Economic evaluation of simultaneous intercropping systems from the perspective of crop intensification .

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Crop Intensification systems are the most important systems that are 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 point of view if adoption of one or another of intercropping system is recommended.

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

These equations has included the factors that intervene in the agricultural process, that is affecting the final production of the system and also the economic return to land for calculating 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 .

Simultaneous intercropping system:

An equation for evaluating the different systems of simultaneous intercropping has been established by **El-Hawary 1993** , on the basis of biological yield and economic parameters to determine the **E**conomic **L**and **E**quivalent **R**atio ($ELER_1$) as follows:

$$\mathbf{ELER_1 = (Y_{a1} \times Y_a^{-1}) + (Y_{a2} \times P_{r2})\ (Y_o \times Pry)^{-1} + (C_o - C_1)\ (Y_o \times Pry)^{-1}}$$ (EL-Hawary , 1993).

Y_o =Yield / Fadden of the crop that substituted by intercropping crops and , also, is one of the crops that used in the intercropping (Yo =Y_a)
Y_{a1} = The production of the major intercropped crop..
Y_a = The production of the same major crop cultivated alone .
P_{ry} = The price of the production unit of y_o .
Y_{a2} = The production of the secondary intercropped crop.
P_{r2} = The price of the production unit of y_{a2} .
C_o = Total costs of y_o .
C_1 = Total costs of intercropping (included : fertilizers , labors , pesticide control , seeds …..etc.)

Where $ELER_1$ value is the productivity of the intercropped yield compared to the substituted crop.

If the substituted crop was differed from either of the two intercropped crops , the following equation is adopted :

$$\mathbf{ELER_2 = (Y_{a1} \times P_{r1})(Y_{o2} \times P_{ry})^{-1} + (Y_{a2} \times P_{r2}))(Y_{o2} \times P_{ry})^{-1} + (C_o - C_1))(Y_{o2} \times P_{ry})^{-1}}$$
(EL-Hawary , 1993).

Where :
Y_{o2} = Expected yield / Fadden of the crop that exchanged by intercropping crops (tomato , for example…etc.)

Ya_1 = The production of the first crop .
Ya_2 = The production of the second crop .
Pry = The price of the production unit of yo2 .
Pry & Pr_2 = are the prices of the production unit of first and second crops , respectively .
Co & C_1 =are total costs of yo2 and the intercropping yield, respectively .

Where $ELER_2$ values is the productivity of the intercropped yield compared to the substituted crop .

Modified Economic Land Equivalent Ratio equation **(MELER):**

ELER equations have been established since 1993 . These equations have been limited to some extent. Therefore, these equations have been modified in a single equation combine advantages of both equations with more possibilities . Modified Economic Land Equivalent Ratio equation (**MELER** equation) is as follows :

MELER = A/O + B/O +C/O (**El-Hawary, 2011**)

Where :

A : first or major crop . B: Secondary crops . O : Monoculture crop (traditional crop or compared crop)

$$A = \left(\sum_{L=1}^{m^-} Y_{aL} \, Pr_{aL} \right) \quad , \quad C = \left(C_o - C_1 \right)$$

$$B = \left(\sum_{K=1}^{n} \left(\sum_{L=1}^{n^-} Y_{bkL} \, Pr_{bkL} \right) \right) \quad , \quad O = \left(\sum_{L=1}^{m} Y_{oL} \, Pr_{oL} \right)$$

and :

n , m^- , n^- and m : Number of secondary crops ,the total number of main and by products together of first or major crop , secondary crop and monoculture crop (or substituted by intercropping crops) , respectively . where n^- varies according to each crop (where $n^- = nk$)

Y_{aL} , Y_{bkL} and Y_{oL} : Yield /F. of main and by products of first or major crop , secondary crop (s) and monoculture crop (or substituted by intercropping crops) , respectively .

Pr_{aL} , Pr_{bkL} and Pr_{oL} : Price of production unit of main and by products of first or major crop , secondary crop (s) and monoculture crop (or substituted by intercropping crops) , respectively .

C_o and C_1 : Total costs of monoculture crop (or substituted by intercropping crops) and the intercropping crops , respectively .

The computation of the intercropping advantage net return is as follows:

=Gross income of the compared crop x (MELER value (of the treatment) -1)

The computation of the total net return is as follows:

= (Gross income of the compared crop – cost) + (Net return of the intercropping advantage of the treatment) .

Modified Economic Land Equivalent Ratio (MELER) equation has included the factors that affecting the final production of the system and also the economic return to land . The economic returns of such systems compared with the traditional methods used by farmers are the reference to the profit or loss and thus the success or failure of the proposed system . One of the features proposed equations 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 through the market prices .

Economic evaluation by using MELER equation :

MELER equation value is the productivity of the intercropped yield compared to the sole or substituted crop (s).

Example

Monoculture crop or substituted crop		Systems	First or major crop		Secondary crops		Costs/F LE/F	
Yield	Price LE/ P.U		Yield Ardab (ton)/F	Price LE/ P.U	Yield Ardab (ton)/F	Price LE/ P.U	C_o	C_1
1- Maize 24.8 ardab/F.	175	2:2	19.3 M	175	0.80 S	2500	3470	3810
		2:4	13.2 M	175	1.20 S	2500		
2- Soybean 1.50 Ton/F.	2500	2:2	0.80 S	2500	19.3 M	175	3165	3810
		2:4	1.20 S	2500	13.2 M	175		
3-Rice . 3.5 ton/F.	1900	2:2	19.3 M	175	0.80 S	2500	4150	3810
		2:4	13.2 M	175	1.20 S	2500		

M : Maize . S : Soybean . P.U : Production Unit . C_o and C_1 : Total costs of monoculture and intercropping crops , respectively .)
(In this example :n = 1 ,n^-= 1,m^- =1 ,m =1)

1-a : If the intercropping system is **2M:2S** and the substituted crop (Y_{oL}) was **Maize** :
MELER = (19.3x175)(24.8x175)$^{-1}$ + (0.8 x 2500) (24.8 x175)$^{-1}$ +(3470-3810) (24.8x175)$^{-1}$

MELER = 0.7782 + 0.4608 +(-0.07834) = **1.161 (16.071%)**

Intercropping advantage net return= (24.8x175) (1.161 -1)= 4340 x.161 = **697.5 LE/F**

Total net return of treatment = 4340 – 3470 + 697.5 = **1567.5 LE/F**

1-b : If the intercropping system is **2M:4S** and the substituted crop (Y_{oL}) was **Maize** :

MELER = $(13.2x175)(24.8x175)^{-1} + (1.20 \times 2500)(24.8 \times 175)^{-1} + (3470-3810)(24.8x175)^{-1}$

MELER = 0.532 + 0.691 +(-0.0783) = **1.1451**

Intercropping advantage net return= (24.8x175) (1.1451 -1)= 4340 x.145 = **630.0 LE/F**

Total net return of treatment = 4340 – 3470 + 630.0 = **1500.0 LE/F**

2-a : If the intercropping system is **2M:2S** and the substituted crop (Y_{oL}) was **Soybean:**

MELER = $(0.8x2500)(1.50x2500)^{-1} + (19.3 \times 175)(1.50 \times 2500)^{-1} + (3165-3810)(1.50x800)^{-1}$

MELER = 0.533 + 0.901 + (-0.172) = **1.262**

Intercropping advantage net return= (1.5x2500) (1.262 -1)= 3750 x.262 = **982.50 LE/F**

Total net return of treatment = 3750 – 3165 + 982.5 = **1262.5 LE/F**

2-b : If the intercropping system is **2M:4S** and the substituted crop (Y_{oL}) was **Soybean**:

MELER = $(1.20x2500)(1.50x2500)^{-1} + (13.20 \times 175)(1.50 \times 2500)^{-1} + (3165-3810)(1.50x2500)^{-1}$

MELER = 0.800 + 0.6160 + (-0.174) = **1.244**

Intercropping advantage net return= (1.5x2500) (1.244 -1)= 3750 x.244 = **915.0 LE/F**

Total net return of treatment = 3750 – 3165 + 915.0 = **1195.0 LE/F**

3-a : If the intercropping system is **2M:2S** and the substituted crop (Y_{oL}) was **Rice :**

MELER = $(19.3 \times 175)(3.5x1900)^{-1} + (0.98 \times 2500)(3.5x1900)^{-1} + (4150-3810)(3.5x1900)^{-1}$

MELER = 0.508 + 0.301 + 0.0511 = **0.8597 (- 14.03 %)**

Explanation of the results of the previous example :

1-MELER value is relative to the yield of the compare crop or that substituted by the intercropping system. The comparisons should be made between MELER values have the same compared crop.

2- It is not permitted comparison between the MELER equation values relative to different compared crops .In the previous example , find that the number of the equation output 1.161 attributed to the maize crop and the resulting number 1.262 attributed to soybean crop, but when you compare them,

should refer to the total net return of for each intercropping system. Where we find that the value that attributed to maize crop (1567.5 LE/F) is better than that attributed to soybean crop (1262.5 LE/F) .

3 - As in the comparative crop such as rice as in the previous example, it is not recommended the farmer to cultivation the intercropping system instead of rice because it will get a gross income lower by 14. 03 % than rice gross income .

From the previous example, it can be noticed that MELER values had bean influenced by the intercropping system, crops costs and the productivity of the intercropped crops and more sensitive than LER. High values of MELER means that the best intercropping system for using. One of the features proposed equations 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 through the market prices .

Another example :

Intercropping patterns	Costs LE/F	Intercropping wheat with sugar beet							
		Sugar beet				wheat			
		Root		Top		Grains		Straw	
		Yield T/F	Price LE/T	Yield T/F	Price LE/T	Yield T/F	Price LE/T	Yield T/F	Price LE/T
100% SB on ridges	4460	31.900	348.21	12.08	90	-	-	-	-
100% SB on beds	4460	29.655	345.12	10.64	90	-	-	-	-
Average of two seasons									
Ridges									
100%SB+ 50% WH	5015	21.00	324.5	8.6	90	2.29	2300	3.408	400
100%SB+ 25%WH	4738	24.75	340.58	10.6	90	1.88	2300	2.871	400
100%SB+ 16.6 %WH	4644	26.75	344.3	11.3	90	1.66	2300	2.652	400
100%SB+ 12.5 %WH	4599	28.75	351.31	12.1	90	1.38	2300	2.316	400

(In this example : :n = 1 ,n^{-}=2,m^{-} =2 ,m =2

Data of 100% sugar beet planted on ridges as a compared crop and treatment of 100%SB + 50% wheat planted on ridges from the previous table will be used to apply MELER equation as an example as follows:

MELER value = [(21.00 x 324.5 + 8.6 x 90) + (2.29 x 2300 + 3.408x 400)+ (4460- 5015)](31.9x348.21+12.087x90)$^{-1}$ =1.1203 (+12.03 %)

MELER values of 100SB+50% wheat = +12.03% yield over the yield of the compared crop (100 % SB planted on ridges).

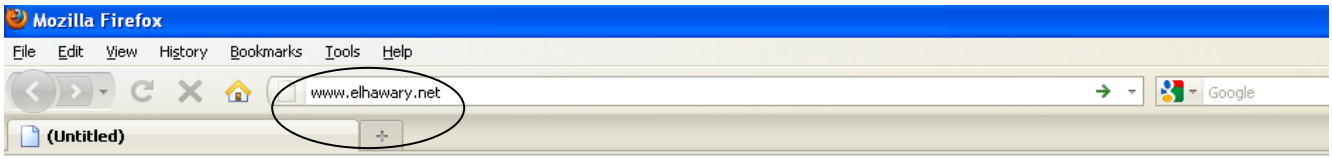
Intercropping advantage net return = 12195.75 x 0.1203 = 1467.97 LE/F

Total net return = (12195.75 – 4460)+ 1467.97 = 9203.72 LE/F.

Web application for the formulas of intercropping systems evaluation .

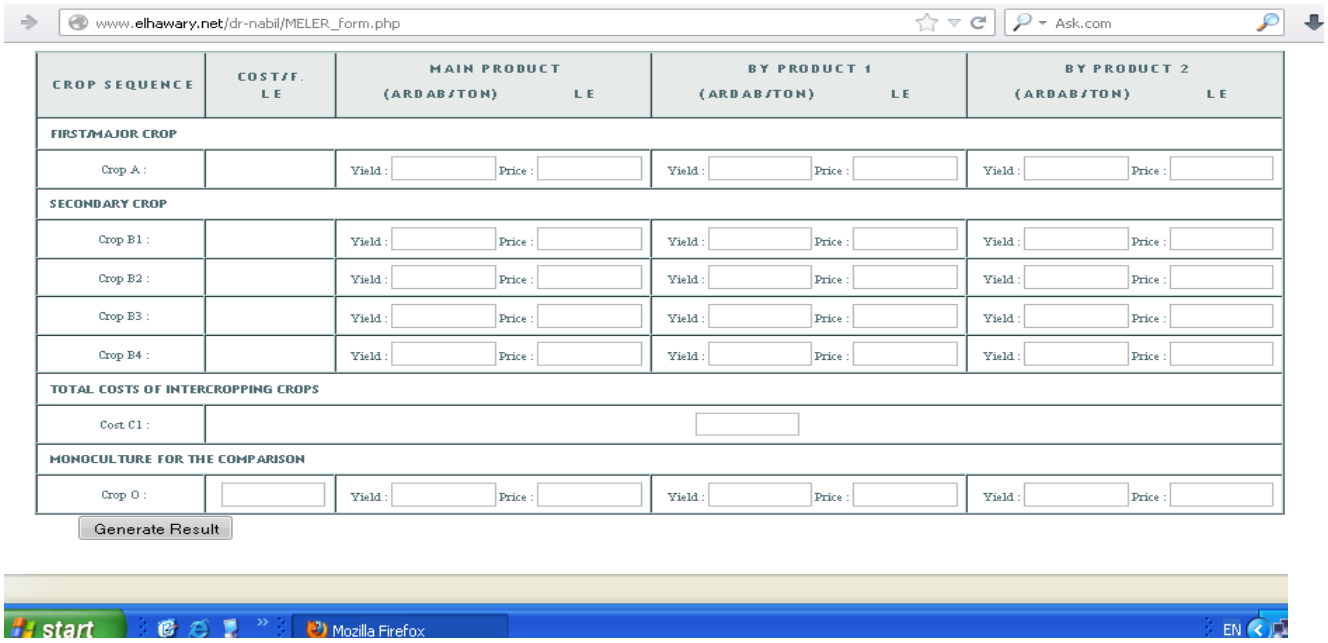
For the easy usage of the intercropping systems evaluation formulas, a web application has been designed on the website **“** **www.elhawary.net** “ . The web application can be used if the following steps have been applied .

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

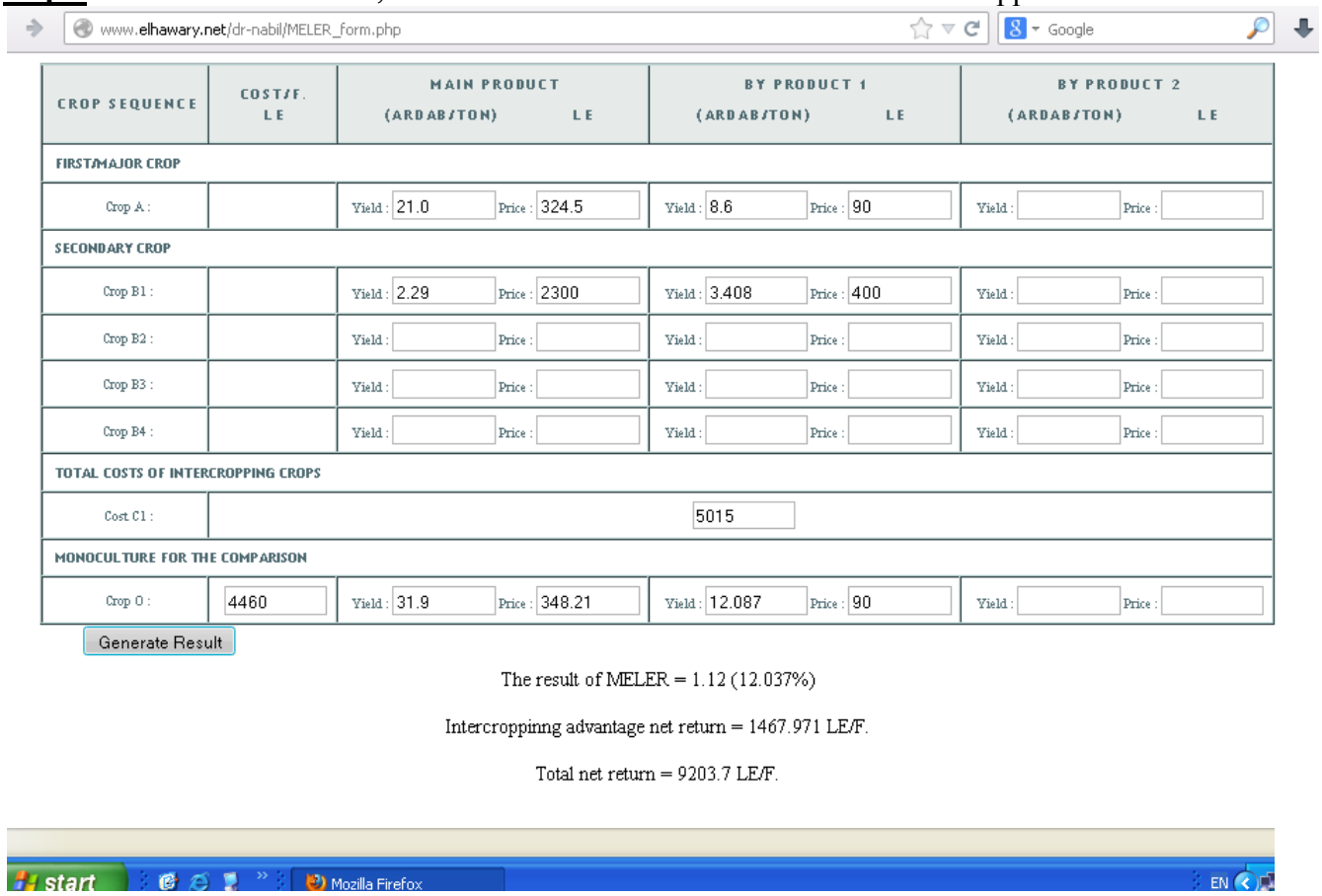


Step2 . After pressing the Enter Button , the website page will appear as follows :

Step 3. Find formulas icons or formula name , for example **MELER** 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 the Button named " Generate results " to appears the result.

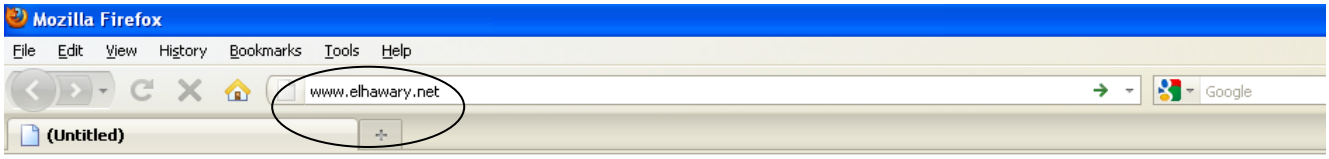


Important Note: Do not Type any thing in the empty cells and leave it as is.

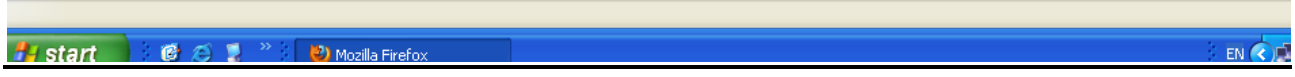
Web application for the formulas of intercropping systems evaluation .

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

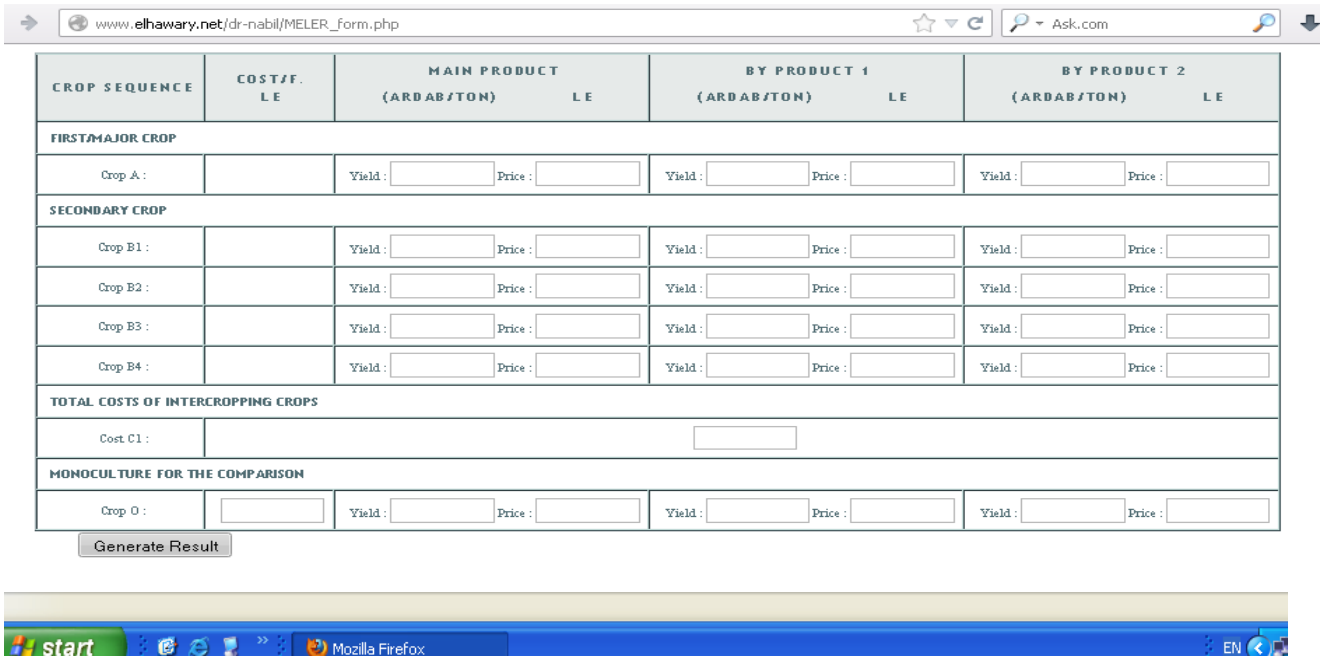
الخطوه 1 : إفتح صفحه الويب بكتابه اسم الموقع ". www. elhawary.net" ثم إضغط على زر إدخال .



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



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

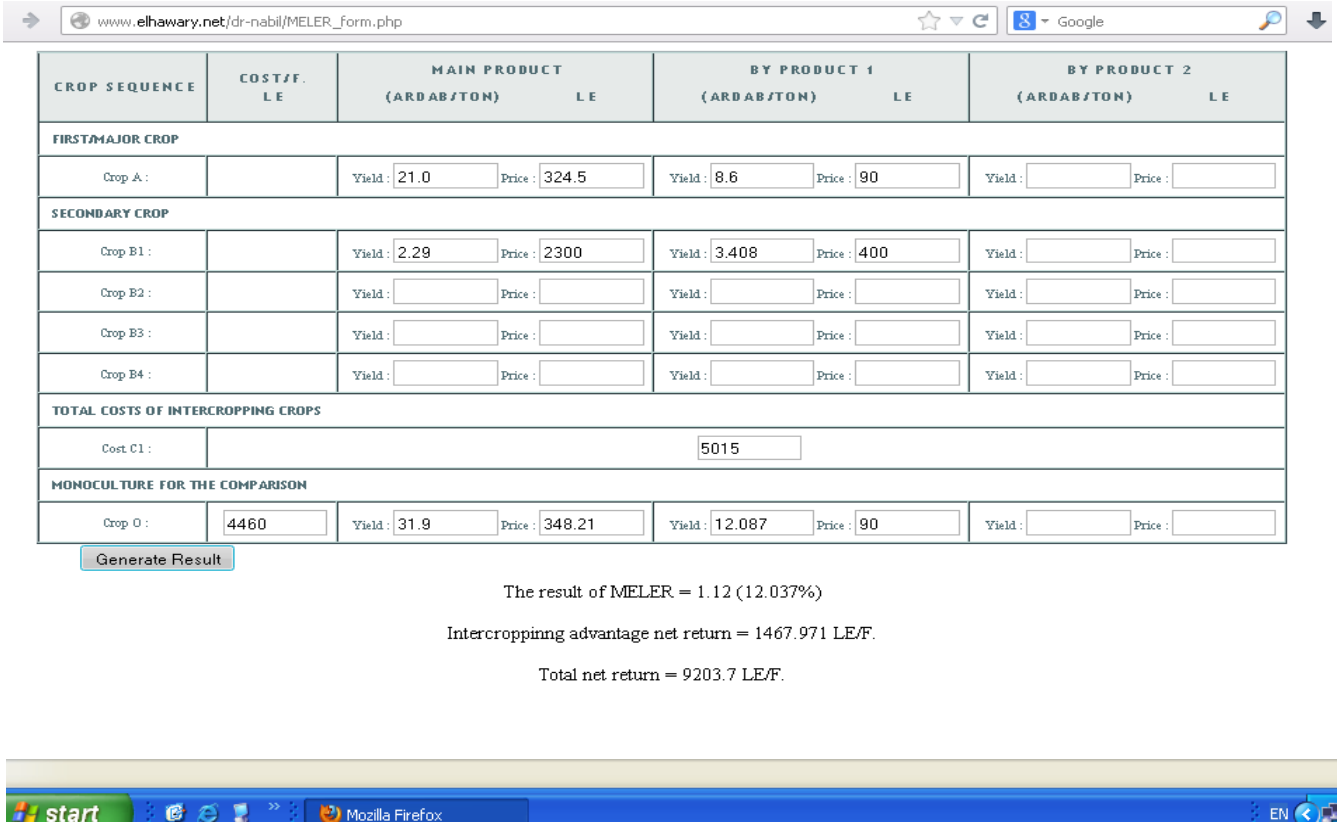


www.elhawary.net/dr-nabil/MELER_form.php

CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE	BY PRODUCT 1 (ARDAB/TON) LE	BY PRODUCT 2 (ARDAB/TON) LE
FIRST/MAJOR CROP				
Crop A :		Yield : Price :	Yield : Price :	Yield : Price :
SECONDARY CROP				
Crop B1 :		Yield : Price :	Yield : Price :	Yield : Price :
Crop B2 :		Yield : Price :	Yield : Price :	Yield : Price :
Crop B3 :		Yield : Price :	Yield : Price :	Yield : Price :
Crop B4 :		Yield : Price :	Yield : Price :	Yield : Price :
TOTAL COSTS OF INTERCROPPING CROPS				
Cost C1 :				
MONOCULTURE FOR THE COMPARISON				
Crop O :		Yield : Price :	Yield : Price :	Yield : Price :

Generate Result

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



www.elhawary.net/dr-nabil/MELER_form.php

CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE	BY PRODUCT 1 (ARDAB/TON) LE	BY PRODUCT 2 (ARDAB/TON) LE
FIRST/MAJOR CROP				
Crop A :		Yield : 21.0 Price : 324.5	Yield : 8.6 Price : 90	Yield : Price :
SECONDARY CROP				
Crop B1 :		Yield : 2.29 Price : 2300	Yield : 3.408 Price : 400	Yield : Price :
Crop B2 :		Yield : Price :	Yield : Price :	Yield : Price :
Crop B3 :		Yield : Price :	Yield : Price :	Yield : Price :
Crop B4 :		Yield : Price :	Yield : Price :	Yield : Price :
TOTAL COSTS OF INTERCROPPING CROPS				
Cost C1 :		5015		
MONOCULTURE FOR THE COMPARISON				
Crop O :	4460	Yield : 31.9 Price : 348.21	Yield : 12.087 Price : 90	Yield : Price :

Generate Result

The result of MELER = 1.12 (12.037%)

Intercroppinng advantage net return = 1467.971 LE/F.

Total net return = 9203.7 LE/F.

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

References:

1-El-Hawary , N. A. 1993 .Evaluation of some intercropping systems of maize with soybean . *J.Agric. Sci. Mansoura Univ*. 18(11) : 3156-3165 .

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 .

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