Economic evaluation of relay intercropping and crop sequences systems from the perspective of crop intensification .

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Crop Intensification systems are the most important systems that used by the farmer to increase the economic return of the land. Crop Intensification includes several systems such as simultaneous and relay intercropping and successions crops .

Among the factors that farmers take into account are the economic factors in terms of the price of seeds, fertilizers, insecticides and fungicides as well as the selling price of the crops to be able to choose the appropriate system for use , compared with the traditional systems.

A lot of intercropping trails are evaluated on basis of LER equation (Biological basis), while no attention is paid for economics of intercropping, e.g., price of major or secondary crops in addition to the land occupied by any of them or even the productivity evaluated as cash money are not taken in account. Since the Egyptian farmer evaluates the economics of intercropping on the basis of cash money incomes, attention must be paid for his view point if adoption of one or another of intercropping system is recommended.

It has therefore equations have been established for the economic valuation of crop intensification systems on the bases of biological yield and economic parameters from perspective of the crop intensification specialists

These equations has included the factors that intervene in the agricultural process, that affecting the final production of the system and also the economic return to land for calculate the economic returns of such systems compared with the traditional methods used by farmers is the reference to the profit or loss and thus the success or failure of the proposed system . One of the features proposed equivalencies that can predict how the success or failure of the proposed system through price policy of inputs on the market . So we can monitor the spread of the implementation of the proposed programs in pursuing the market prices .

The agricultural year usually starts soon after harvesting the preceding autumn, which beginning of October and ended before the beginning of November in the next year . The agricultural year will consider 365 days (100 % duration) . The duration by days of sequential were accounted from the date of the first crop planting until harvesting date of the last crop . It was called "Area time land occupied " , and expressed as a percentage as follows: duration by days / 365 days(100% duration). (El-Hawary, 2009)

Concerning relay intercropping and crop sequences systems there are many factors need to be included in the cost of production estimates that all farms should be calculating as they consider length of rotation and cropping sequences , water irrigation quantity addition to the price of seeds, fertilizers, insecticides and fungicides as well as the selling price of the crops to be able to choose the appropriate system for use , compared with the traditional systems.

Formulas were established for relay intercropping and crop sequences evaluations based on biological and economical parameters from crop intensification perspective . The formulas were established for estimating the Economical Yield Advantage Ratio (EYAR) of the relay intercropping and crop sequence systems .

1-Evaluation of relay intercropping in comparison with a traditional sequence ($EYER_1$):

Economical Yield Advantage Ratio (relay/ sequ.) ($EYAR_1$): (**El-Hawary, 2009)**

$$EYAR_1=[(\sum_{i=1}^{n}(\sum_{j=1}^{n-}Y_{aij}\,Pr_{aij})-\sum_{i=1}^{n}Co_{ai})\,D_b]\;[\,(\sum_{L=1}^{m}(\sum_{k=1}^{m-}(Y_{bLK}\,Pr_{bLK})-Co_{bL}))\,D_a\,]^{-1}$$

Economical Yield Advantage Ratio as percentage = ((EYAR1) -1)x 100= + %

Where :

Formula numerator should be occupied by crop sequence (a) (relay intercropping crops) .

Formula denominator should be occupied by crop sequence (b).

n : number of crops pertaining to crop sequence (a) . *n*- : number of main and by products together of the crop . Which n^- varies according to each crop.

Ya_{ij} , Pra_{ij} and Coa_{ij} :Yield, price and production cost (main and by products)of each crop pertaining to crop sequence (a) , respectively.

m: number of crops pertaining to crop sequence (b) . *m*- : number of main and by products together of the crop . Which m^- varies according to each crop.

$Y_{b\,LK}$,Pr_{bLK} and Co_{bLK} : Yield, price and production cost (main and by products) of each crop

pertaining to crop sequence (b) , respectively.

D_a and D_b : Crop sequence (a) and crop sequence (b) durations by days, respectively. .

$EYAR_1$ value was relative to the net return per day of compared sequence(b*)* .

The computation of yield advantage net return of evaluated sequence is as follows:

= Net return of evaluated sequence "*a*" - net return of compared sequence "*b*"

Example 1 :

Relay intercropping (sequence "a")			
	Yield	Price	Costs
Wheat: main product : Grain	$Y_{a11=}$ 3.180 Ton/Fed.	$Pr_{a11=}$1100 LE/Ton	Co_{a1} =1921 LE/Fed
by product :Straw	$Y_{a12=}$ 2.77 Ton/Fed	Pr_{a12}=500 LE/Ton	
Cotton	$Y_{a21=}$ 8.3 kentar/Fed.	Pr_{a21} =850 LE/kentar	Co_{a2} =2622 LE/fed
Duration	$D_{a=}$334 days		
Total costs			Co_{a1+z2}=4543LE/Fed
Crop sequence (b) (compared sequence)			
Two –cut clover	$Y_{b1=}$ 15 ton/Fed.	$Pr_{b1=}$140 LE/Ton	$Co_{b1=}$900 LE/Fed
Cotton	$Y_{b2=}$ 8.5kentar/Fed.	Pr_{b2} =850 LE/kentar	Co_{b2} =2622 LE/fed
Duration	$D_{b=}$388 days		

Economical Yield Advantage Ratio $_{(relay/\ sequ.)}$ ($EYAR_1$)

= [((3.18 x 1100 + 2.77x 500 + 8.3x850) – 4543) 388][(((15x140 - 900) + (8.5.0x850 – 2622))334]$^{-1}$

= [22.1407(NR /day of sequence "*a*')][14.9561 (NR /day of sequence "*b*')]$^{-1}$ =1.48087 (**+ 48.037 %**)

$EYAR_1$ value observed that the net return per day of evaluated sequence increased by 48.087% over the net return per day of compared sequence (b) .

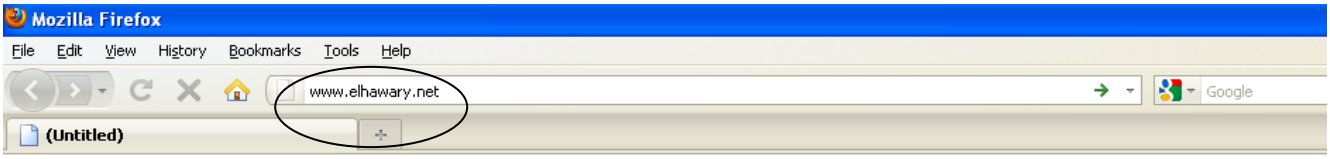
Yield Advantage net return of sequence "*a*"= (11938 - 4543) – (9325 - 3522)= **1592.5 LE/F.**

It means ,if the farmer grown the relay intercropping, he will get the net return of the compared sequence plus **1592.5** LE/F.

Web application for the formulas of sequences systems evaluation .

For the easy usage of the sequence systems evaluation formulas, a web application has been designed on the website **“** **www.elhawary.net** “ . The web application can be used if the following steps have been applied .

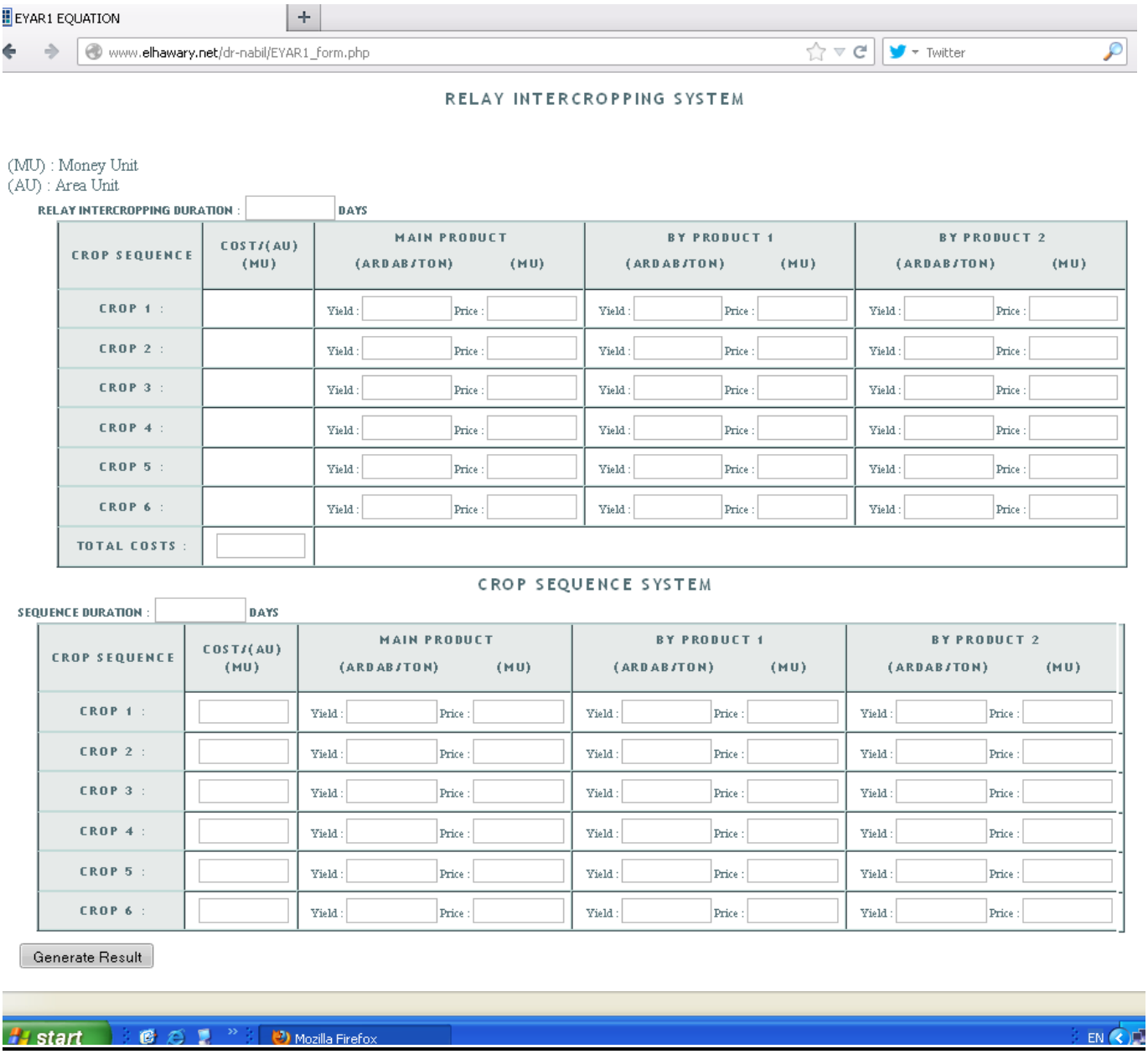
Step1 . Open the web page and Type "www. elhawary.net ". Then press Enter Button .



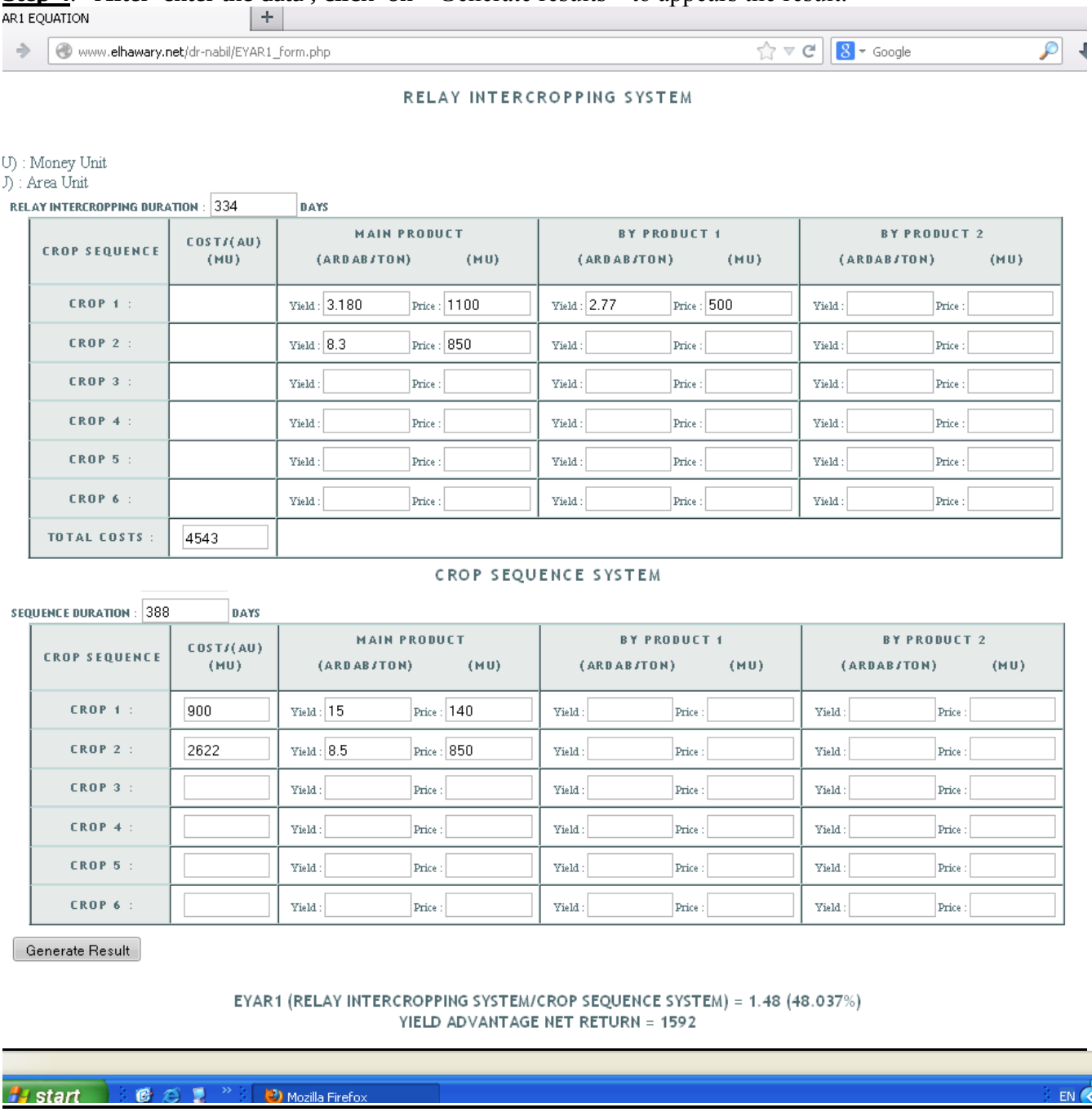
Step2 . After pressing the Enter Button , the website page will appear as follows :

Step 3. Find formulas icons or formula name , for example **$EYER_1$** equation, press on it . The

formula page will appear containing the table in which the data will be entered in it



Step 4. After enter the data , click on " Generate results " to appears the result.



Important Note: Do not Type any thing in the empty cells and leave it as is.

2-Evaluation of sequence in comparison with another sequence ($EYER_2$):

Economical Yield Advantage Ratio (sequ/ sequ.) ($EYAR_2$) : (**El-Hawary, 2009**)

$$EYAR_2 = [(\sum_{i=1}^{n} (\sum_{j=1}^{n^-} (Y_{aij} Pr_{aij}) - Co_{ai}))) D_b] [(\sum_{L=1}^{m} (\sum_{k=1}^{m^-} (Y_{bLk} Pr_{bLK}) - Co_{bL})) D_a]^{-1}$$

Economical Yield Advantage Ratio(sequ/ sequ.) as percentage = ((EYAR2) -1)x 100= + %

Formula numerator should be occupied by the wished sequence for evaluation. While the formula denominator should be occupied by the other sequence as a comparing.

n : number of crops pertaining to crop sequence (a) . *n*- : number of main and by products together of the crop . Which n^- varies according to each crop.

Ya_{ij} , Pra_{ij} and Coa_{ij} :Yield, price and production cost (main and by products)of each crop pertaining to crop sequence (a) , respectively.

m: number of crops pertaining to crop sequence (b) . *m*- : number of main and by products together the crop . Which m^- varies according to each crop.

$Y_{b\,LK}$,Pr_{bLK} and Co_{bLK} : Yield, price and production cost (main and by products) of each crop pertaining to crop sequence (b) , respectively.

D_a and D_b : Crop sequence (a) and crop sequence (b) durations by days, respectively. .

$EYAR_2$ value was relative to the net return per day of compared sequence .

The computation of yield advantage net return of evaluated sequence is as follows:

= Net return of evaluated sequence "*a*" - net return of compared sequence "*b*"

Example 2 :

Sequence (a)			
Fba baen :	Yield	price	costs
Seeds:			
Straw	$Y_{b11=}$ 1.477 Ton/Fed..	$Pr_{b11=}$1800 LE/Ton	
	Y_{b12} = 1.362 Ton/F.	Pr_{b12} = 134 LE/Ton	$Co_{b1=}$1841 LE/Fed
Summer maize :			
Geains:	$Y_{b21=}$ 4.02 Ton/F	Pr_{b21} =967 LE/Ton	Co_{b2} =2484LE/fed
Straw:	Y_{b22}= 2.913 Ton/F	Pr_{b22}= 127 LE/F	
Duration	$D_{b=}$352 days		
Sequence (b) (Traditional sequence)			
	Yield	price	costs
Faba bean:			
Seeds:	$Y_{a11=}$1.503 Ton/Fed..	$Pr_{a11=}$1800 LE/Ton	Co_{a1}=1800 LE/Fed
Straw:	$Y_{a12=}$ 1.530 Ton/Fed	Pr_{a12}=134 LE/Ton	
Summer Maize:			
Grains:	$Y_{a21=}$4.137 Ton/Fed..	$Pr_{a21=}$967 LE/Ton	Co $_{a2}$=1838 LE/fed
Straw:	$Y_{a22=}$ 3.120 Ton/Fed.	Pr_{a22} =127 LE/ Ton	
Fall Maize:			
Grains:	$Y_{a31=}$2.085 Ton/Fed..	$Pr_{a31=}$ 967 LE/Ton	Co_{a3} =1950 LE/F.
Straw:	$Y_{a32=}$ 3.234 Ton/Fed.	Pr_{a32} =127 LE/ Ton	
Duration	$D_{a=}$418 days		

Economical Yield Advantage Ratio $_{(sequ/\ sequ.)}$ ($EYAR_2$)

= [(((1.477x1800 + 1.362 x134 -1841) + (4.02x967+2.913x127 – 2484)) 418] [((1.503 x 1800 +1.530x134-1800) + (4.137x 967 + 3.12x127-1838)+(2.085x967+3.234x127-1950)) 352] $^{-1}$ =

= [7.878974 (Net return /day of sequence (a))][9.614957 (Net return /day of sequence (b))]$^{-1}$ =

$EYAR_2$ = (7.87897 / 9.9187) = 0.7943

$EYAR_2$ as percentage = ((EYAR2) -1)x 100= (0.7943-1)x 100= **-20.565** %

$EYAR_2$ value observed that the net return per day of evaluated sequence was lower than the net return per day of the compared sequence (b) by20.565 % .

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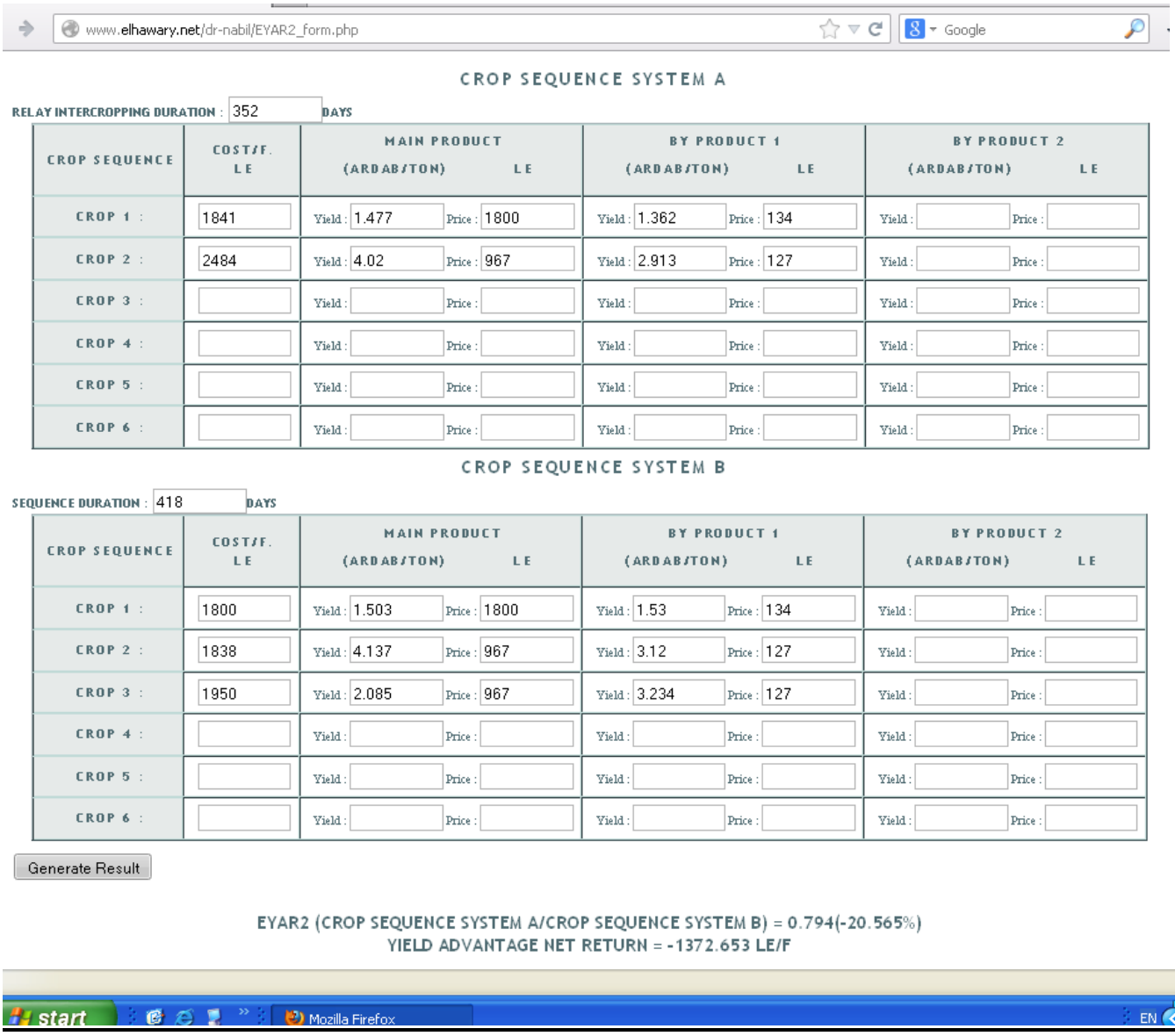
Yield Advantage (or disadvantage) net return of sequence "*a*" :

=(7098.399 – 4325) - (9734.052- 5588)= **-1372.653LE/F.**

It means ,if the farmer grown sequence (a) , he will lose **1372.6**531 LE from the net return of the compared sequence .



3-Evaluation of a sequence in comparison with relay intercropping system($EYAR_3$) :

Economical Yield Advantage Ratio $_{(sequ/\ relay.)}$ ($EYAR_3$) : (**El-Hawary, 2009**)

$$EYAR_3 = [\sum_{i=1}^{n}(\sum_{j=1}^{n^-}(Y_{aij}\,Pr_{aij}) - Co_{ai}))\,D_b\,][(\sum_{L=1}^{m}(\sum_{k=1}^{m^-}Y_{bLk}\,Pr_{bLk}) - \sum_{L=1}^{m}Co_{bj})\,D_a]^{-1}$$

Economical Yield Advantage Ratio$_{(sequ/\ relay.)}$ as percentage = (($EYAR_3$) -1)x 100= $\pm$ %

For applying the EYAR3 equation ,the sequence that wished to evaluation should be occupied the formula numerator , while the relay intercropping that used as a comparing should be occupied the denominator of formula .

n : number of crops pertaining to crop sequence (a) . *n*- : number of main and by products together of the crop . Which n^- varies according to each crop.

Ya_{ij} , Pra_{ij} and Coa_{ij} :Yield, price and production cost (main and by products)of each crop pertaining to crop sequence (a) , respectively.

m: number of crops pertaining to crop sequence (b) . *m*- : number of main and by products together the crop . Which m^- varies according to each crop.

$Y_{b\ LK}$,Pr_{bLK} and Co_{bLK} : Yield, price and production cost (main and by products) of each crop pertaining to crop sequence (b) , respectively.

D_a and D_b : Crop sequence (a) and crop sequence (b) durations by days, respectively. .

$EYAR_3$ value was relative to the net return per day of compared sequence(b) .

The computation of yield advantage net return of evaluated sequence is as follows:

= Net return of evaluated sequence "*a*" - net return of compared sequence "*b*"

4-Evaluation of relay intercropping comparing with another relay intercropping system ($EYAR_4$):

Economical Yield Advantage Ratio (relay/ relay.) (EYAR4) : (**El-Hawary, 2009**)

$$EYAR_4 = [(\sum_{i=1}^{n} (\sum_{j=1}^{n-} Y_{aij}\, Pr_{aij}) - \sum_{i=1}^{n} Co_{ai})\, D_b][(\sum_{L=1}^{m} (\sum_{k=1}^{m-} Y_{bLK}\, Pr_{bLk}) - \sum_{L=1}^{m} Co_{bL})\, D_a]^{-1}$$

Economical Yield Advantage Ratio $_{(relay/\ relay.)}$ as percentage = (($EYAR_4$) -1)x 100= $\pm$ %

For applying the $EYAR_3$ equation ,the relay intercropping that wished to evaluation should be occupied the formula numerator , while the relay intercropping that used as a comparing should be occupied the denominator of formula .

n : number of crops pertaining to crop sequence (a) . *n*- : number of main and by products together of the crop . Which n^- varies according to each crop.

Ya_{ij} , Pra_{ij} and Coa_{ij} :Yield, price and production cost (main and by products)of each crop pertaining to crop sequence (a) , respectively.

m: number of crops pertaining to crop sequence (b) . *m*- : number of main and by products together the crop . Which m^- varies according to each crop.

$Y_{b\ LK}$,Pr_{bLK} and Co_{bLK} : Yield, price and production cost (main and by products) of each crop pertaining to crop sequence (b) , respectively.

D_a and D_b : Crop sequence (a) and crop sequence (b) durations by days, respectively. .

$EYAR_4$ value was relative to net return per day of compared sequence(b) .

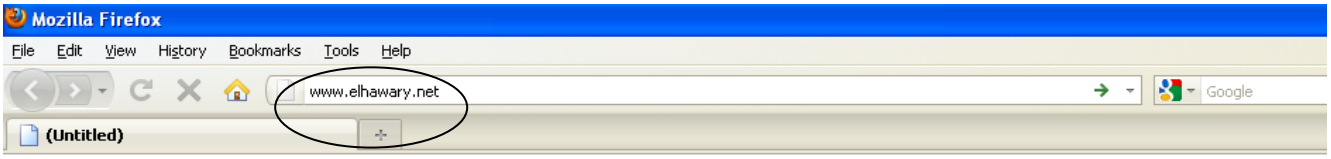
The computation of yield advantage net return of evaluated sequence is as follows:

= Net return of evaluated sequence "*a*" - net return of compared sequence "*b*"

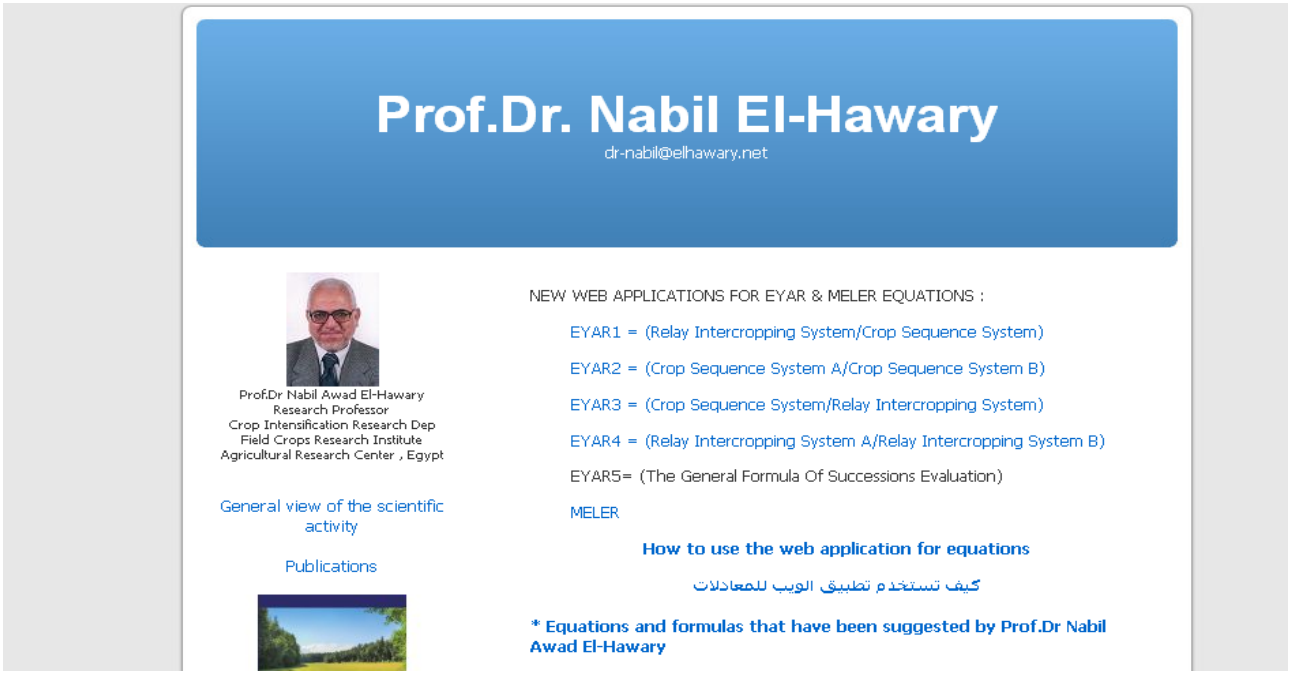
Web application for the formulas of intercropping systems evaluation .

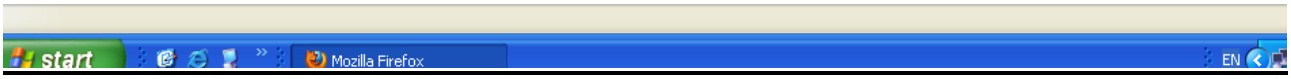
من أجل استخدام الصيغ الخاصه بتقييم نظم التعاقب فإنه تم تصميم صفحه ويب على الموقع www.elhawary.net " ويمكن إستخدام صفحه الويب بإتباع الخطوات التاليه :

الخطوه 1 : إفتح صفحه الويب بكتابه اسم الموقع ". www. elhawary.net" ثم إضغط على زر إدخال .

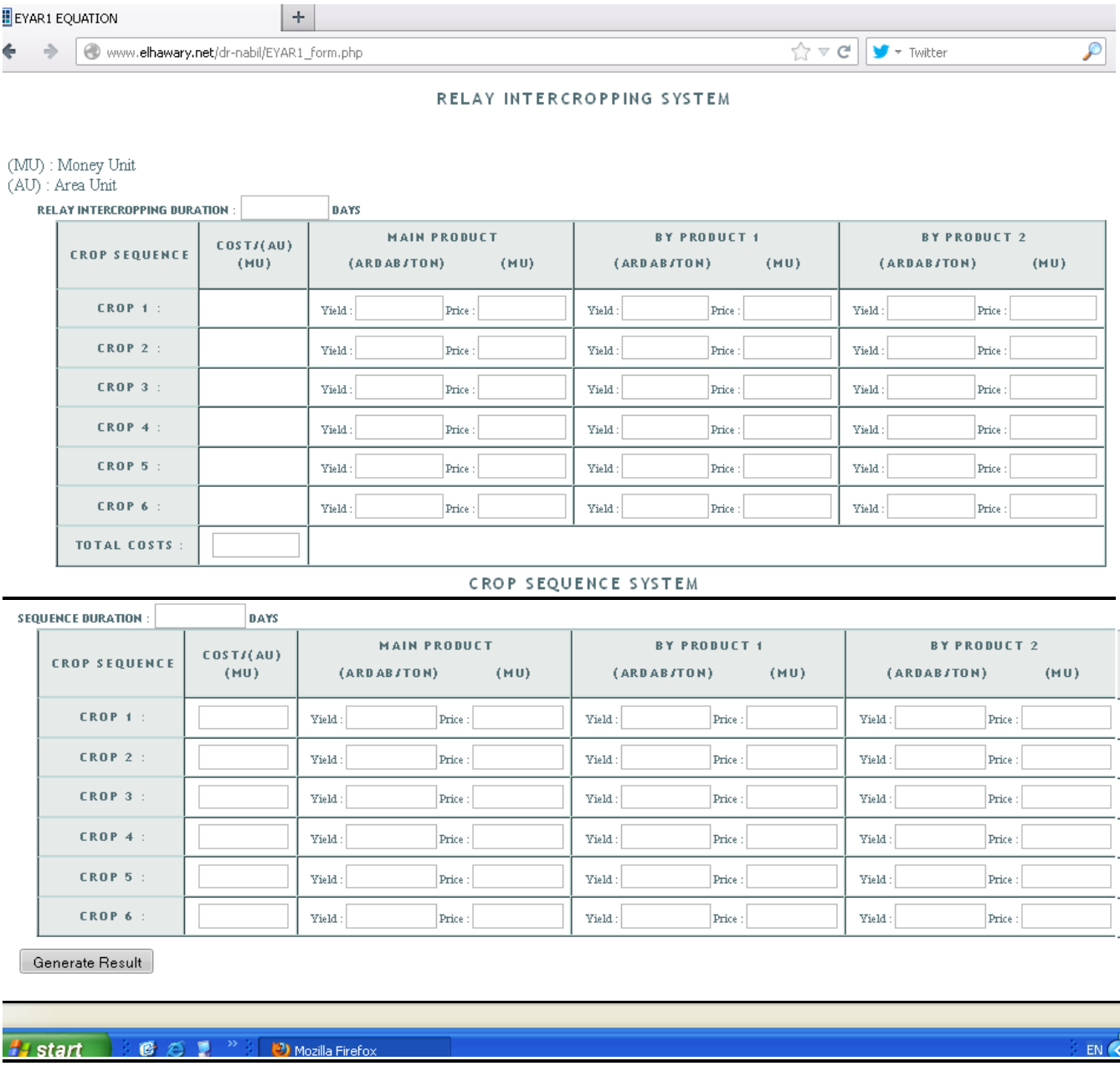


الخطوه 2: بعد الضغط على زر ادخال سوف تظهر الصفحه التاليه :

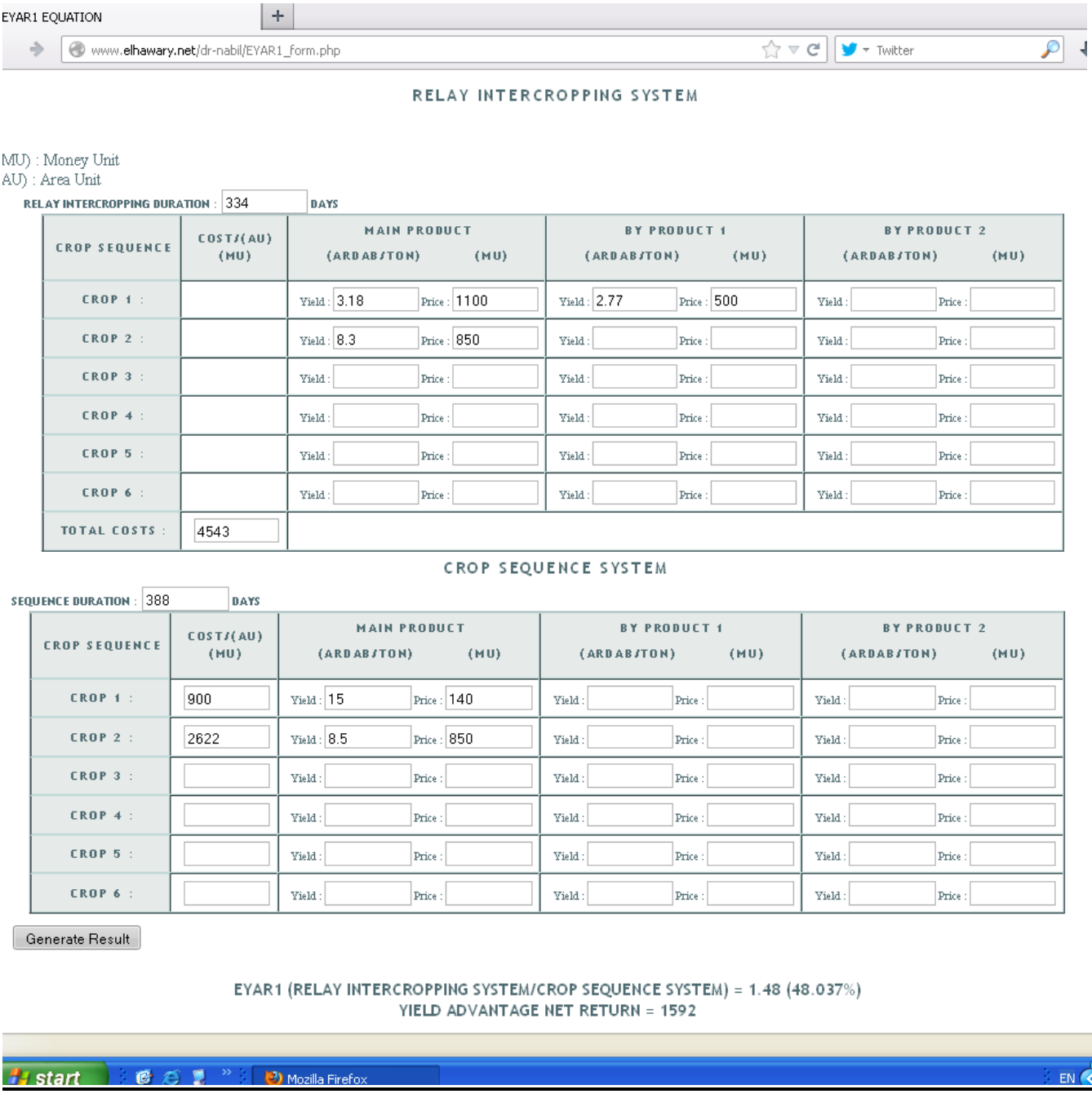




الخطوه3: إبحث عن إ سم المعادله " على سبيل المثال معادله $EYER_1$ إضغط عليه سوف تظهر لك صفحه المعادله محتويه على الجدول التى سيتم إدخال البيانات فيه .



الخطوه 4: إدخل الأرقام فى الخانات المخصصه وأترك باقى الخانات بالجدول كما هى فارغه . بعد إدخال البيانات إضغط على " Generate results " لكى تظهر النتيجه .



الخطوه 5: عند الذهاب لمعادله اخرىارجع الى الصفه الرئيسيه ثم إضغط على إسم المعادله وسوف تظهر صفحه المعادله .

الخطوه 6 : يمكن إتباع الخطوات السابقه لأستخدام أى من المعادلات الموجوده على الموقع .

References:

2-El-Hawary, N.A . 2009 : Formulas for relay intercropping and crop sequence systems evaluation . *J. Appl. Sci. Res.* 5(12) : 2074-2082 .

3-El-Hawary, N.A. 2011 : Formulas for economic evaluation of intercropping systems . "Economic evaluation from the perspective of crop intensification."Book ,128 pages. Publisher :LAP LAMPERT Academic Publishing , (August 22, 2011) ,Germany ..ISBN: 978-3-8454-0246-8 .