediately observed on the growth curve. The finer the fit, the better the fit quality of the growth curve. But it's always up to the Solver add-in to convert to the most accurate and appropriate values.

Solver add-in adjustments, when triggered, depend on iterations for the success of your conversion, and it may take a few minutes to complete your calculation (up to 5-10 minutes), depending on the quality of the computer's math processor.



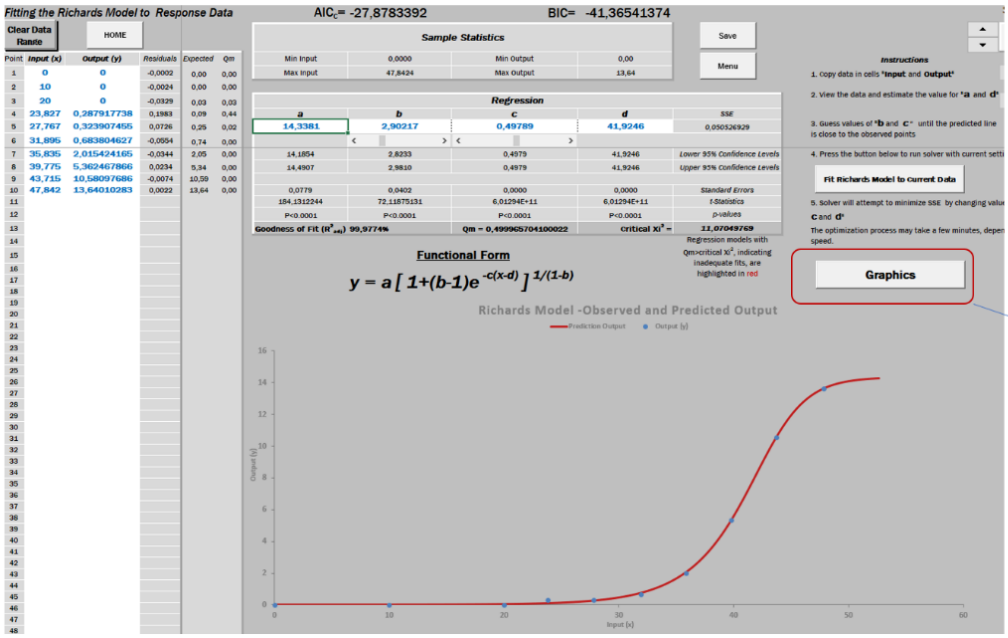


Indication of the time required to run Solver



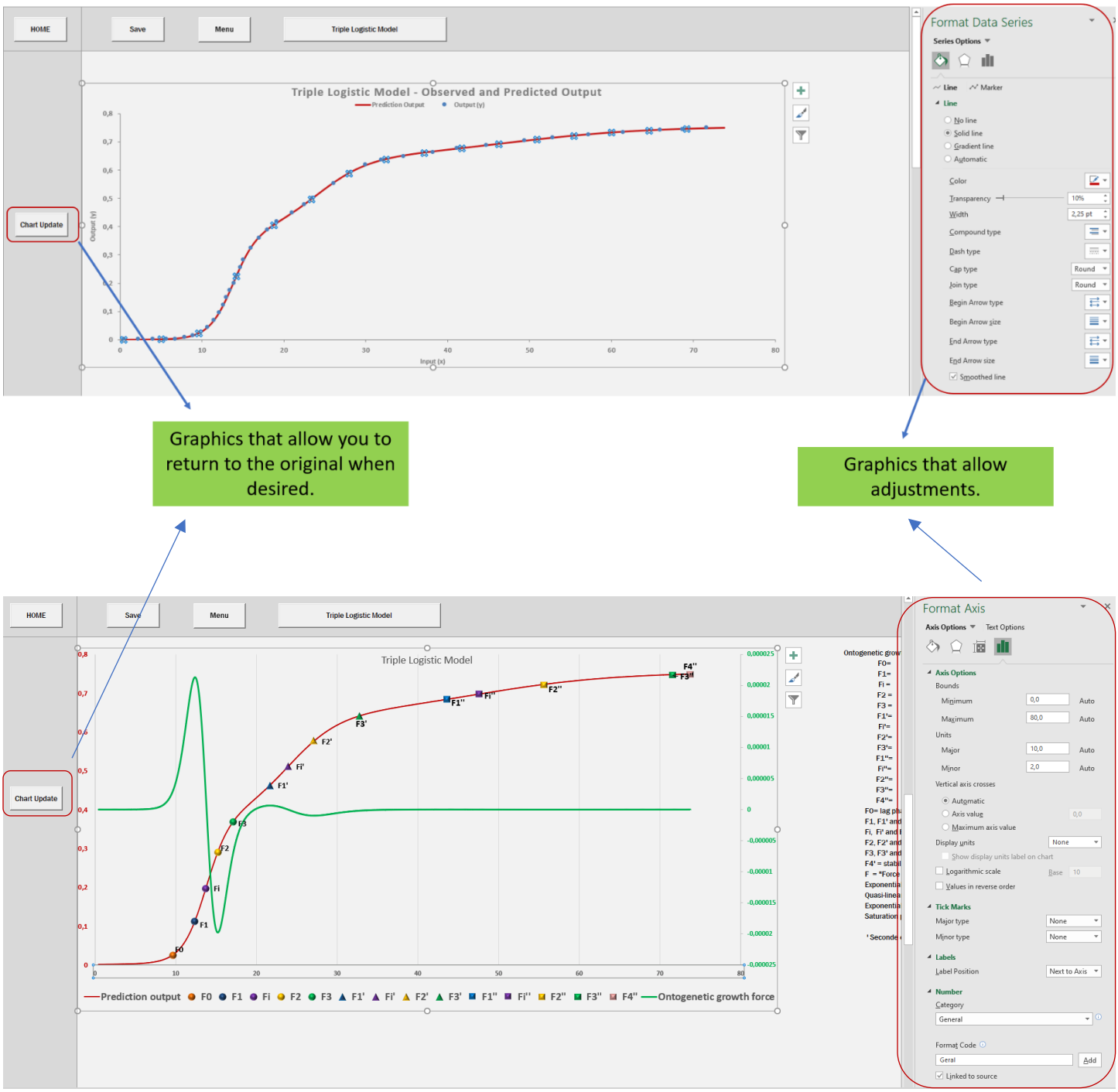
GRAPHS AND RESULTS

Charts can be changed as desired by the user or even exported to other spreadsheets.

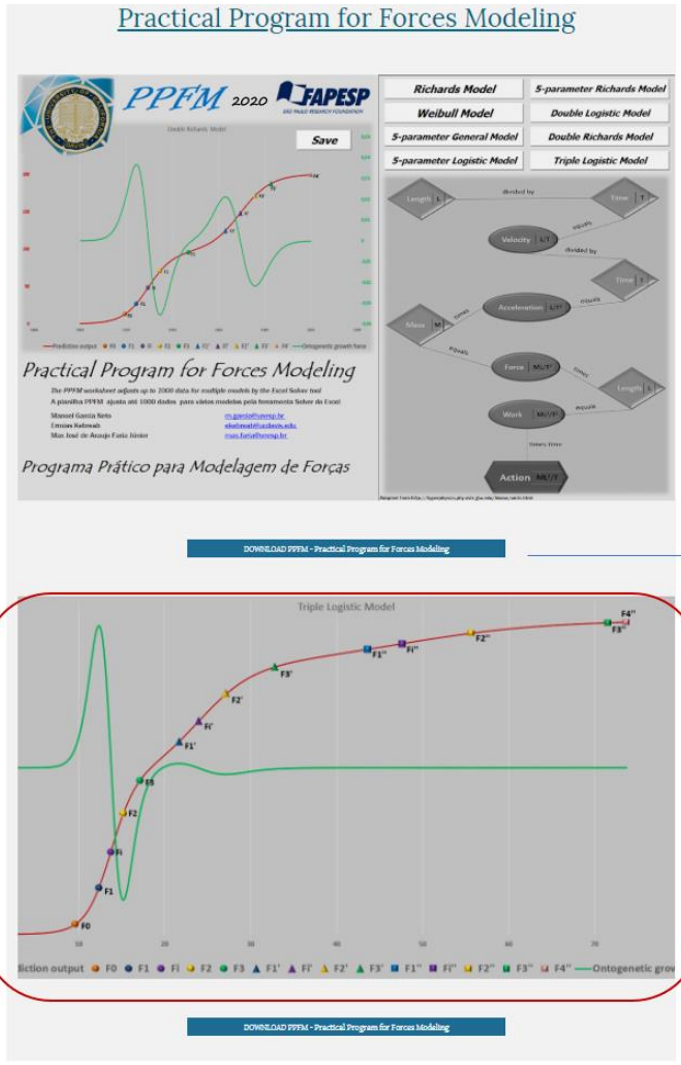


Graphics that allow adjustments or return to the original when desired.

If necessary, you can return to your original condition.

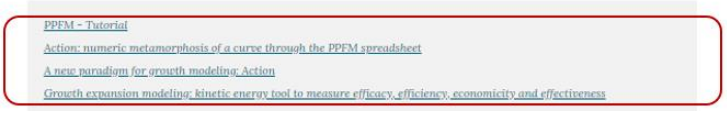


SITE PPFM https://sites.google.com/view/ppfm-spreadsheet/

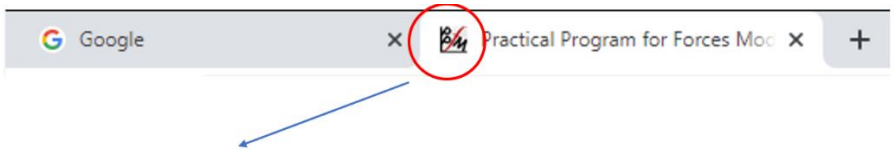


Download PPFM

Picture Carousel



Background material



PPFM site favicon


Practical Program for Forces Modeling
PPFM 2020
FAPESP
Richards Model
5-parameter Richards Model
Weibull Model
Double Logistic Model
5-parameter General Model
Double Richards Model
5-parameter Logistic Model
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Save
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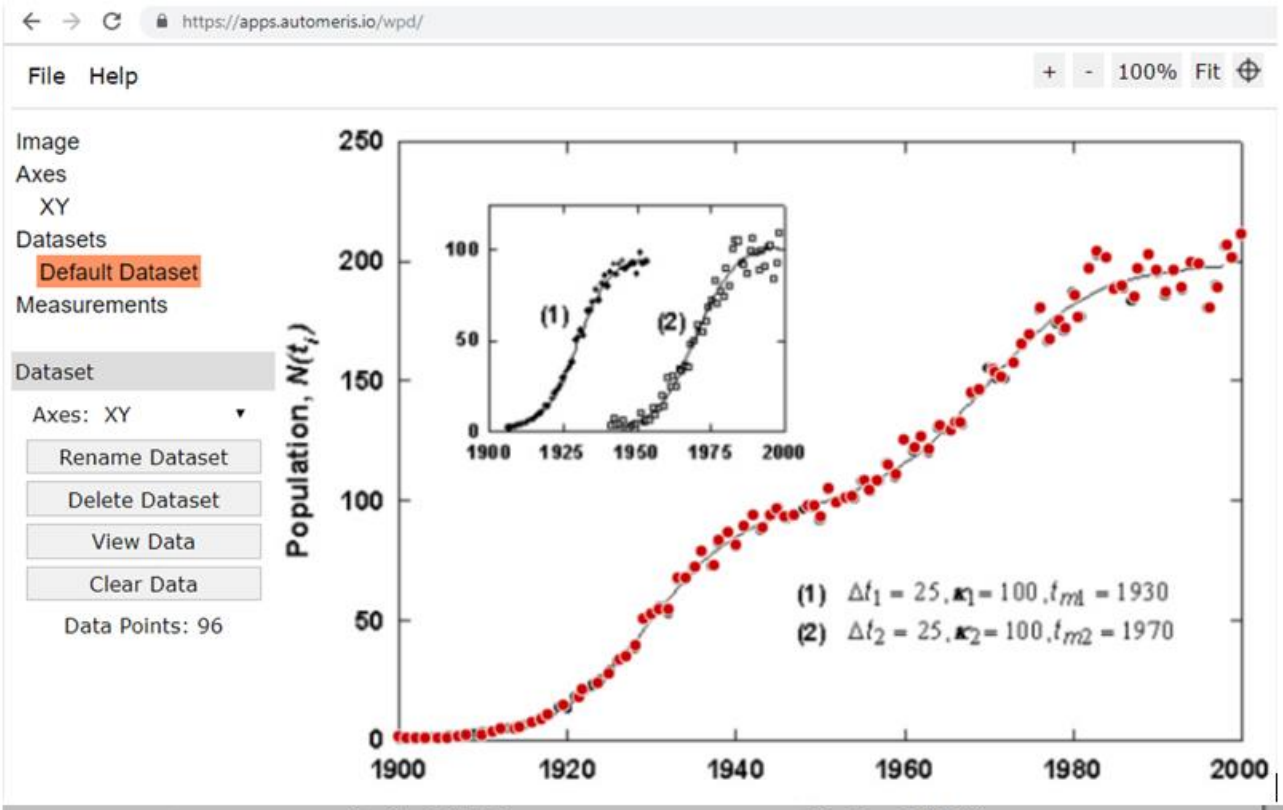
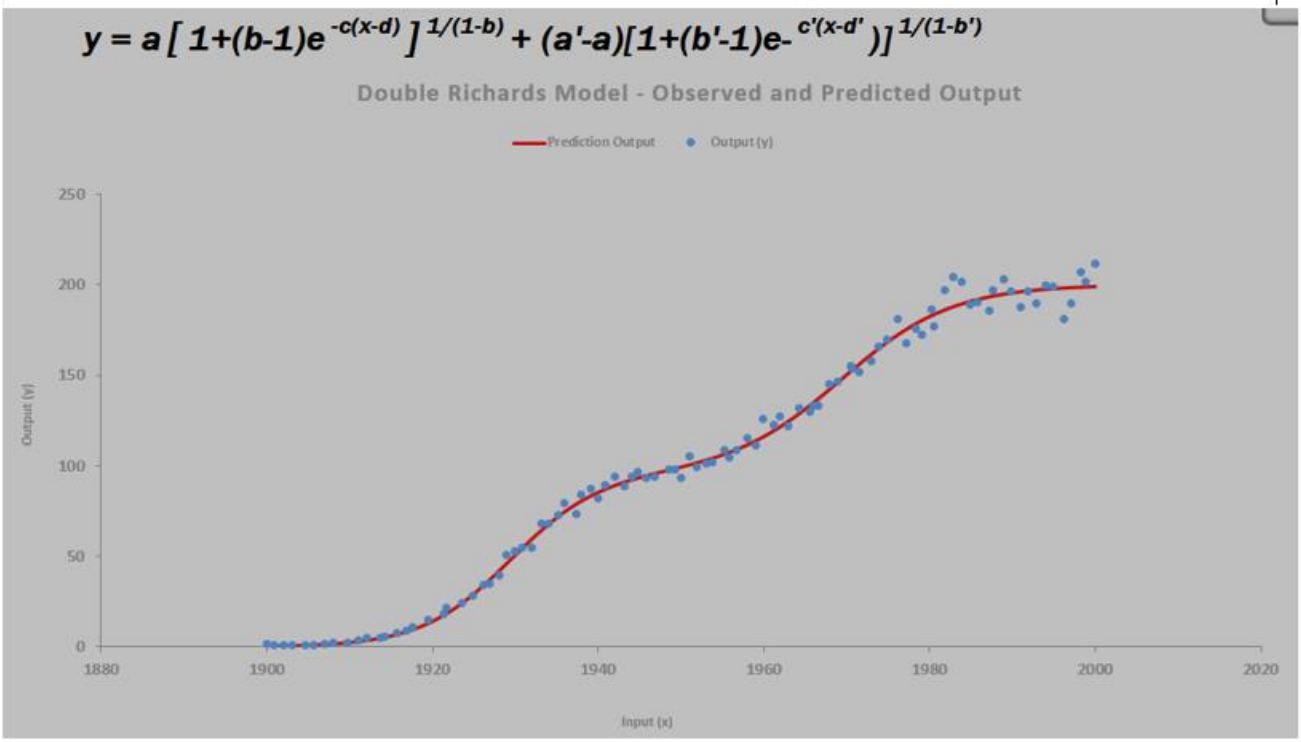
ADJUSTMENT EXAMPLES:

https://phe.rockefeller.edu/Bi-Logistic/





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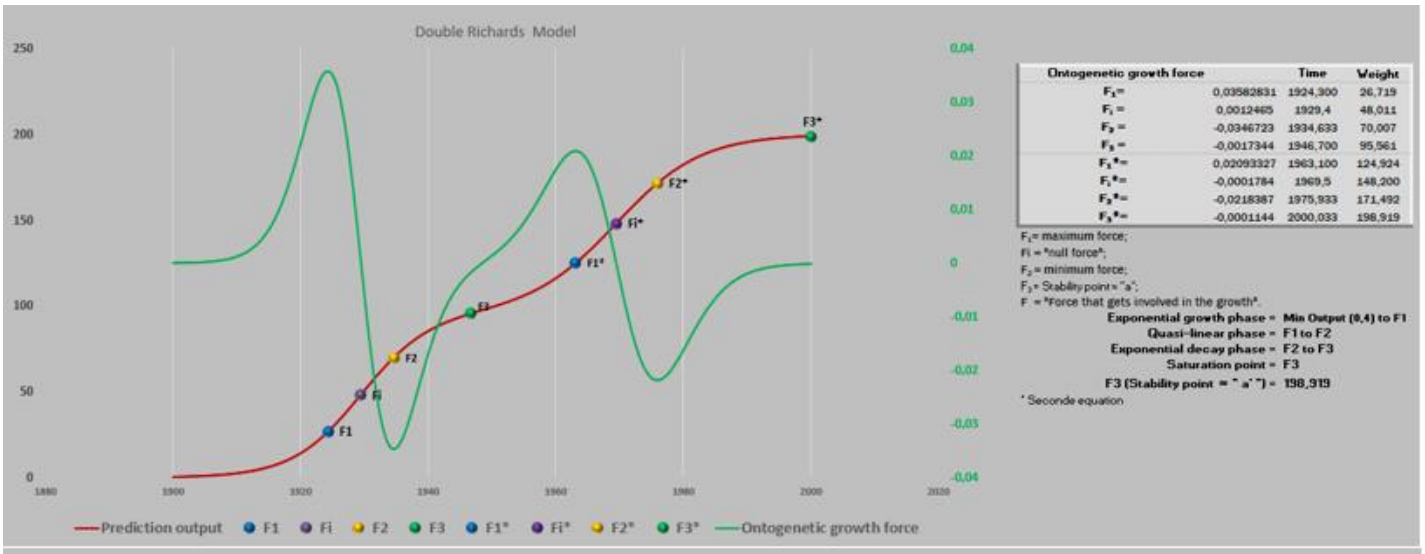
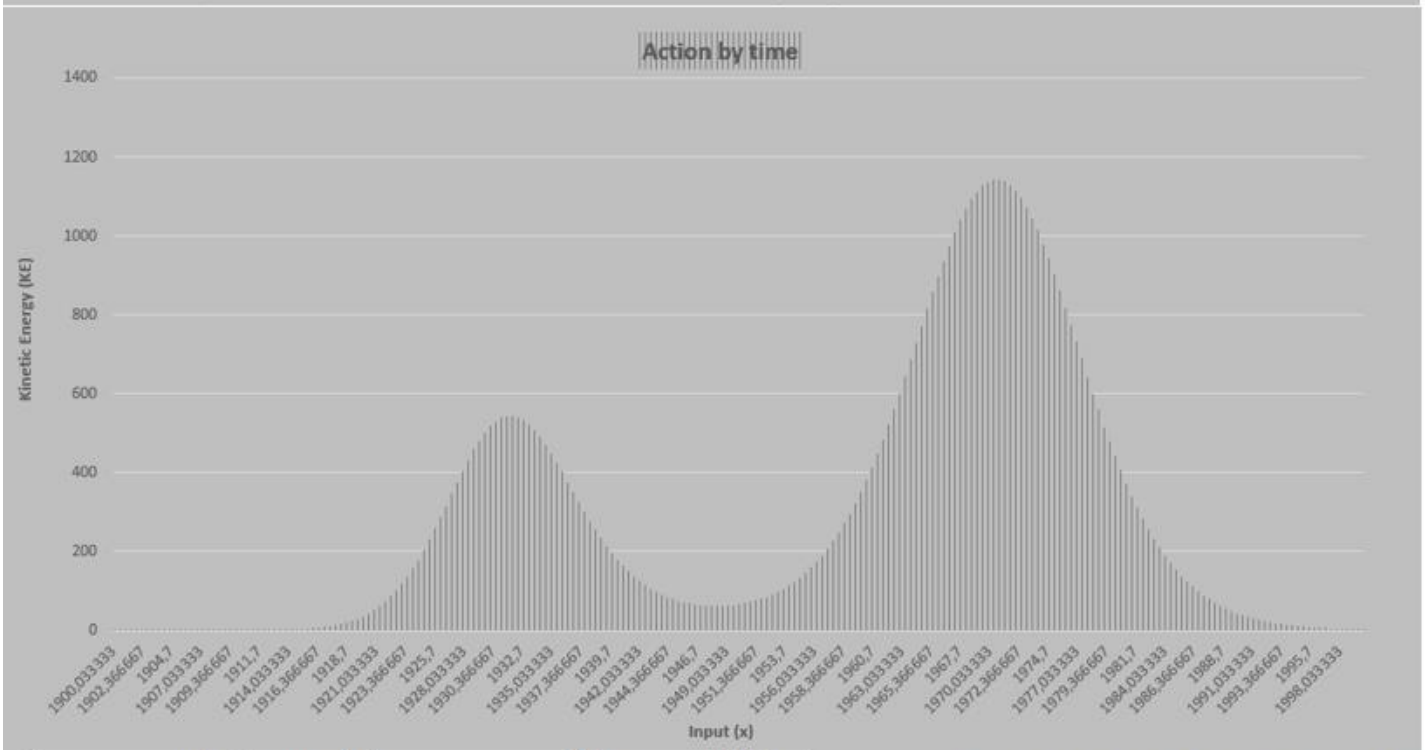


Ontogenetic growth force		Time	Weight
F_1=	0,03582831	1924,300	26,719
F_i =	0,0012465	1929,4	48,011
F_2 =	-0,0346723	1934,633	70,007
F_3 =	-0,0017344	1946,700	95,561
F_1*=	0,02093327	1963,100	124,924
F_i*=	-0,0001784	1969,5	148,200
F_2*=	-0,0218387	1975,933	171,492
F_3*=	-0,0001144	2000,033	198,919

F_1= maximum force;
Fi = "null force";
F_2 = minimum force;
F_3 = Stability point = "a";
F = "Force that gets involved in the growth".

Exponential growth phase =	Min Output (0,4) to F1
Quasi-linear phase =	F1 to F2
Exponential decay phase =	F2 to F3
Saturation point =	F3
F3 (Stability point = "a") =	198,919

* Seconde equation



	Kinetic Energy (KE)		Time	Weight
$KE_{maximum}$ =	1.142,92	1,1429E+03	1970,600	152,479

By Time

ACTION =	833.012,06	8,3301E+05	**2000,033**	198,919

Theory of growth based on first principles of energy conserva

$KE=m*v^2/2$

KE= Kinetic Energy
m=total biomass
v=velocity

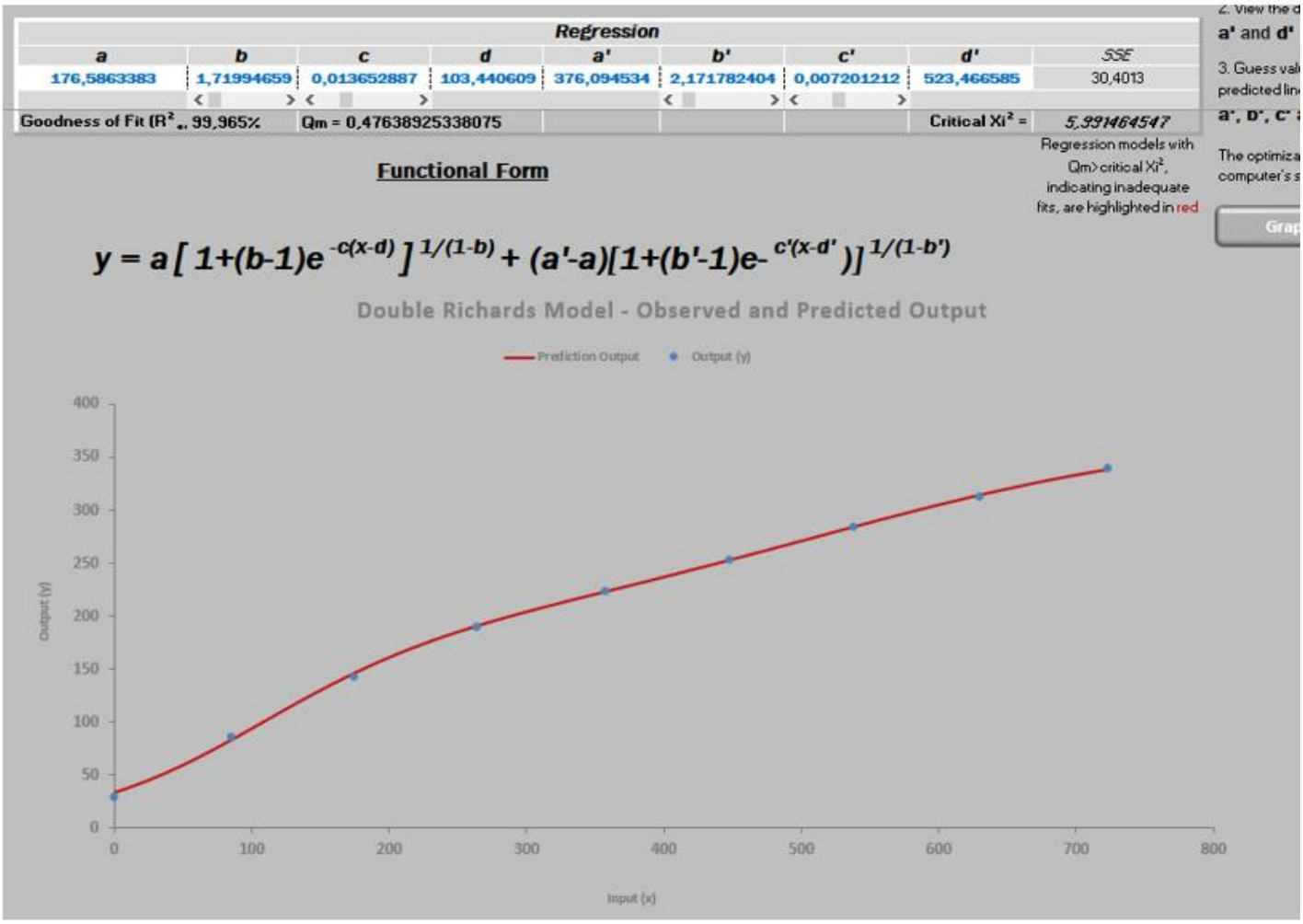
Power tells you how fast a job is done (J / s). The action, on the other h
work is in a given period of time (J × s) (Girtler, 2011).

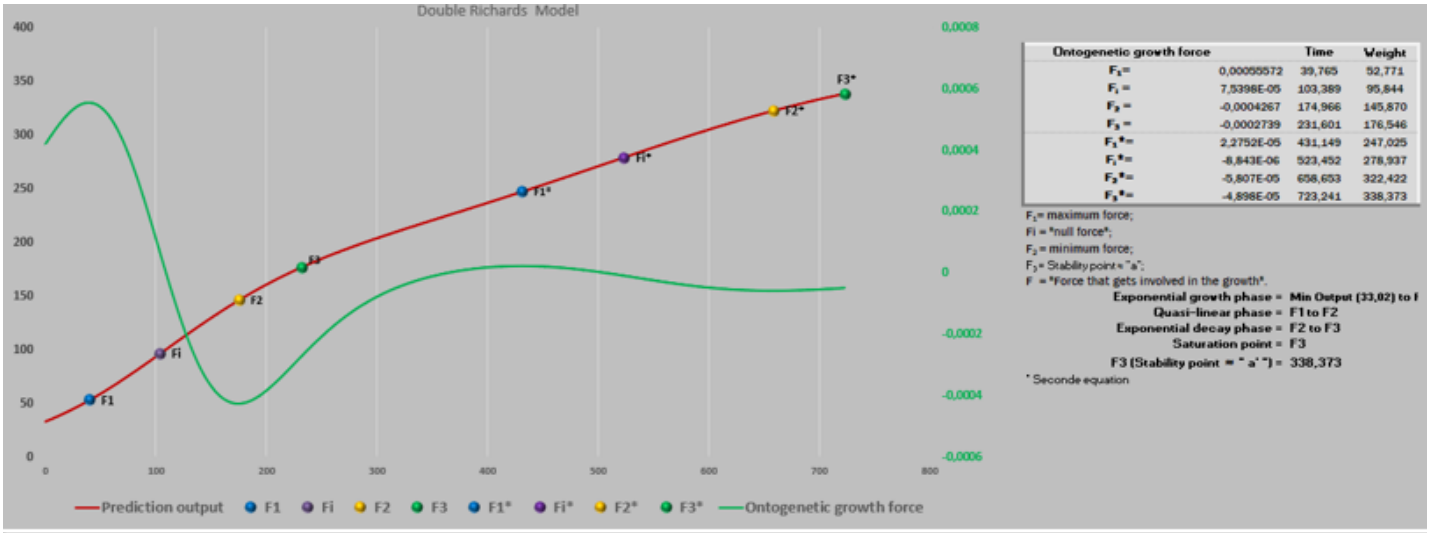
Female Zebus:

https://www.researchgate.net/publication/269028226_On_starting_values_for_parameters_of_nonlinear_growth_functions_with_application_in_animal_science

Table 3: Average age and weight of 166 female zebus from ABCZ database.

Age (days) t_i	0 85 174 264 357 448 538 630 723
Weight(kg) w_i	30 86 143 190 224 253 284 313 339



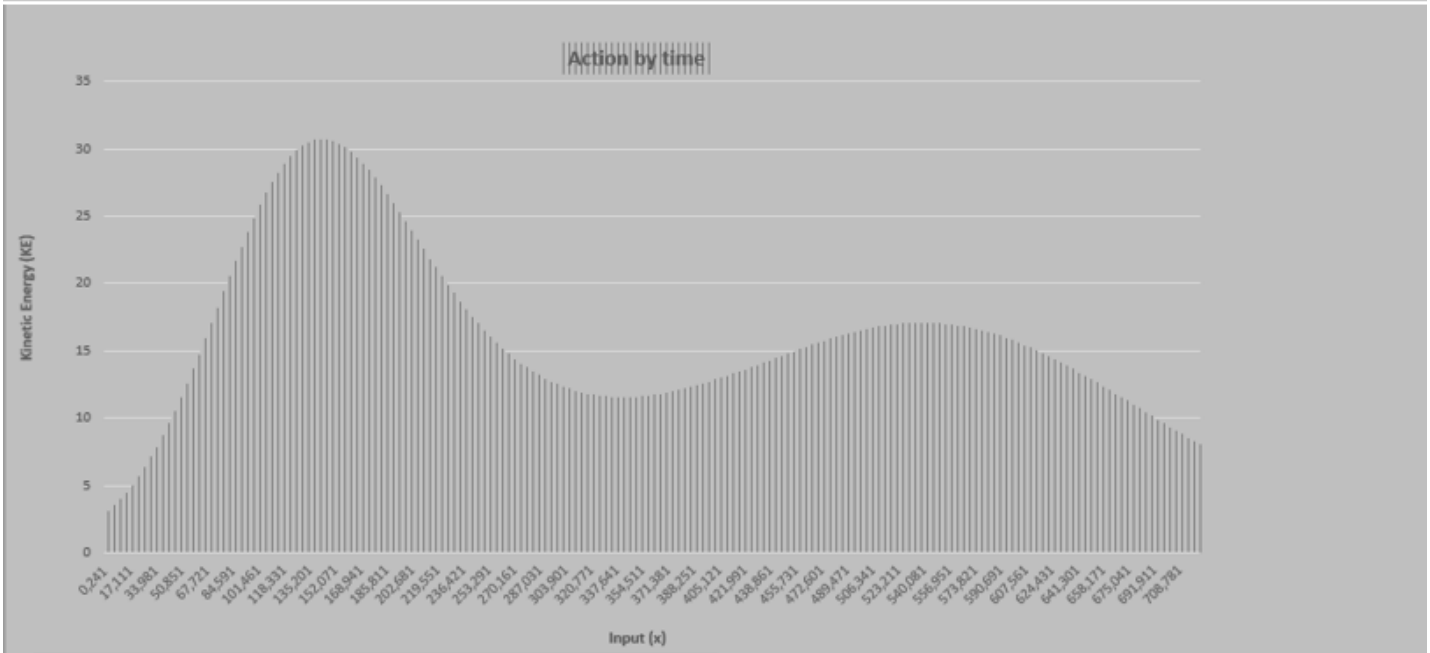


Ontogenetic growth force		Time	Weight
F_1=	0,00055572	39,765	52,771
F_i =	7,5398E-05	103,389	95,844
F_2 =	-0,0004267	174,966	145,870
F_3 =	-0,0002739	231,601	176,546
F_1*=	2,2752E-05	431,149	247,025
F_i*=	-8,843E-06	523,452	278,937
F_2*=	-5,807E-05	658,653	322,422
F_3*=	-4,898E-05	723,241	338,373

F_1= maximum force;
Fi = "null force";
F_2 = minimum force;
F_3 = Stability point = "a";
F = "Force that gets involved in the growth".

Exponential growth phase =	Min Output (33,02) to F
Quasi-linear phase =	F1 to F2
Exponential decay phase =	F2 to F3
Saturation point =	F3
F3 (Stability point = " a' ") =	338,373

* Seconde equation



	Kinetic Energy (KE)		Time	Weight
$KE_{maximum}$ =	30,70	3,0701E+01	143,636	125,063
			By Time	
ACTION =	48.209,13	4,8209E+04	723,241	338,373

Theory of growth based on first principles of energy conservation and allocatio

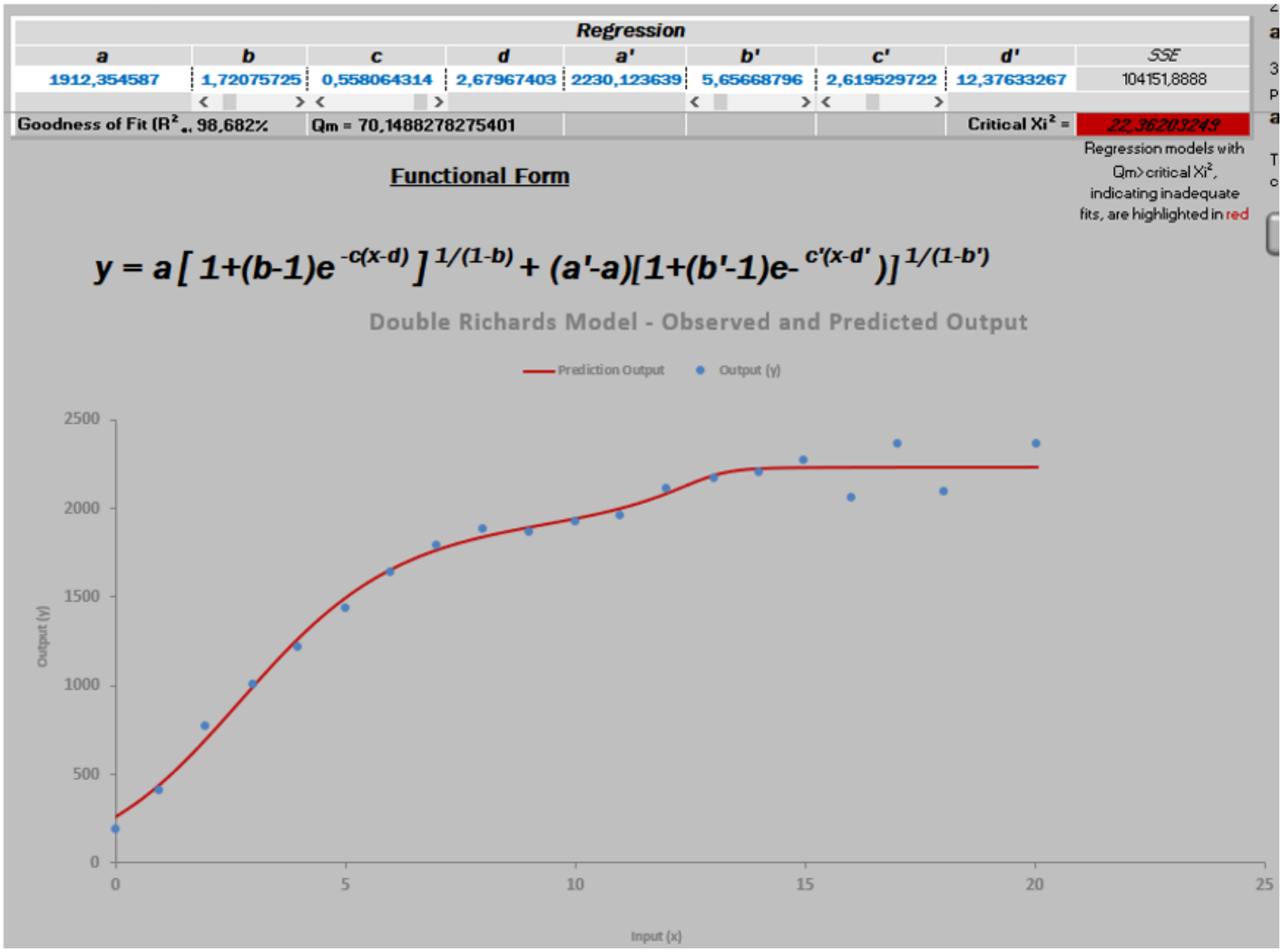
$KE=m*v^2/2$

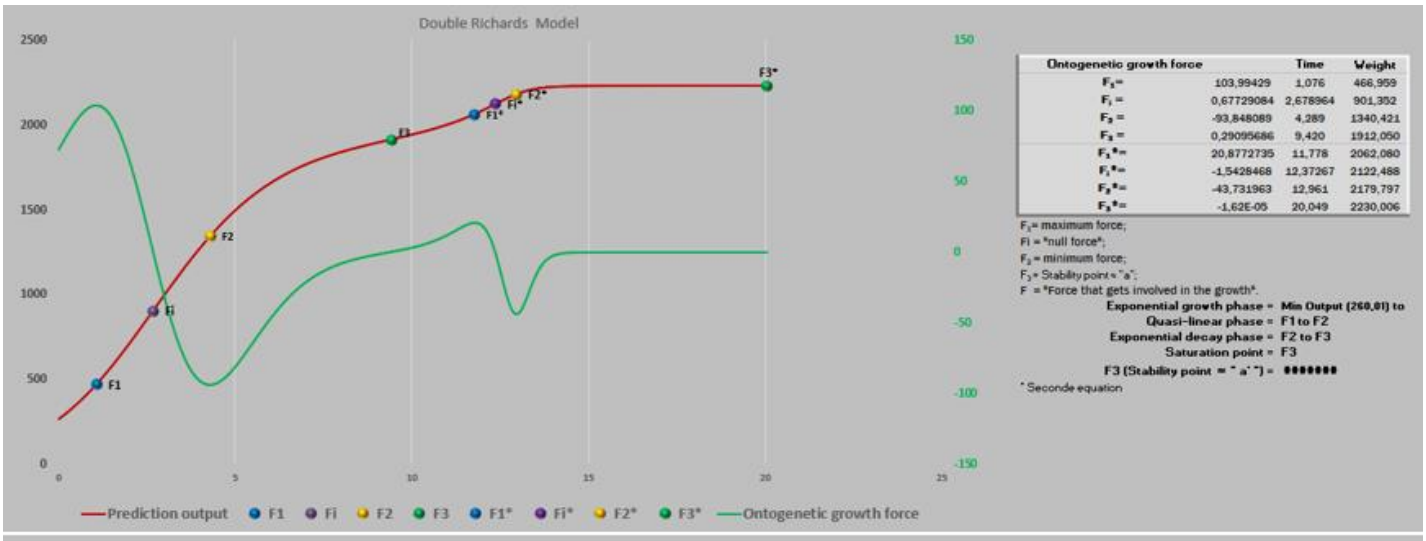
KE= Kinetic Energy
m=total biomass
v=velocity

Power tells you how fast a job is done (J / s). The action, on the other hand, clarifies how great work is in a given period of time (J × s) (Girtler, 2011).
The action presents as quantitative base the dimension energy × time, integrating the evaluatic

Fish:

https://peerj.com/articles/5973.pdf



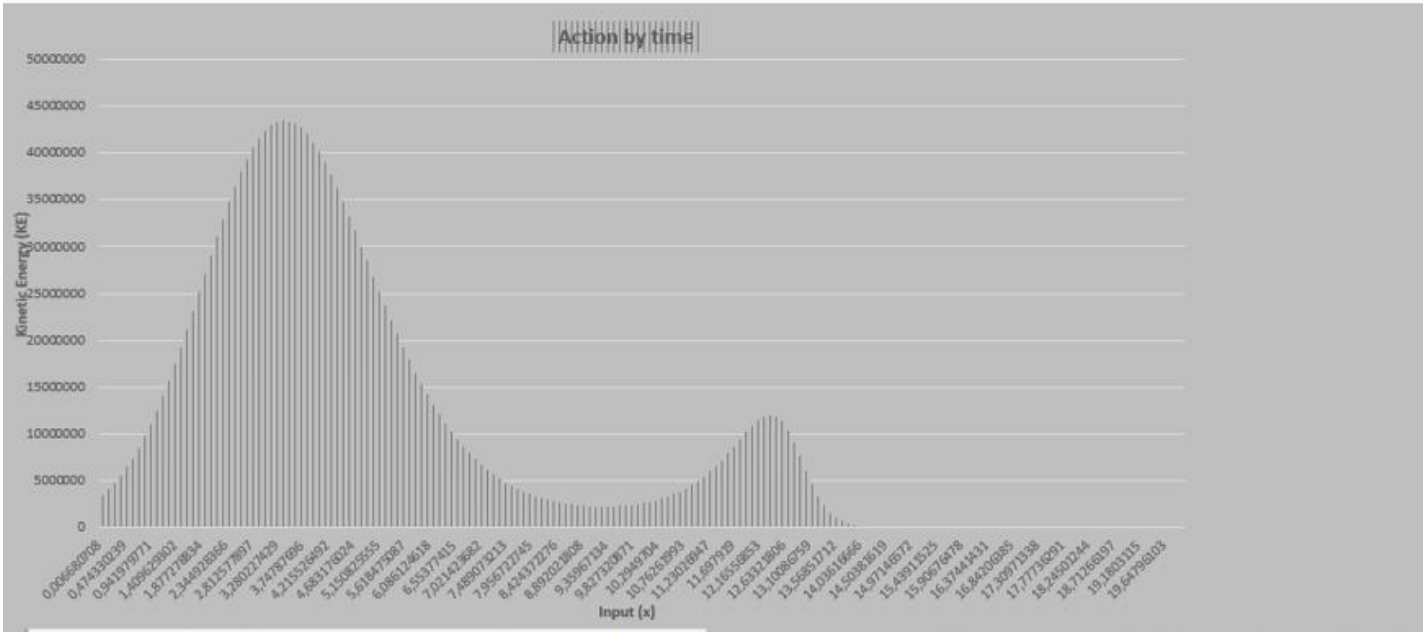


Ontogenetic growth force		Time	Weight
F_1=	103,99429	1,076	466,959
F_i =	0,67729084	2,678964	901,352
F_2 =	-93,848089	4,289	1340,421
F_3 =	0,29095686	9,420	1912,050
F_1*=	20,8772735	11,778	2062,080
F_i*=	-1,5428468	12,37267	2122,488
F_2*=	-43,731963	12,961	2179,797
F_3*=	-1,62E-05	20,049	2230,006

F_1= maximum force;
Fi = *null force*;
F_2 = minimum force;
F_3 = Stability point = "a";
F = *Force that gets involved in the growth*.

Exponential growth phase = Min Output (268,01) to
Quasi-linear phase = F1 to F2
Exponential decay phase = F2 to F3
Saturation point = F3
F3 (Stability point = " a' ") = ########

* Seconde equation



Kinetic Energy (KE)			Time	Weight
$KE_{maximum}$ =	#########	4,3441E+07	3,414	1113,121

			By Time	
ACTION =	###########	3,0403E+10	20,049	2230,006

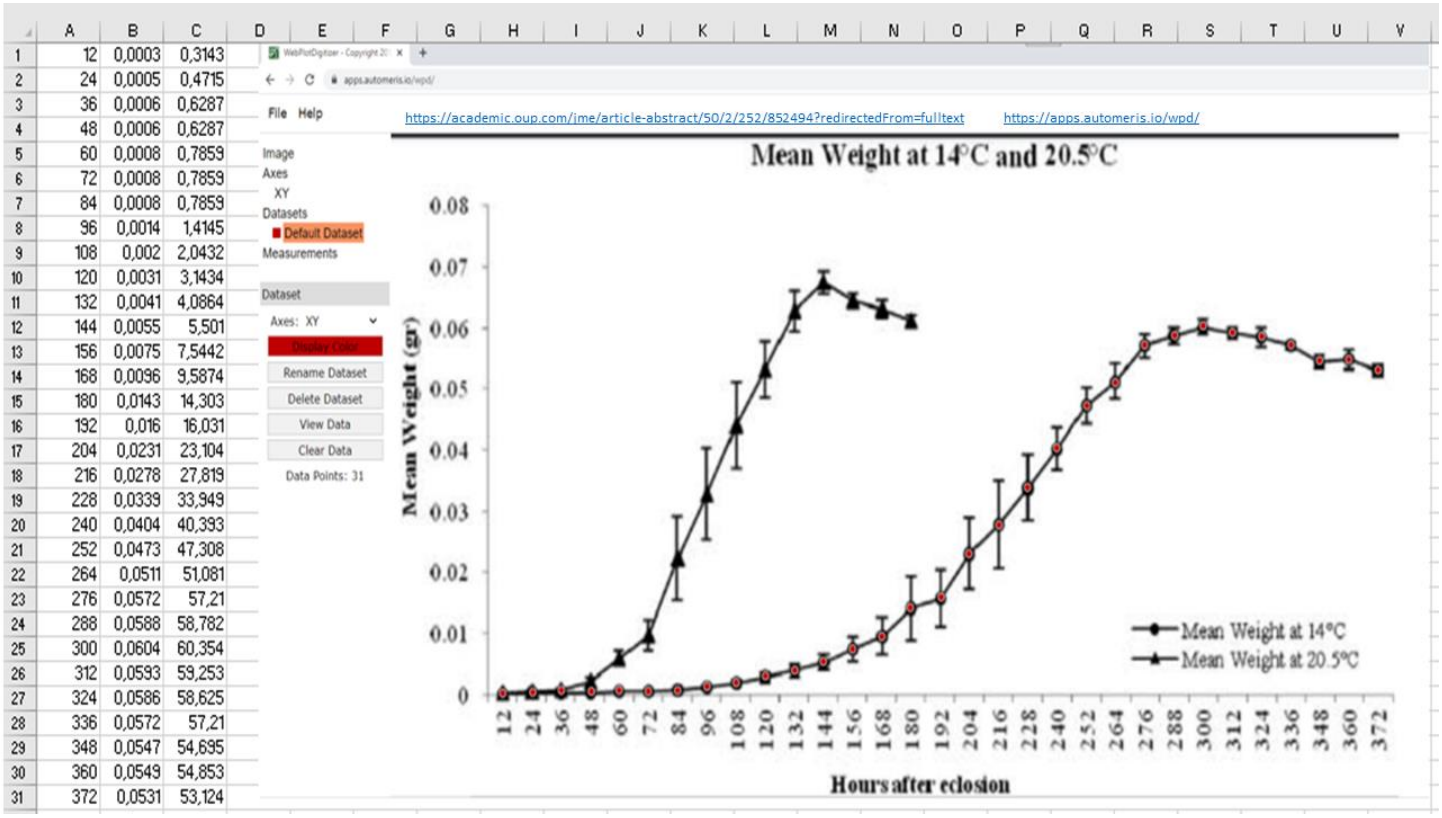
Theory of growth based on first principles of energy conservation and allocation:

$KE=m*v^2/2$

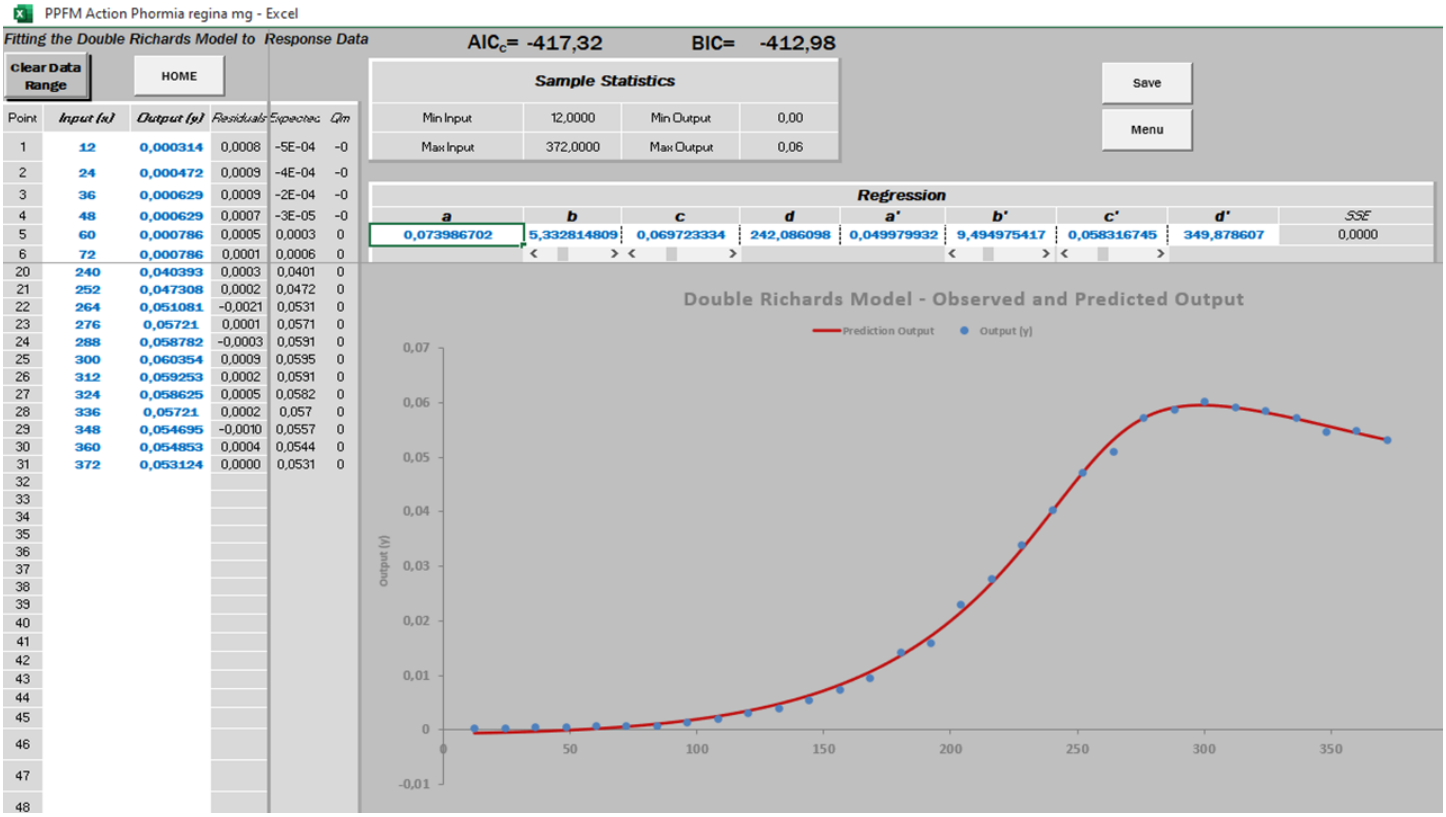
KE= Kinetic Energy
m=total biomass
v=velocity

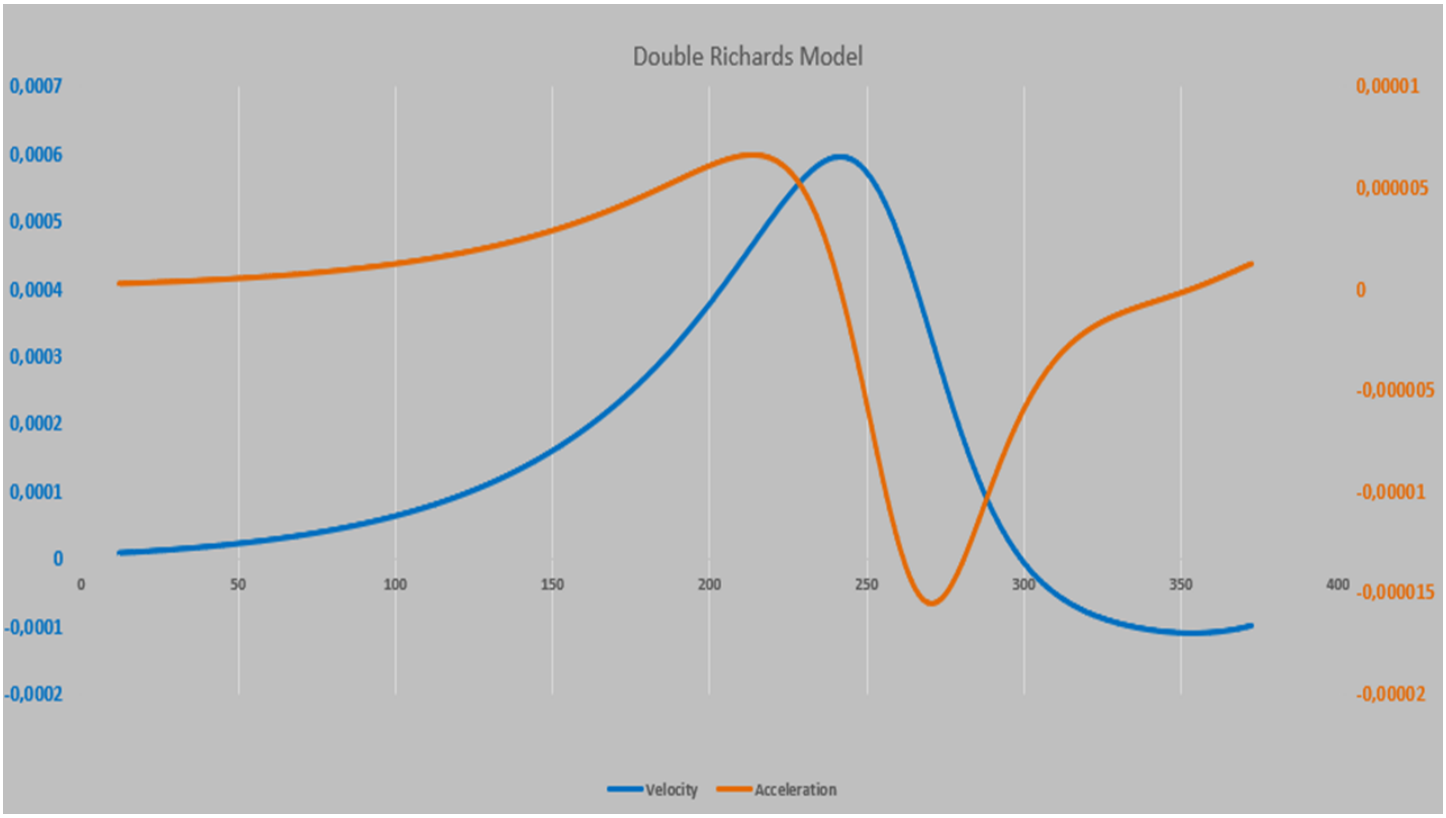
Power tells you how fast a job is done (J / s). The action, on the other hand, clarifies how great th
work is in a given period of time (J × s) (Girtler, 2011).
The action presents as quantitative base the dimension energy × time, integrating the evaluation

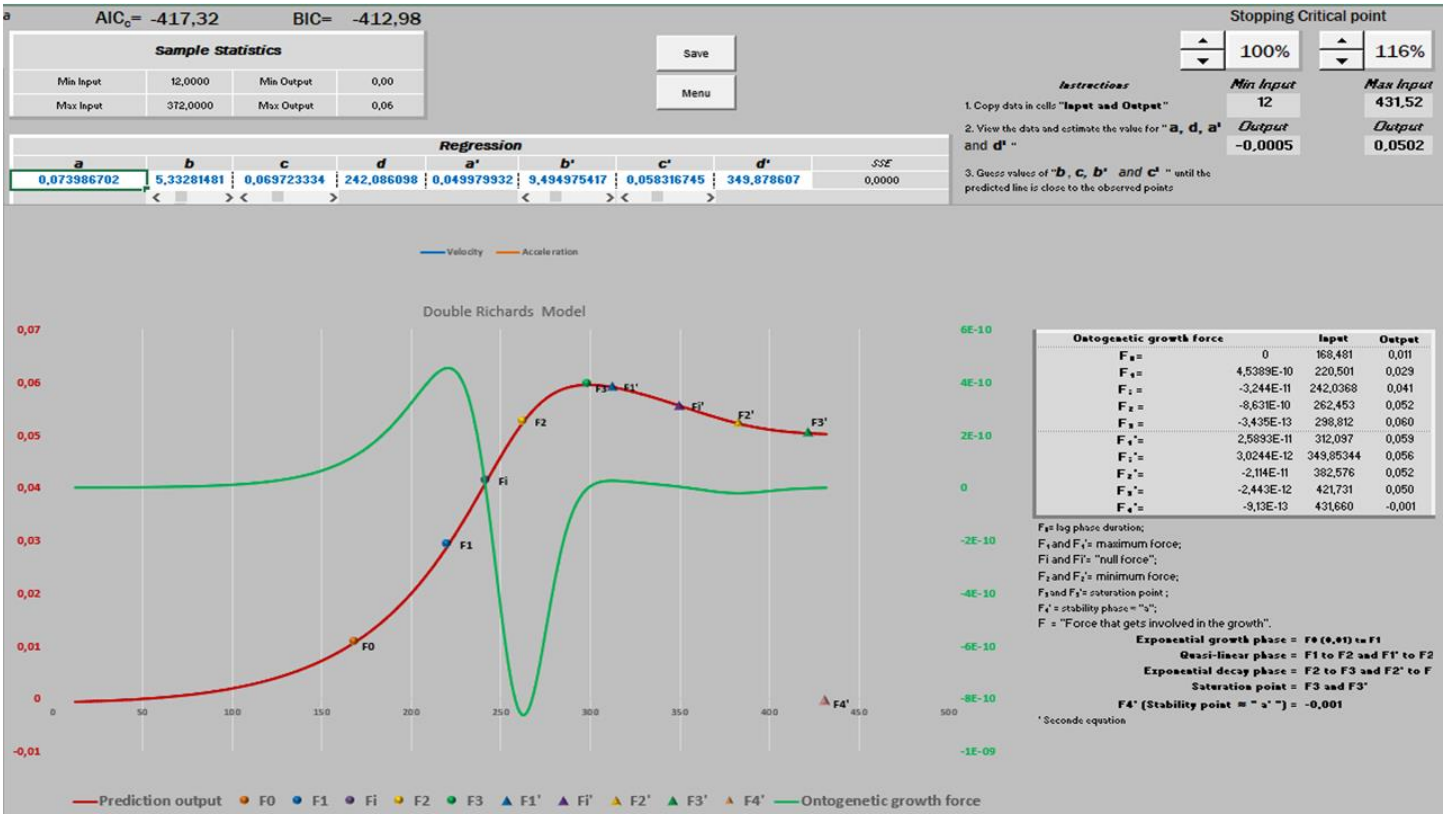
Phormia regina - mean weight the larval instars:

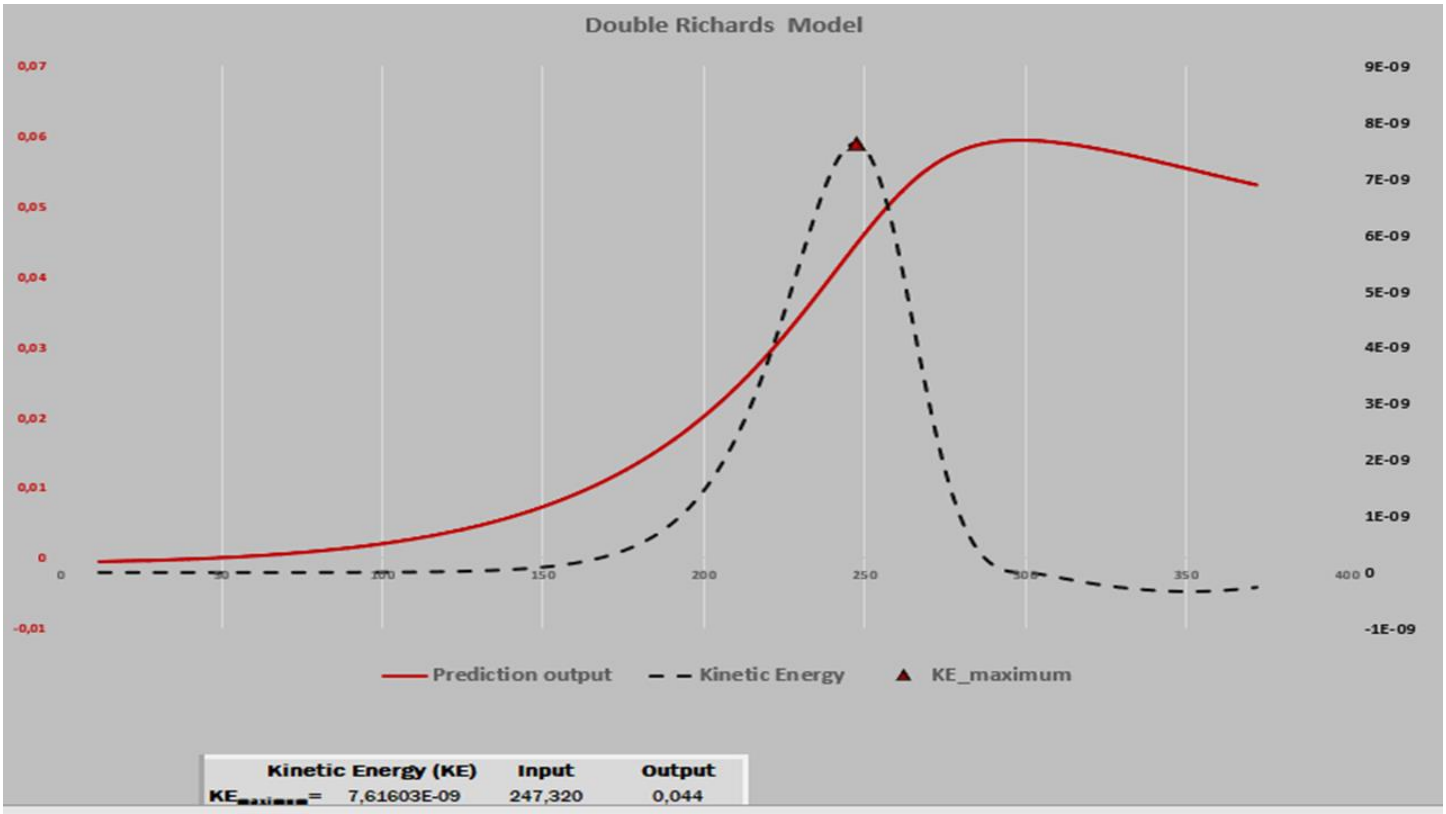


https://apps.automeris.io/wpd/

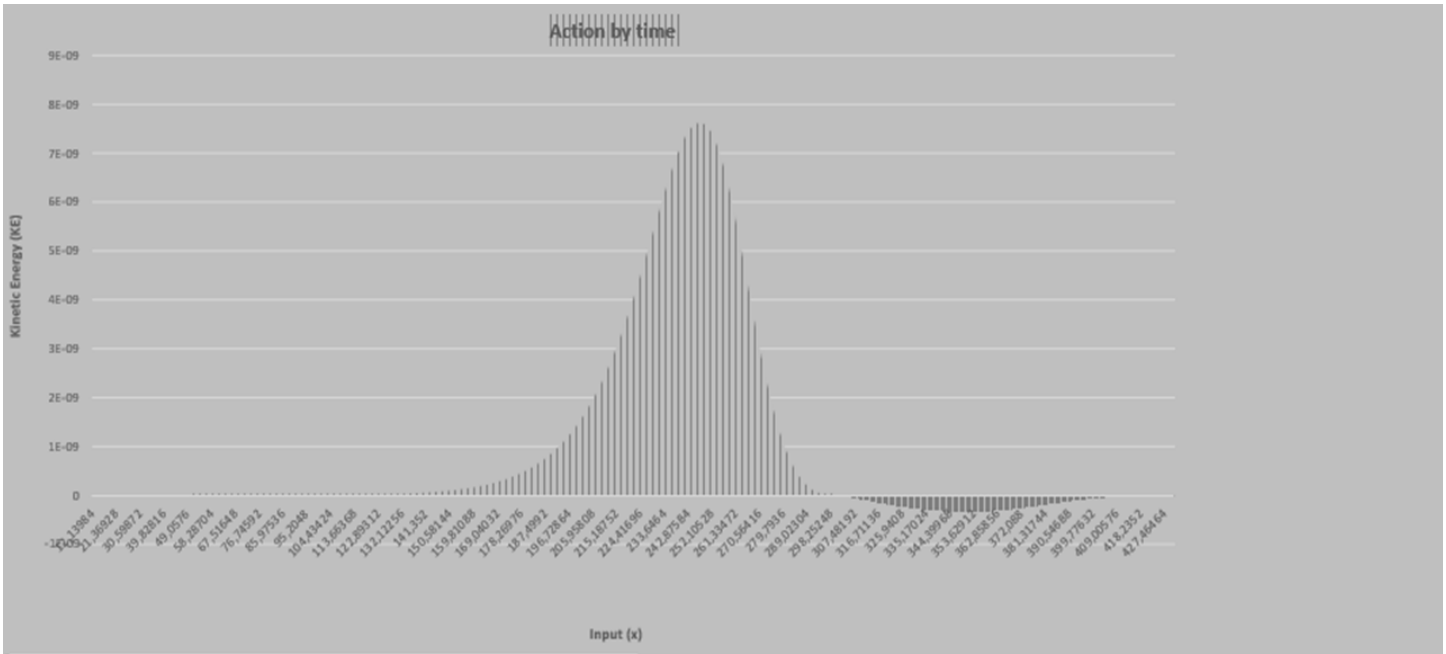



Double Richards Model
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
-0,0001
-0,0002
0,00001
0,000005
0
-0,000005
-0,00001
-0,000015
-0,00002
0
50
100
150
200
250
300
350
400
Velocity
Acceleration


AIC$_c$= -417,32
BIC= -412,98
Sample Statistics
Min Input 12,0000
Min Output 0,00
Max Input 372,0000
Max Output 0,06
Save
Menu
Regression
a b c d a' b' c' d' SSE
0,073986702 5,33281481 0,069723334 242,086098 0,049979932 9,494975417 0,058316745 349,878607 0,0000
Stopping Critical point
100%
116%
Instrections
Min Input
Max Input
1. Copy data in cells "Input and Output"
12
431,52
2. View the data and estimate the value for " a, d, a' and d' "
Output
Output
-0,0005
0,0502
3. Guess values of "b, c, b' and c' " until the predicted line is close to the observed points
Velocity
Acceleration
Double Richards Model
F0
F1
Fi
F2
F3
F1'
Fi'
F2'
F3'
F4'
Ontogenetic growth force
Input
Output
F0 = 0 168,481 0,011
F1 = 4,5389E-10 220,501 0,029
Fi = -3,244E-11 242,0368 0,041
F2 = -8,631E-10 262,453 0,052
F3 = -3,435E-13 298,812 0,060
F1' = 2,5893E-11 312,097 0,059
Fi' = 3,0244E-12 349,85344 0,056
F2' = -2,114E-11 382,576 0,052
F3' = -2,443E-12 421,731 0,050
F4' = -9,13E-13 431,660 -0,001
F0= lag phase duration;
F1 and F1'= maximum force;
Fi and Fi'= "null force";
F2 and F2'= minimum force;
F3 and F3'= saturation point ;
F4' = stability phase = "s";
F = "Force that gets involved in the growth".
Exponential growth phase = F0 (0,01) to F1
Quasi-linear phase = F1 to F2 and F1' to F2
Exponential decay phase = F2 to F3 and F2' to F
Saturation point = F3 and F3'
F4' (Stability point = " s' ") = -0,001
' Seconde equation
Prediction output
F0
F1
Fi
F2
F3
F1'
Fi'
F2'
F3'
F4'
Ontogenetic growth force



	Kinetic Energy (KE)	Input	Output
$KE_{maximum}$ =	7,61603E-09	247,320	0,044



	Kinetic Energy (KE)		Input	Output
$KE_{maximum}$ =	7,616E-09	7,6160E-09	247,211	0,044
		By input		
ACTION =	2,68506E-06	2,6851E-06	**431,660**	0,050

Theory of growth based on first principles of energy conservation and allocation:

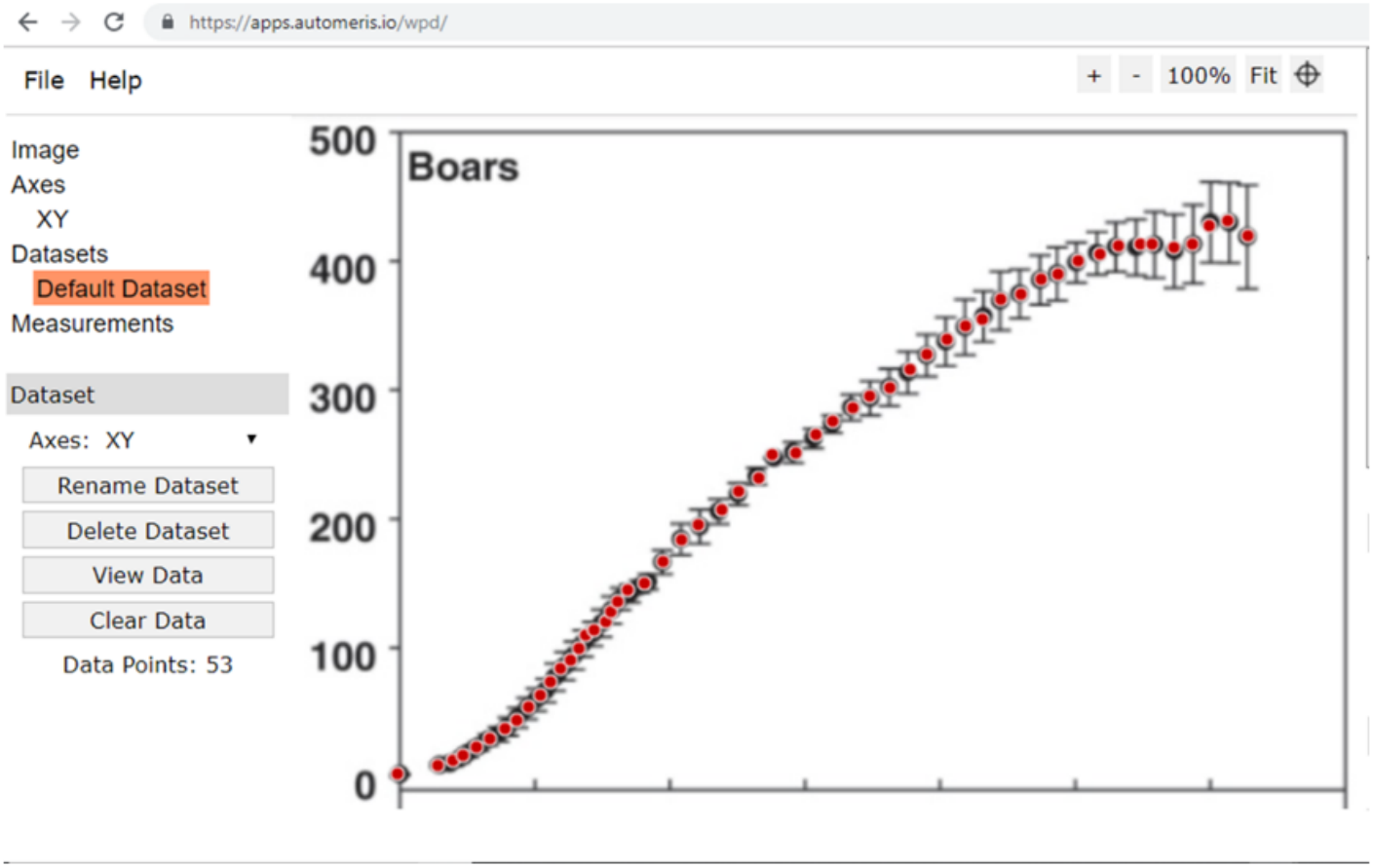
$KE=m*v^2/2$

KE= Kinetic Energy
m=total biomass
v=velocity

Power tells you how fast a job is done (J / s). The action, on the other hand, clarifies how great the performance of work is in a given period of time (J × s) (Girtler, 2011).

Model growth in pigs

https://pdfs.semanticscholar.org/5acf/0e4ca67340d81a0a67e7a7b22cbe1ca674de.pdf



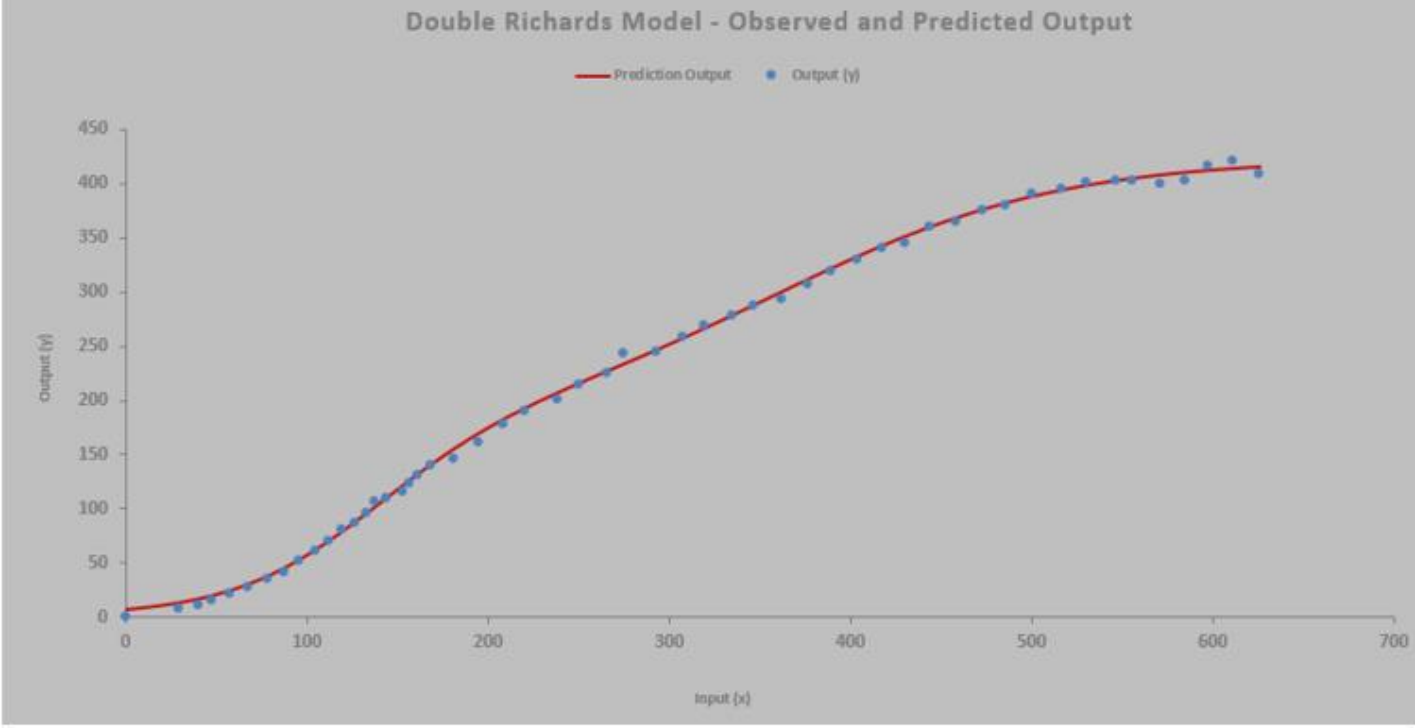
https://apps.automeris.io/wpd/

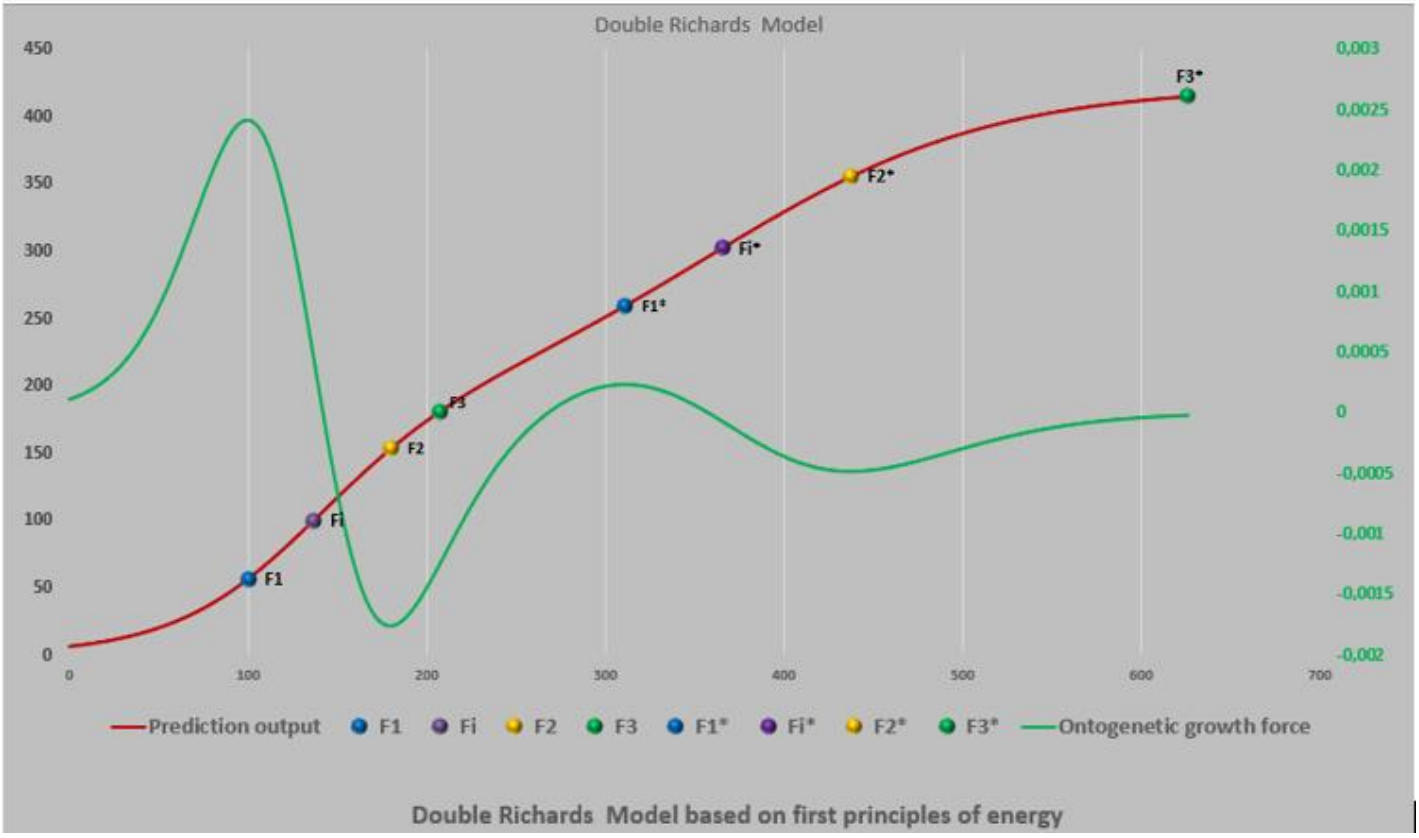
Regression								
a	b	c	d	a'	b'	c'	d'	SSE
180,6588801	1,83196463	0,023746832	136,987185	422,3207451	2,070082276	0,013184148	365,5398474	729,8034
Goodness of Fit (R^2): 99,929%		Qm = 10,2285175015156					Critical Xi^2 =	62,82962041

Regression models with Qm> critical Xi^2, indicating inadequate fits, are highlighted in red

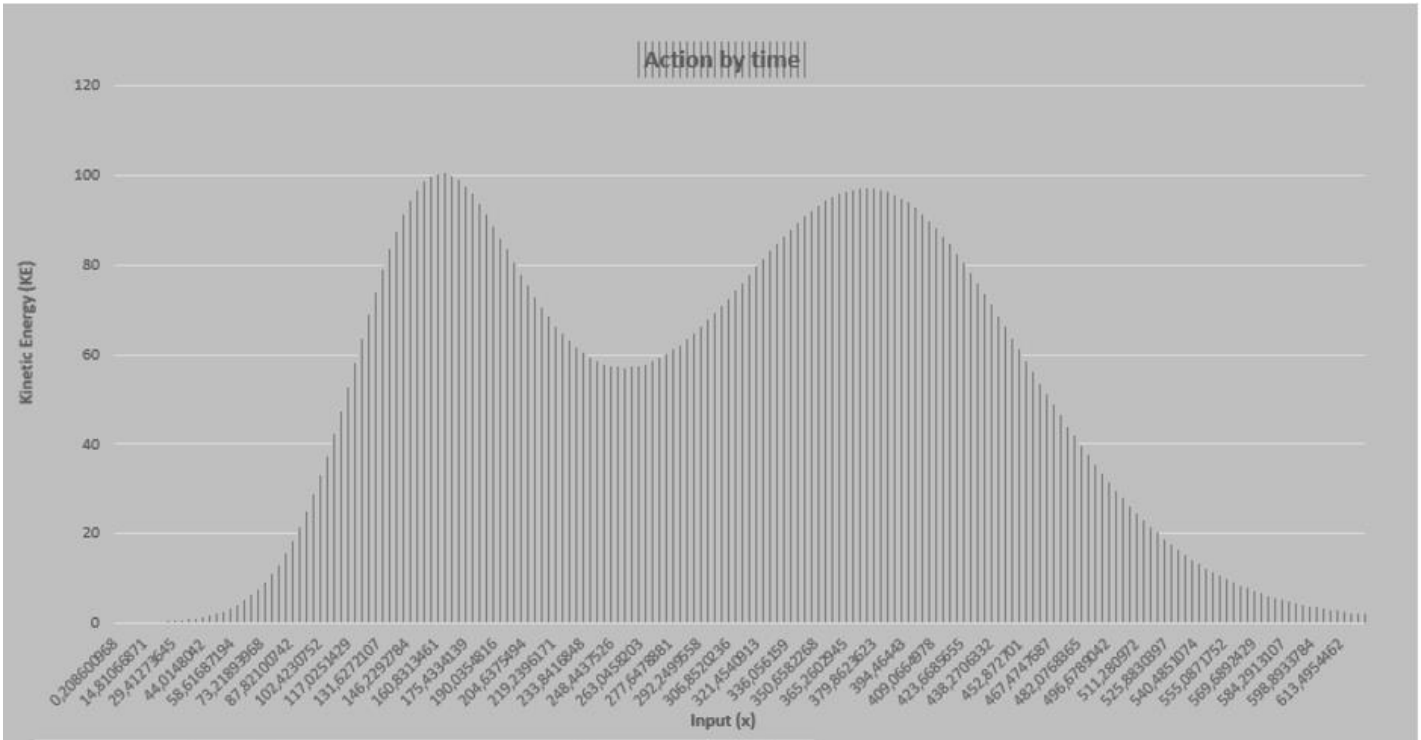
Functional Form

$$y = a\left[1+(b-1)e^{-c(x-d)}\right]^{1/(1-b)} + (a'-a)\left[1+(b'-1)e^{-c'(x-d')}\right]^{1/(1-b')}$$





Double Richards Model based on first principles of energy



	Kinetic Energy (KE)		Time	Weight
$KE_{maximum}$ =	100,39	1,0039E+02	163,335	133,773

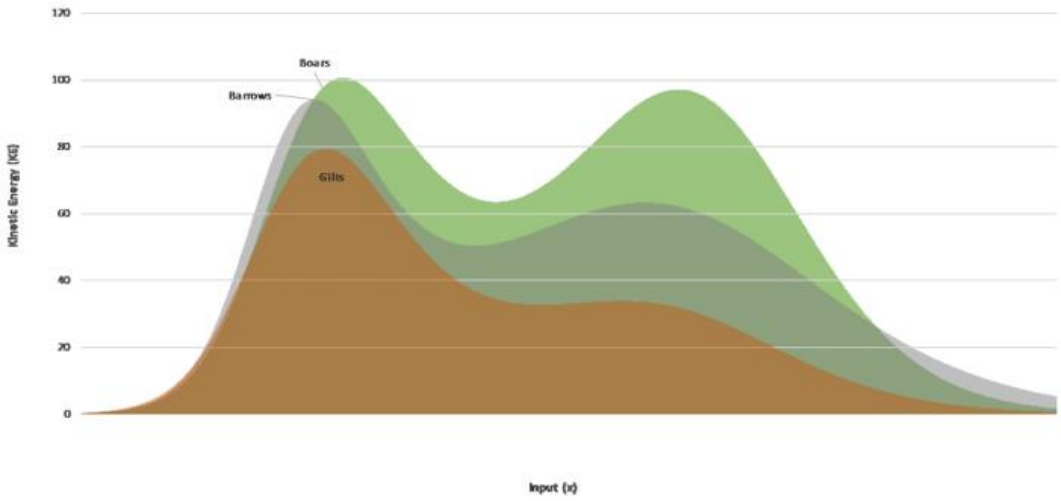
			By Time	
ACTION =	149.986,28	1,4999E+05	**626,012**	414,776

Theory of growth based on first principles of energy co

$KE=m*v^2/2$

KE= Kinetic Energ
m=total biomass
v=velocity

Power tells you how fast a job is done (J / s). The action, on the other h
work is in a given period of time (J × s) (Girtler, 2011).
The action presents as quantitative base the dimension energy × time,



		Index 100	
Gilts	83314,32	52,99433	47,00567
Barrows	128504,8	81,73895	18,26105
Boars	157213,7	100	

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