

**The general formula for economic evaluation of the crop sequence from the perspective of crop intensification.**

Formulas for relay intercropping and crop sequence evaluation based on biological and economical parameters from crop intensification perspective were established by El-Hawary , 2009 . At the same time as predictive formulas to predict the success of intensive crop systems from farmer 's perspective .

The formulas that suggested were based on two probabilities ,first , that the total area time land occupied during the agriculture year was occupied by the monoculture crop sequence ,and second ,that the total area time land occupied during the agriculture year was occupied by the relay intercropping system .

However , there is a third probability that did not consider , planting monoculture crop followed by simultaneous intercropping ( or relay intercropping ) system or vs. . So, new formula to compute the net return of area time land occupied of crop sequence included monoculture crop followed by simultaneous intercropping ( or relay intercropping ) system or vs. was established as follows: :

$$NR = \left( \sum_{L=1}^m \left( \sum_{k=1}^{mL} (Y_{nlk} Pr_{nlk}) - C_{o_{nL}} \right) \right) + \left( \sum_{i=1}^n \left( \sum_{j=1}^{ni} Y_{nij} Pr_{nij} \right) - \sum_{i=1}^n C_{o_{ni}} \right)$$

↑ **monoculture crop(s)** ↑
↑ **simultaneous (or relay) intercropping system** ↑

Where :

$m$  : number of monoculture crops pertaining to crop sequence . $mL$  :the total number of main and by-products together of the monoculture crop available for every  $L$  (where  $L$  is monoculture crop).

$n$ : number of simultaneous or relay intercropping crops pertaining to crop sequence .  $ni$  : the total number of main and by-products together of the intensive crop available for every  $i$  (where  $i$  is intensive crop ).

$Y_{nlk}$  ,  $Pr_{nlk}$  and  $Co_{nlk}$  :Yield, price and production cost ( main and by- products ) of each crop of traditional sequence ( monoculture crops) , respectively.

$Y_{nij}$  ,  $Pr_{nij}$  and  $Co_{nij}$  :Yield, price and production cost ( main and by-products ) of each crop of intensive sequence , respectively.

$$\sum_{i=1}^n Co_{ni} = \text{Total costs of intensive sequence .}$$

The agricultural year was considered 365 days. The duration by days of crop sequence was accounted from the planting date of the first crop planting until the harvesting date of the last crop and will be called Area Time Land Occupied. So ,the duration of crop sequence must be taken into considered and the formula become as follows :

$$NR_{/d} \cdot \text{Seq. "n"} (\text{Sequence "n"}) = \left[ \left( \sum_{L=1}^m \left( \sum_{k=1}^{mL} (Y_{nlk} Pr_{nlk}) - Co_{nL} \right) \right) + \left( \sum_{i=1}^n \left( \sum_{j=1}^{ni} Y_{nij} Pr_{nij} \right) - \sum_{i=1}^n Co_{ni} \right) \right] [D_n]^{-1}$$

Where : $NR_{/d} \cdot \text{Seq. "n"}$  : Net return per day of sequence "n" and expressed as ( Sequence "n") .  $D_n$  :the duration by days of the sequence .

The previous formula can evaluate all the possible probabilities of The cropping systems ( monoculture crops sequence , relay intercropping system sequence and monoculture crop followed by simultaneous intercropping system or vs. sequence), in addition to computing the net return per day of the sequence. Hence , it can be called " The general formula for economic evaluation of crop sequence and relay intercropping systems" . The general formula will be used to compute the both successions , where the “ a “will be symbol of the succession to

be evaluated , and the “ *b*” will be symbol of the succession to be used as compared .

According to crop intensification perspective , a comparison should be made between the succession to be evaluated and the traditional sequence to be used as a compared , where the succession to be evaluated takes up the numerator of evaluation equation, while the succession as a compared will be in the denominator of the equation .

The computation of economic yield advantage ratio ( EYAR )of the succession by using the general formula and expressed as EYAR<sub>5</sub> is as follows :

$$EYAR_5 = [NR/d.Seq."a"] [NR/d.Seq."b"]^{-1}$$

$$\text{or } EYAR_5 = [ \text{Sequence "a"} ] [ \text{Sequence "b"} ]^{-1}$$

Where :

$$\text{Sequence "a"} = [ ( \sum_{L=1}^m ( \sum_{k=1}^{mL} (Y_{alk} Pr_{alk}) - Co_{al} ) ) + ( \sum_{i=1}^n ( \sum_{j=1}^{ni} Y_{aij} Pr_{aij} ) - \sum_{i=1}^n Co_{ai} ) ] [D_a]^{-1}$$

$$\text{Sequence "b"} = [ ( \sum_{L=1}^m ( \sum_{k=1}^{mL} (Y_{blk} Pr_{blk}) - Co_{bl} ) ) + ( \sum_{i=1}^n ( \sum_{j=1}^{ni} Y_{bij} Pr_{bij} ) - \sum_{i=1}^n Co_{bi} ) ] [D_b]^{-1}$$

Where :

*m* : number of monoculture crops pertaining to crop sequence .*mL* : the total number of main and by-products together of the monoculture crop available for every *L*( where *L* is monoculture crop) .

*n*: number of simultaneous or relay intercropping crops pertaining to crop sequence . *ni* : the total number of main and by-products together of the intensive crop available for every *i* (where *i* is intensive crop) .

*Y<sub>alk</sub>* , *Pr<sub>alk</sub>* and *Co<sub>alk</sub>* :Yield, price and production cost ( main and by-products ) of each crop of monoculture crops of sequence “*a*” , respectively.

*Y<sub>aij</sub>* , *Pr<sub>aij</sub>* and *Co<sub>aij</sub>* :Yield, price and production cost ( main and by-products ) of each crop of crop sequence “*a*” , respectively.

$Y_{blk}$  ,  $Pr_{blk}$  and  $Co_{blk}$  :Yield, price and production cost ( main and by-products ) of each crop of monoculture crops of sequence “ $b$ ” , respectively.

$Y_{bij}$  ,  $Pr_{bij}$  and  $Co_{bij}$  :Yield, price and production cost ( main and by-products ) of each crop of intensive sequence “ $b$ ” , respectively.

$$\sum_{i=1}^n Co_{ni} = \text{Total costs of intensive sequence .}$$

$D_a$  and  $D_b$  are the durations by days of sequences “ $a$ ” and “ $b$ ”. respectively

$$EYAR_5 = [ \text{NR /day of sequence "a"} ] [ \text{NR /day of sequence "b"} ]^{-1}$$

$$EYAR_5 \text{ value as percentage} = ( EYAR_5 \text{ value} - 1 ) \times 100 = \pm \%$$

So,  $EYAR_5$  value given was relative to the net return per day of sequence that used as compared ( sequence “ $b$ ” ) .

The computation of the yield advantage ( or disadvantage ) net return of sequence “ $a$ ” is as follows :

$$\text{Yield advantage ( or disadvantage ) net return} = \pm \text{LE/F.}$$

$$= ( \text{NR of the evaluated sequence "a"} ) - ( \text{NR of the compared sequence "b"} ) .$$

$$= ( \text{Gross income –total costs of evaluated seq.} ) - ( \text{Gross income –total costs of compared seq.} )$$

**Example 1:**

<b>Sequence "a" (evaluated sequence )</b>			
<b>Monoculture crop</b>			
<b>Crops</b>	<b>Yield</b>	<b>Price</b>	<b>Costs</b>
Crop1 Wheat			
Main product: Grains	$Y_{a11}=3.33$ Ton/fed.	$Pr_{a11}=1133$ LE/ton.	$Co_{a1}=1998.5$ LE/fed.
by-product :Straw	$Y_{a12}=2.77$ Ton/fed.	$Pr_{a12}=500$ LE/ton.	
<b>Simultaneous intercropping system</b>			
Crop2 Maize			
Main product :Grains	$Y_{a21}=2.89$ Ton/fed.	$Pr_{a21}=967$ LE/ton.	
by-product :Straw	$Y_{a22}=2.72$ Ton/fed	$Pr_{a22}=127$ LE/ton.	
Crop3 Soy bean : Seeds	$Y_{a31}=0.8$ Ton/fed	$Pr_{a31}=2500$ LE/ton.	
Total costs	$Co_{a2+3}=3010$ LE/fed		
Duration	$D_a =334$ days.		
<b>Sequence "b" (compared sequence )</b>			
<b>Monoculture crops</b>			
Crop1 Wheat			
Main product :Grains	$Y_{b11}=3.21$ Ton/fed	$Pr_{b11}=1133$ LE/ton	$Co_{b1}=1998.5$ LE/fed
by-product :Straw	$Y_{b12}=3.09$ Ton/fed	$Pr_{b11}=500$ LE/ton	
Crop2 Maize			
Main product :Grains	$Y_{b21}=3.298$ Ton/fed	$Pr_{b21}=967$ LE/ton	$Co_{b2}=2584$ LE/fed
by-product :Straw	$Y_{b22}=2.87$ Ton/fed	$Pr_{b22}=127$ LE/ton	
Duration	$D_b = 298$ days		

(Sequence "a" :where:  $m=1$  and  $mL=2$  for crop1 ,  $n=2$  and  $ni=2$  and 1 for crop2 and crop3 ,respectively. ).(Sequence "b" :where :  $m=2$  and  $mL= 2$  and 2 for crop1 and crop2 ,respectively.)

$$EYAR_5 = [\text{Sequence "a"}] [\text{Sequence "b"}]^{-1}$$

$$\text{Sequence "a"} = (3.33 \times 1133 + 2.77 \times 500 - 1998.5) + ((2.89 \times 967 + 2.72 \times 127) + (0.800 \times 2500) - 3010) [334]^{-1} = 15.837 \text{ LE/day}$$

$$\text{Sequence "b"} = (3.21 \times 1133 + 3.09 \times 500 - 1998.5) + (3.298 \times 967 + 2.87 \times 127 - 2584) [298]^{-1} = 13.936 \text{ LE/day}$$

$$= [15.837 (\text{NR /day of sequence "a"})] [13.936 (\text{NR /day of sequence "b"})]^{-1}$$

$$EYAR_5 \text{ value} = 15.837 / 13.936 = \mathbf{1.1363}$$

$$EYAR_5 \text{ value as percentage} = (1.1363 - 1) \times 100 = \mathbf{+13.635 \%}$$

EYAR<sub>5</sub> value observed that net return per day of evaluated sequence increased by 13.635 % over the net return per day of the compared sequence .

The computation of yield advantage ( or disadvantage) of sequence "a" is as follows : NR of evaluated sequence – NR of the compared sequence.

Yield advantage ( or disadvantage ) net return =

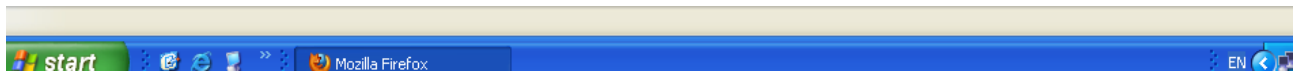
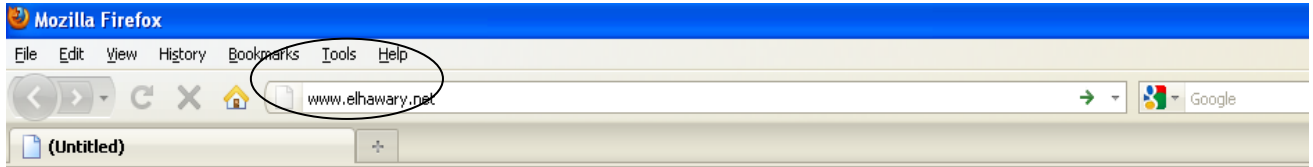
$$= (\text{Gross income –total costs of evaluated seq.}) - (\text{Gross income –total costs of compared seq.}) = (10297.97 - 5008) - (8735.586 - 4582.5)$$

$$= 5289.46 - 4153.086 = \mathbf{+1136.374 \text{ LE/F.}}$$

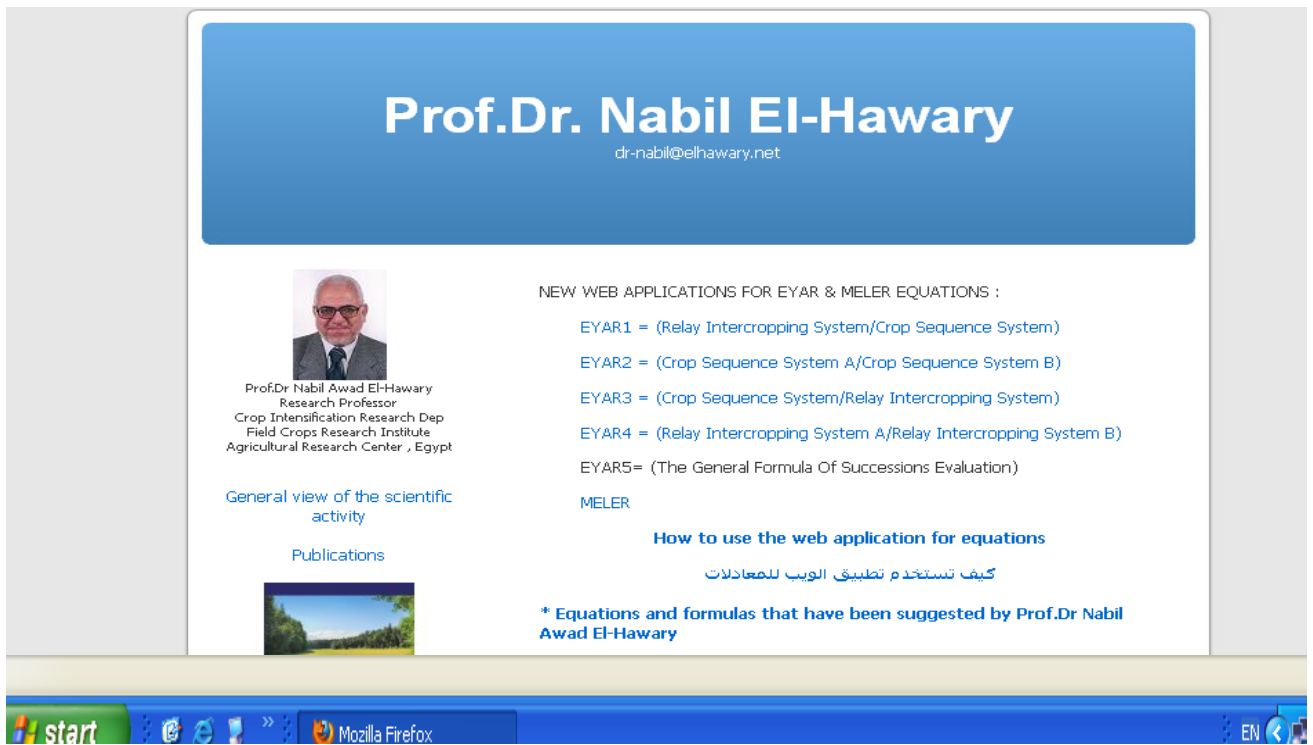
From the previous example , EYAR<sub>5</sub> value showed that the crop sequence “a” that included monoculture crop and simultaneous intercropping system was surpassed sequence “b” by 1136.374 LE/F. over the net return of the compared sequence.

For the easy usage of the previous formula , a web application has been designed on the website “ [www.elhawary.net](http://www.elhawary.net) “. The web application can be used if the following steps have been applied :

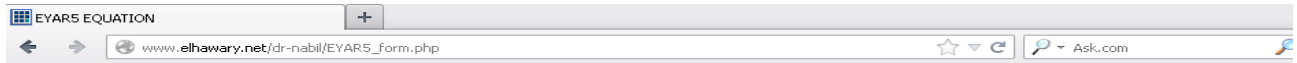
**Step1** . Open the web page and Type "www. Elhawary.net ". Then press Enter Button



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



**Step 3.** Find formula icon or formula name ( EYER<sub>5</sub> ), press on it . The formula page will appear containing the tables in which the data will entered in it



**CROP SEQUENCE SYSTEM A**

SEQUENCE DURATION :  DAYS

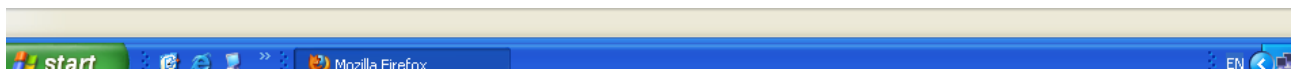
MONOCULTURE CROPS								
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE		
CROP 1 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
SIMULTANEOUS (OR/RELAY) INTERCROPPING								
CROP 1 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
	<input type="text"/>							

**CROP SEQUENCE SYSTEM B**

SEQUENCE DURATION :  DAYS

MONOCULTURE CROPS								
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE		
CROP 1 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
SIMULTANEOUS (OR/RELAY) INTERCROPPING								
CROP 1 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
	<input type="text"/>							

Generate Result





**Step 4.** After enter the data , click the Button named “ Generate results “ to appear the results.

**CROP SEQUENCE SYSTEM A**

SEQUENCE DURATION :  DAYS

MONOCULTURE CROPS								
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE		
CROP 1 :	<input type="text" value="1998.5"/>	Yield : <input type="text" value="3.33"/>	Price : <input type="text" value="1133"/>	Yield : <input type="text" value="2.77"/>	Price : <input type="text" value="500"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
SIMULTANEOUS (OR/RELAY) INTERCROPPING								
CROP 1 :	<input type="text"/>	Yield : <input type="text" value="2.89"/>	Price : <input type="text" value="967"/>	Yield : <input type="text" value="2.72"/>	Price : <input type="text" value="127"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text" value="0.800"/>	Price : <input type="text" value="2500"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
		<input type="text" value="3010"/>						

**CROP SEQUENCE SYSTEM B**

SEQUENCE DURATION :  DAYS

MONOCULTURE CROPS								
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE		
CROP 1 :	<input type="text" value="1998.5"/>	Yield : <input type="text" value="3.21"/>	Price : <input type="text" value="1133"/>	Yield : <input type="text" value="3.09"/>	Price : <input type="text" value="500"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text" value="2584"/>	Yield : <input type="text" value="3.298"/>	Price : <input type="text" value="967"/>	Yield : <input type="text" value="2.87"/>	Price : <input type="text" value="127"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
SIMULTANEOUS (OR/RELAY) INTERCROPPING								
CROP 1 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 2 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 3 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
CROP 4 :	<input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	Yield : <input type="text"/>	Price : <input type="text"/>	
		<input type="text"/>						

EYAR5 (THE GENERAL FORMULA OF SUCCESSIONS EVALUATION) = 1.136(13.635%)  
YIELD ADVANTAGE NET RETURN = 1136.374 LE/F

**Example2:**

Sequence "a" ( relay intercropping system)				
Crop1. Wheat:	Yield	Price	costs	
main product : Grain	$Y_{a11} = 3.33$ Ton/fed.	$Pr_{a11} = 1150$ LE/ton	$Co_{a1} = 2623$	
By-product :Straw	$Y_{a12} = 2.77$ Ton/fed	$Pr_{a12} = 500$ LE/ton.	LE/fed	
Crop2 . Cotton	$Y_{a21} = 8.3$ kentar/fed	$Pr_{a21} = 850$ LE/kentar	$Co_{a2} = 2000$	
Duration	$D_a = 334$ days		LE/fed	
Total costs	4623LE/fed			
Sequence "b" (traditional sequence ) ( compared sequence )				
Crop1. Two –cut clover	$Y_{b1} = 15.5$ Ton/fed.	$Pr_{b1} = 140$ LE/ton.	$Co_{b1} = 1200$ LE/fed	
Crop2. Cotton	$Y_{b2} = 8.6$ kentar/fed.	$Pr_{b2} = 850$ LE/kentar	$Co_{b2} = 2700$ LE/fed	
Duration	$D_b = 388$ days			

(where:  $n = 2$  for sequences  $a$ .  $n_i = 2$  and  $1$  for crop1 and crop2 ,respectively).

( where:  $m = 2$  for sequences  $b$ .  $mL = 1$  and  $1$  for crop1 and crop2 ,respectively).

Sequence "a" =  $[(3.33 \times 1150 + 2.77 \times 500) + (8.3 \times 850) - (2623 + 2000)] [334]^{-1} = 22.89$  LE/d.

Sequence "b" =  $[(15.5 \times 140 - 1200) + (8.6 \times 850 - 2700)] [388]^{-1} = 14.38$  LE/d.

=  $[ 22.8937 ( NR /day \text{ of sequence "a"} ) ] [ 14.3814 ( NR /day \text{ of sequence "b"} ) ]^{-1}$

EYAR<sub>5</sub> value = **1.59189**

EYAR<sub>5</sub> value as percentage =  $(1.592 - 1) \times 100 = + 59.189 \%$

EYAR<sub>5</sub> value given was relative to the net return per day of the compared sequence.

EYAR<sub>5</sub> value observed that net return per day of evaluated sequence increased by 59.189 % over the net return per day of the compared sequence .

The computation of the economic yield advantage net return of sequence “a” is as follows :

**Yield Advantage net return of sequence "a" =**

$$\begin{aligned} &= (\text{Gross income "a"} - \text{Total costs "a"}) - (\text{Gross income "b"} - \text{Total costs "b"}) \\ &= (12269.5 - 4623) - (9480 - 3900) = \mathbf{2066.5 \text{ LE/F.}} \end{aligned}$$

From the previous example , EYAR<sub>5</sub> value showed that the crop sequence “a” that included relay intercropping system was surpassed sequence “b” by 2066.5 LE/F. over the net return of the compared sequence.

The web application can be used if the following steps have been applied :

The web application of the formula :

CROP SEQUENCE SYSTEM A

SEQUENCE DURATION : 334 DAYS

MONOCULTURE CROPS							
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
SIMULTANEOUS (OR/RELAY) INTERCROPPING							
CROP 1 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
		4623					

CROP SEQUENCE SYSTEM B

SEQUENCE DURATION : 388 DAYS

MONOCULTURE CROPS							
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :	1200	Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :	2700	Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
SIMULTANEOUS (OR/RELAY) INTERCROPPING							
CROP 1 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :

Generate Result

EYAR5 (THE GENERAL FORMULA OF SUCCESSIONS EVALUATION) = 1.592(59.189%)  
YIELD ADVANTAGE NET RETURN = 2066.5 LE/F

**Example 3:**

<b>Sequence "a" ( intensive sequence ( evaluated sequence ))</b>			
	Yield	price	costs
Crop1. Mono cut clover	Y <sub>a11</sub> =1 cut 13.665	Pr <sub>a11</sub> =145 LE /ton	Coa1 =679 LE/F
Crop2. Wheat: main product : Grain by product :Straw	Y <sub>a21</sub> = 3.368 Ton/fed	Pr <sub>a21</sub> =1133 LE/ton	Coa2 =1873 LE/F.
	Y <sub>a22</sub> = 3.262 Ton/fed	Pr <sub>a22</sub> =500 LE/ton	
Crop3. S. maize main product : Grain by product :Straw	Y <sub>a31</sub> = 3.508 Ton/fed	Pr <sub>a31</sub> =967 LE/ton	Coa3 =2004 LE/F.
	Y <sub>a32</sub> = 2.881 Ton/fed	Pr <sub>a32</sub> =127 LE/ton	
Duration	D <sub>a</sub> =351 days		
<b>Sequence "b" ( relay intercropping sequence ( compared sequence ))</b>			
Crop1. Wheat: main product : Grain by product :Straw	Y <sub>b11</sub> = 3.205 Ton/fed.	Pr <sub>b11</sub> =1133 LE/ton	Co <sub>b1</sub> =1985.5 LE/fed
	Y <sub>b12</sub> =2.885 Ton/fed	Pr <sub>b12</sub> =500 LE/ton	
Crop2. Cotton	Y <sub>b21</sub> = 8.4 kentar/fed.	Pr <sub>b21</sub> =850 LE/kentar	Co <sub>b2</sub> =2672 LE/fed
Duration	D <sub>b</sub> =335 days		
Total costs			Co <sub>b1</sub> +ba2=4657.5LE/fed

(where:  $m= 3$  for sequences  $a$ .  $mL= 1,2$  and  $2$  for crop1, crop2 and crop3 ,respectively).

(where:  $n= 2$  for sequences  $b$ .  $ni= 2$  and  $1$  for crop1 and crop2 ,respectively).

$$EYAR_5 = [ \text{Sequence "a"} ] [ \text{Sequence "b"} ]^{-1}$$

$$\text{Sequence "a"} = [ ( \sum_{l=1}^m ( \sum_{k=1}^{mL} ( Y_{alk} Pr_{alk} ) - Co_{al} ) ) + ( \sum_{i=1}^n ( \sum_{j=1}^{ni} Y_{aij} Pr_{aij} ) - \sum_{i=1}^n Co_{ai} ) ) ] [ D_a ]^{-1}$$

$$\text{Sequence "b"} = [ ( \sum_{l=1}^m ( \sum_{k=1}^{mL} ( Y_{blk} Pr_{blk} ) - Co_{bl} ) ) + ( \sum_{i=1}^n ( \sum_{j=1}^{ni} Y_{bij} Pr_{bij} ) - \sum_{i=1}^n Co_{bi} ) ) ] [ D_b ]^{-1}$$

$$\text{Sequence "a"} = [(13.665 \times 145 - 679) + (3.368 \times 1133 + 3.2615 \times 500 - 1873) + (3.508 \times 967 + 2.881 \times 127 - 2004)] [351]^{-1} = 18.889 \text{ LE/day}$$

$$\text{Sequence "b"} = [(3.205 \times 1133 + 2.885 \times 500) + (8.4 \times 850) - (1985.5 + 2672)] [335]^{-1} = 22.556 \text{ LE/day}$$

$$\text{EYAR}_5 = [18.889 \text{ (NR/day of sequence a)}] [22.556 \text{ (NR/day of sequence b)}]^{-1}$$

$$\text{EYAR}_5 = (18.889 / 22.556) = \mathbf{0.837}$$

$$\text{EYAR}_5 \text{ as percentage} = (0.837 - 1) \times 100 = \mathbf{-16.252\%}$$

The computation of yield advantage (or disadvantage) of sequence "a" is as follows : NR of evaluated sequence – NR of the compared sequence

Yield advantage (or disadvantage) net return =

$$= (\text{Gross income} - \text{total costs of evaluated seq.}) - (\text{Gross income} - \text{total costs of compared seq.})$$

$$= (11186.24 - 4556) - (12213.77 - 4657.5)$$

$$= 6630.242 - 7556.265 = \mathbf{-925.773 \text{ LE/F.}}$$

It means ,if the farmer grown sequence "a" instead of the relay system , he will get net return /day low by 16.252 % and lose **925.773.164** LE/F.

# The web application of the EYAR<sub>5</sub> formula .

## CROP SEQUENCE SYSTEM A

SEQUENCE DURATION :  DAYS

MONOCULTURE CROPS					
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE	BY PRODUCT 1 (ARDAB/TON) LE	BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :	<input type="text" value="679"/>	Yield : <input type="text" value="13.665"/> Price : <input type="text" value="145"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 2 :	<input type="text" value="1873"/>	Yield : <input type="text" value="3.368"/> Price : <input type="text" value="1133"/>	Yield : <input type="text" value="3.262"/> Price : <input type="text" value="500"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 3 :	<input type="text" value="2004"/>	Yield : <input type="text" value="3.508"/> Price : <input type="text" value="967"/>	Yield : <input type="text" value="2.881"/> Price : <input type="text" value="127"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 4 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
SIMULTANEOUS (OR/RELAY) INTERCROPPING					
CROP 1 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 2 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 3 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 4 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
	<input type="text"/>				

## CROP SEQUENCE SYSTEM B

SEQUENCE DURATION :  DAYS

MONOCULTURE CROPS					
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE	BY PRODUCT 1 (ARDAB/TON) LE	BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 2 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 3 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 4 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
SIMULTANEOUS (OR/RELAY) INTERCROPPING					
CROP 1 :	<input type="text"/>	Yield : <input type="text" value="3.205"/> Price : <input type="text" value="1133"/>	Yield : <input type="text" value="2.885"/> Price : <input type="text" value="500"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 2 :	<input type="text"/>	Yield : <input type="text" value="8.4"/> Price : <input type="text" value="850"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 3 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
CROP 4 :	<input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>	Yield : <input type="text"/> Price : <input type="text"/>
	<input type="text" value="4657.5"/>				

EYAR5 (THE GENERAL FORMULA OF SUCCESSIONS EVALUATION) = 0.837(-16.252%)  
YIELD ADVANTAGE NET RETURN = -925.773 LE/F

**Example 4:**

<b>Sequence "a" ( sequence (5) )</b>			
	Yield	Price	costs
Crop1. Multi-cut clover	$Y_{a11} = 39.25$ Ton/fed.	$Pr_{a11} = 145$ LE/ton	$Co_{a1} = 2688$ LE/fed
Crop2. S.maize Grain:	$Y_{a12} = 4.1415$ Ton/fed	$Pr_{a12} = 967$ LE/ton	$Co_{a2} = 2584$ LE/fed
Straw :	$Y_{a21} = 3.240$ Ton/fed.	$Pr_{a21} = 127$ LE/ton	
Duration	$D_a = 351$ days		
<b>Sequence "b" ( sequence) ( as compared sequence )</b>			
Crop1. Wheat : Grain :	$Y_{b11} = 3.207$ Ton/fed.	$Pr_{b11} = 1133$ LE/ton.	$Co_{b1} = 1998.5$ LE/fed
Straw :	$Y_{b12} = 3.096$ Ton/fed.	$Pr_{b12} = 500$ LE/ton.	
Crop2. S. maize Grains:	$Y_{b2} = 3.298$ Ton/fed.	$Pr_{b2} = 967$ LE/kentar	$Co_{b2} = 2584$ LE/fed
Straw:	$Y_{b22} = 2.877$ Ton/fed.	$Pr_{b22} = 127$ LE/ ton	
Duration	$D_b = 298$ days		

(where:  $m = 2$  for sequences  $a$ .  $mL = 1$  and  $2$  for crop1 and crop2 ,respectively).

(where:  $m = 2$  for sequences  $b$ .  $mL = 2$  and  $2$  for crop1 and crop2 ,respectively).

The computation of economic yield advantage ratio ( EYAR ) is as follows :

$$EYAR_s = [ \text{Sequence "a"} ] [ \text{Sequence "b"} ]^{-1}$$

$$\text{Sequence "a"} = \left[ \left( \sum_{l=1}^m \left( \sum_{k=1}^{mL} (Y_{alk} Pr_{alk}) - Co_{al} \right) \right) + \left( \sum_{i=1}^n \left( \sum_{j=1}^{ni} Y_{aij} Pr_{aij} \right) - \sum_{i=1}^n Co_{ai} \right) \right] [D_a]^{-1}$$



$$\text{Sequence "b"} = \left[ \left( \sum_{l=1}^m \left( \sum_{k=1}^{mL} (Y_{blk} \text{Pr}_{blk}) - \text{Co}_{bl} \right) \right) + \left( \sum_{i=1}^n \left( \sum_{j=1}^{ni} Y_{bij} \text{Pr}_{bij} \right) - \sum_{i=1}^n \text{Co}_{bi} \right) \right] [D_b]^{-1}$$

$$\text{Sequence "a"} = [(39.25 \times 145 - 26880) + (4.1415 \times 967 + 3.24 \times 127 - 2584)] [351]^{-1} = 13.776 \text{ LE/d.}$$

$$\text{Sequence "b"} = [(3.207 \times 1133 + 3.096 \times 500 - 1998.5) + (3.298 \times 967 + 2.877 \times 127 - 2584)] [298]^{-1} = 13.938 \text{ LE/d.}$$

$$\text{EYAR}_5 = [13.776 (\text{NR /day of sequence "a"})] [13.938 (\text{NR /day of sequence "b"})]^{-1}$$

$$\text{EYAR}_5 = \mathbf{0.9884}$$

$$\text{EYAR}_5 \text{ value as percentage} = (0.9884 - 1) \times 100 = \mathbf{-1.16 \%}$$

EYAR<sub>5</sub> value given was relative to the net return per day of the compared sequence. EYAR<sub>5</sub> value observed that net return per day of evaluated sequence decreased by 1.16 % of the net return per day of the compared sequence (b) .

The computation of the economic yield advantage net return of sequence “a” is as follows :

**Yield Advantage net return of sequence "a" =**

$$\begin{aligned} &= (\text{Gross income "a"} - \text{Total costs "a"}) - (\text{Gross income "b"} - \text{Total costs "b"}) \\ &= (10107.56 - 5272) - (8736.076 - 4582.5) = \mathbf{681.984 \text{ LE/F.}} \end{aligned}$$

From the previous example , EYAR<sub>5</sub> value showed that the net return per day of crop sequence “a” ( evaluated sequence ) was lower than the net return per day of the sequence “b” ( compared sequence ) by 1.16 % .At the same time the net return of sequence "a" was surpassed by 681.984 LE/F over the net return of the compared sequence.

It means that the increment of the net return of the sequence "a" was not enough to compensate the length of the sequence "a", this was evident in the value of the formula which it came negative.

The web application of EYAR5 formula .



**CROP SEQUENCE SYSTEM A**

SEQUENCE DURATION : 351 DAYS

MONOCULTURE CROPS							
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :	2688	Yield : 39.25	Price : 145	Yield :	Price :	Yield :	Price :
CROP 2 :	2584	Yield : 4.1415	Price : 967	Yield : 3.24	Price : 127	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
SIMULTANEOUS (OR/RELAY) INTERCROPPING							
CROP 1 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :

**CROP SEQUENCE SYSTEM B**

SEQUENCE DURATION : 298 DAYS

MONOCULTURE CROPS							
CROP SEQUENCE	COST/F. LE	MAIN PRODUCT (ARDAB/TON) LE		BY PRODUCT 1 (ARDAB/TON) LE		BY PRODUCT 2 (ARDAB/TON) LE	
CROP 1 :	1998.5	Yield : 3.207	Price : 1133	Yield : 3.096	Price : 500	Yield :	Price :
CROP 2 :	2584	Yield : 3.298	Price : 967	Yield : 2.877	Price : 127	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
SIMULTANEOUS (OR/RELAY) INTERCROPPING							
CROP 1 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 2 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 3 :		Yield :	Price :	Yield :	Price :	Yield :	Price :
CROP 4 :		Yield :	Price :	Yield :	Price :	Yield :	Price :

Generate Result

EYAR5 (THE GENERAL FORMULA OF SUCCESSIONS EVALUATION) = 0.988(-1.16%)  
YIELD ADVANTAGE NET RETURN = 681.9845 LE/F



**Reference :**

**EL-Hawary, N.A. 2014** . Formula for economic evaluation of crop sequence systems ." The general formula for economic evaluation from the perspective of the crop intensification. Book . Publisher : *LAMPERT Academic Publishing , Germany*, pages. 152. ISBN 978-3-659-52049-5.