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The Monetary Value of Ecosystem Services Provided by Insects (A case study for selected crops in Jordan)

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ABSTRACT

This study aims to conduct an assessment of the free benefits derived from pollination which is obtained by ecosystem services provided by insects, including honeybee. These benefits occur as a result of improving productivity and quality. According to the outcomes of this study are the value of ecosystem services provided by insects from (34) selected crops to Jordan economy were JD (91.9) million, which equals $130 million that represents (33%) of the total value of the choosing crops' production. Moreover, an approximate value of estimation due to honeybee pollination, which totally reached to JD (73.6) million, that contribute about (27%) of the total value of chosen crops' production, and are more than (26.3) times of the total value of Jordan domestic honey production (186 Ton ≈ 2.8 million JD). Self-Sufficiency outcomes results indicate that such a scenario of losing insects pollination at least 35% of local crop production that were selected would be no longer able to meet local consumption. New insight policies were recommended to enhance a better understanding by addressing the importance of the mutual interest between the crop producers and the ecosystem services provided by insects, which could be achieved by activating the role of agriculture extension and other stakeholders (environmental associations) in Jordan.

Keywords: Monetary Value, Pollination, Insects, Honeybee, Ecosystem, Jordan.

INTRODUCTION

Flowering plants require pollination to produce seeds or fruits, Some plants are wind pollinated and others are self-pollinated, but many plant species require animal-mediated cross pollination (NRC, 2007). Even in those plant species capable of self- pollination, animal pollination can increase the quantity and quality of production (Klein et al.,2003; Roubik, 2002; Bauer and Wing, 2010)**,** its value is derived from its contribution to the maintenance of ecosystems as well as its impact on agriculture (Mburu and Hein,2006**).**

Agriculture, in particular, has many obvious dependencies on natural services provided by the ecosystem (Kuldna et al.,2009), it has been estimated that pollination is responsible for as much as 30% of agricultural food production (Robinson et al. 1989). Ironically, however, agriculture practices as land use is one of the main driving forces behind the decline of biodiversity (Brading et al.,2009**),** in addition to, other factors such as global warming and urbanization (Klein et al., 2007; Brading et al.,2009)**.**

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Insufficient Land pollination can not only reduce yields, but may also delay them and be the reason for inferior fruit production. in some cases pollination services may contribute as much or more to yield than fertilizers (Brading et al.,2009)**.**

Pollination decline can result a negative ecological and economic impacts that could, significantly, affect the maintenance of wild plant diversity, wider ecosystem stability, crop production, food security and human welfare (Potts et al., 2010**);** It might also have a serious consequences on human health, in particular the decrease of fruit and vegetable availability could impact the health of consumers worldwide (Gallai et al.,2009**).**

Risk of Pollination Decline

Many pollinator species have experienced severe declines due to agricultural intensification (Steffan-Dewenter et al., 2005; Biesmeijer et al., 2006; Kuussaaria et al., 2011). A huge concerns that insect pollinators are threatened by environmental changes such as, climate change, habitat loss, the extensive use of pesticides same as fertilizers, and emerging diseases (Balmford et al., 2002; Biesmeijer et al.,2006; Mwebaze et al., 2010**).** This concern, also rises more particularly in countries, where agriculture sector contributes as a large portion of the economy (Kluser and Peduzzi, 2007; Steffan-Dewenter et al., 2005; Allen-Wardell et al.,1998; Bauer and Wing ,2010). For instance, mortality of honeybees is a serious problem that beekeepers have to face periodically in Jordan (Haddad et al, 2008), and since 2007 most of the beekeepers around the world had face a huge colony losses and unusual incident of disappearance of the bees (Haddad, 2010). The types of pollinators in decline include wild bees (Social and Solitary) domesticated honey bees, hoverflies, butterflies, bats, hummingbird and other small animals (Brading et al., 2009).

Pollination, in such system, is unmanaged and is usually incidental supported by nearby ecosystem (Kasina et al., 2009). For example, most developing countries, crop production is by small scale farmers, who mainly produce for their own consumption and extra for market, therefore without wild pollinator species the levels of agricultural productivity are under threat (Brading et al., 2009). Moreover, It is worth to mention of the reasons of not managing pollination is the lack of understanding its economic value (Kasina et al., 2009; Mwebaze et al., 2010).

Literature Review

Klein et al. (2007) review found that 87 out of 115 global primary food crops require some level of animal pollination, the title of the study was “Importance of pollinators in changing landscapes for world crops”. The study shows that the levels of pollinator dependency vary dramatically among crops, and indicated that the highest level of dependence was found, predominantly, in fruits, vegetables, and nuts. While other crops are essentially dependent on animal pollination like Brazil nuts, Cantaloupe, Cocoa Beans, Kiwi fruit, Pumpkins, Squash, vanilla, and Watermelon.

A study “Economic valuation of the vulnerability of world agriculture confronted with pollinator decline” which was performed by Gallai et al.(2009) estimated that the world production annual value for crops used for human food by (1618) Trillion euro in 2005; indicating that the total annual value of the 46 insect pollinated direct crops was 625 Billion euro, which contribute with 39% of the world production value year 2005.

A published article entitled “The Economic Value of Ecological Services Provided by Insects” to the USA by Losey and Vaughan (2006) estimated that the annual value was about $58 billion. In 2006 the GDP of the USA was $13 trillion, this amount represents 0.45% of the GDP, with pollination services accounting almost is 0.02%.

In study about part of Middle East region "The Value of Pollination Services to Egypt by Brading et al. (2009) for (70) selected crops grown in Egypt, showed that almost EGP 13.5 billion (US $2.4 billion) would be lost annually in case of absence of insect pollination.

A case of study about honeybee pollination in the UK "Quantifying the Value of Ecosystem Services" by Mwebaze et al.(2010) aimed to evaluate the public support to prevent a further decline to maintain the current number of bee colonies. A questionnaire was designed in order to evaluate, whether the resident would be willing to support such a policy and the amount which they could pay. The results showed that the mean "willing to pay" to support the bee protection policy from declining due to environmental threats was £1.37/week/household, which is equivalent to £1.77 billion per year in the UK.

A published article "Monetary Valuation of the Pollination Service Provided by Insects to European Agriculture "using a bio-economic approach by Gallai et al. (2010) calculated the value of the contribution of pollinators in the crop production that used directly for human food in Europe exceeded €14.2 billion, which participate about 10% of the total value of the 2005 crops.

Robinson et al.(1989) performed a research work which aimed to estimate the monetary value associated with increase in crop productivity due to contribution of honeybee pollination, there were about 40 crops selected from the U.S.A agricultural sector, the results showed that the amount value of pollination reached to (9.3) billion dollars, while the value of these crops were (30) billion dollar. Two years later, Gill R., (1991) estimates the economic value of increasing productivity due to pollination contribution by honeybee for 25 crops were selected in Australia agricultural sector by using Robinson et al. (1989) Approach, therefore the economic value of pollination outcome reached to 1.2 billion dollar, his pioneer work in the study was by applying partial equilibrium model as a technique for measuring social welfare. The result illuminates the change in the 'producer surpluses in case of the absence of pollination. The same methodology (Welfare analysis) was performed as well, to some extent in the U.S.A by Southwik E. and Southwik L. (1992) in order to conduct the change in producer surpluses that reach to (5.7) billion Dollar due to pollination.

A published article "The Value of Honeybee as Pollinators to Selected Crops in Jordan" by Ghani et al. (2007) applying Robinson et al.(1989) methods in order to estimate the pollination value of 14 selected crops, the results showed that the amount value reached to JD.35.9 million which was more than 16 times the value of domestic honeybee production in Jordan 2005.

An academic dissertation "The Economies of Beekeeping in Jordan " by Shammout (2009) , focused on the economic value of honeybee role in pollination, that causes an increase of the productivity to the main citrus species in Jordan. The estimation was about (6.76) million J.D per year which is about (% 31) of the value of citrus production in Jordan in 2007. A Partial equilibrium model according to welfare economic analysis was applied, showed that net social loss reached about (9.2) million JD per year in case of international trade exist, and indicated to the citrus producers (Farmers) were the only to be charged to this amount due to the absence of honeybees.

METHODS

In this study, a mathematical formula was adopted to estimate the monetary value of pollination which was performed by Gallai et al. (2009) and by Brading et al.(2009) to estimate the pollination loss impact in the monetary value of to Egyptian economy. And it was adopted (The same formula) by Mwebaze et al.(2010) as well, in order to estimate the impact of pollination loss that reflected by a monetary value of to UK economy as follows:

MVIP= $\sum_{i=1}^{I}\sum_{x=1}^{x}(Pix * Qix * Di)$

Where:

MVIP: The total monetary value of insects' pollination

Qix :is the quantity of crop (i) produced in country (x).

Pix :is the price of crop(i) per unit produced in country (x).

According to this study, one country is considered (x=1) that is Jordan.

Therefore, the outcomes' formula is as follows:

MVIP= $\sum_{i=1}^{I}(Pix * Qix * Di)$

Di: is the dependences' ratio of the crop. (I =34) on insect pollination, which based on five levels of the extensive classification system for animal pollinator dependency, due to Klein et al.(2007) approach on animal pollination (as in the literature reviewed); This technique places the available information for each crop into one of following categories of the impact of pollinator loss on yield:

Essential (Reduction of > 90%).

- High (40-90%) loss.
- Modest (10-40%) loss.
- Little (0-10%) loss.
- None; Zero loss; no reduction in production.

Simply it was multiplied the value for each crop by the proportion of the yield that would be lost if pollinators were absent, for calculation; the midpoints were used for these ranges, 95,65,25,5 and Zero respectively (Brading et al.,2009).

The selected crops "vulnerability ratio" were used in order to demonstrate the pollinator decline , which they upon crop dependence on pollinators, and to indicate the farmers' capacity to adapt to pollinator decline; which is defined by Gallai et al.(2009) as following formula:

RV=$\frac{\sum_{i=1}^{I}\sum_{x=1}^{x}(Pix*Qix*Di)}{\sum_{i=1}^{I}\sum_{x=1}^{x}(Pix*Qix)}$ (%)

By applying one country (Jordan) (X=1); therefore, the outcome formula became as follows;

RV=$\frac{\sum_{i=1}^{I}(Pix*Qix*Di)}{\sum_{i=1}^{I}(Pix*Qix)}$ (%)

Where:

RV :The vulnerability ratio was calculated for each crop category; which was between the monetary value of pollination and the current total crop value (Gallai et al.,2009**)**.

The value of crops' shape or quality improvement was excluded in this study, as well as the value of commercially produced insect-derived products, such as honey, wax, silk, or shellac, and any value derived from the capture and consumption of insects themselves.

Selected Crops

About (34) crops were selected ;(18) Fruit crops and (16) Vegetables crops, which satisfied the following criteria:

1. An appropriate data are available.
2. Those were known to be dependent on insect pollination or to benefit from insect pollination.
3. Commercially grown in Jordan (Relatively).

The Dependency on Insects Pollination

According to the methodology the (Dependency-factors) which was adopted by Klein et al.(2007) ,animal pollination was provided in column No. (2) of Table (1). Further calculations were used in order to estimate the pollination value due to Gallai et al.(2009) approach as It was illustrated in tables; Table (2) and Table (3).

Table 1. Crops Production (2010), Dependency Factor and Production loss

Fruit and Vegetable	(1) Production (Thousand Ton)	(2) Dependency-factors (D)	(3) Production Loss (Thousand Ton)
Fruits			
Almond	2.4	0.65	1.56
Apples	28.8	0.65	18.72
Lemons	28.7	0.05	1.43
Orange	43.0	0.05	2.15
Mandarin	13.6	0.05	0.68
Clementine's	24.9	0.05	1.24
Grape Fruit	3.6	0.05	0.18
Pummelos	4.9	0.05	0.24
Figs	1.0	0.25	0.25
Peach	11.0	0.65	7.15
Bananas	43.7	0.05	2.18
Plums, Prunes	2.3	0.65	1.49
Apricots	6.8	0.65	4.42
Pomegranate	2.1	0.25	0.52
Pears	2.1	0.65	1.36
Guava	2.3	0.25	0.57
Nectarine	9.8	0.65	6.37
Cherry	0.7	0.65	0.44
Total Fruits	231.7		51.0
Vegetables			
Eggplant	104.7	0.25	26.17
Tomatos	737.3	0.05	36.86
Squash	69.6	0.95	66.12
Hot pepper	18.6	0.05	0.93
Sweet pepper	36.6	0.05	1.83
Broad Bean	21.2	0.25	5.3
Okra	6.8	0.25	1.7
String Beans	8.2	0.05	0.41
Radish	4.2	0.65	2.73
Onion, Green	3.5	0.05	0.17
Onion, Dry	15.7	0.05	0.78
Parsley	2.4	0.65	1.56
Sweet Melon	31.0	0.95	29.45

Fruit and Vegetable	**(1) Production (Thousand Ton)**	**(2) Dependency-factors (D)**	**(3) Production Loss (Thousand Ton)**
Watermelon	153.1	0.95	145.44
Cucumber	176.2	0.65	114.53
Snake Cucumber	21.0	0.65	13.65
Total Vegetables	1410.1		447.7
Total Fruits and Vegetables	**1641.8**		**498.6**

Where:

(1): The actual crops production were published annually by (Jordan Department of Statistics, Annual reports 2010).

(2):The dependency factor "D" was cited from Klein et al.(2007) .

(3): The annual production loss, in case of Insects absence scenario, was computed by multiplying (Dependency x Production).

RESULTS AND DISCUSSION

A. The Value of Insect Pollination Analysis:

The results in column No.(5) of table (2) showed the monetary value of each crop was produced, and the total production reached to JD (272.8) million, which is the sum of JD 73.3 million for fruit and JD 199.5 million for vegetable. While column No.(6) of the same table showed the result of the monetary value of production loss, in case of absence of insects pollination scenario which reach in total about JD (91.9) million, that is the sum of JD 17.16 million for fruit and JD 74.8 million for vegetable.

Table 2.The Monetary Value of production and Insects Pollination Loss

Fruit and Vegetable	**(4) Con-Price (JD/Ton)**	**(5) Monetary value of production (Thousand JD)**	**(6) Monetary value of pollinator (Thousand JD)**
Fruit			
Almond	705.3	1693	1100
Apples	259.2	7466	4853
Lemons	240.2	6895	345
Orange	334.1	14367	718
Mandarin	178.2	2423	121
Clementine	173.2	4312	216
Grape Fruit	126.7	456	23
Pummelors	191.1	937	47
Figs	286.3	286	72
Peach	274.3	3018	1962
Bananas	458.8	20048	1002
Plums,Pruns	346.6	797	518

Fruit and Vegetable	(4) Con-Price (JD/Ton)	(5) Monetary value of production (Thousand JD)	(6) Monetary value of pollinator (Thousand JD)
Apricots	573.2	3898	2534
Pomegranate	319.8	672	168
Pears	588.5	1236	803
Guava	459.5	1057	264
Nectarine	322.1	3157	2052
Cherry	819.8	557	362
Total Fruit		**73275.9**	**17160**
Vegetable			
Eggplant	113.6	11895	2974
Tomatoes	106.1	78255	3913
Squash	212.2	14771	14033
Hot pepper	248.1	4615	231
Sweet pepper	211.6	7746	387
Broad Bean	204.3	4330	1083
Okra	640.9	4358	1090
String Beans	430.6	3531	177
Radish	106.5	447	291
Onion ,Green	280.5	982	49
Onion Dry	136.6	2145	107
Parsley	319.2	766	498
Sweet Melon	239.9	7435	7064
Watermelon	109.6	16787	15948
Cucumber	208.8	36798	23918
Snake Cucumber	224.4	4711	3062
Total Vegetables		**199572.3**	**74822.9**
Total (Fruit and Vegetable)		**272848.2**	**91982.9**

Where:

(4): "Farm-Gate" Price (JD/Ton) which was the average weighted constant price in last published year 2010 (2007=100), based on the Jordan Department of Statistics Data.

(5): Total monetary value for each crop; multiplying column No.(1) from (table 1) by column No.(4) (table 2).

(6): The monetary value of pollination: computed by multiplying column No. (3) (table 1) by column No. (4) (Table 2).

B .Crops Farmers Revenue (JD) from each ton produced due to insect pollination:

A calculation was performed by divided column No.(6) from Table (2) above each crop produced in column No.(1) as it was shown in Table No.(1); therefore the quotient results indicated that the farmers' revenue could be gained (JD/Ton) due to insects pollination contribution as observed in column No.(7) of table No.(3). Therefore, the outcomes indicated to the farmers' revenue which reached to JD (532.9 /Ton) for Cherry, Almond JD (458.5 /Ton) and JD (382.6/Ton) for Pears which illustrate in (Figure.1).

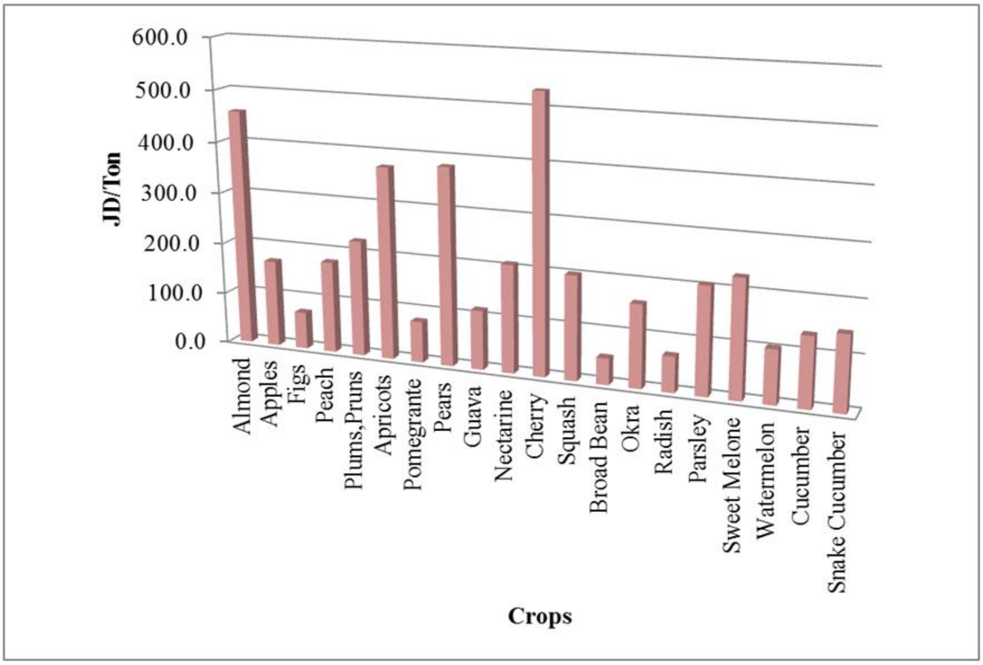

Fig. 1. Most Crops Farmers Revenue (JD) from each ton produced due to insect pollination.

C. Self-Sufficiency (SSR):

Table (3) indicated that some produced crops were clearly exceeded consumption, but such a scenario of losing insects pollination. Therefore, production at least 35% from the selected crops would, no longer, be able to meet local consumption. This is obviously indicated in Self-Sufficiency ratio for 12 crops which observed in columns No.(8,9) of table No.(3); Peach, Plums, Prunes, Apricots, Okra, Radish, Parsley, Cucumber and Snake Cucumber. Some crops, in the same table, showed a steep drop (SSR) ratio. for instance, Squash, Sweet Melon and Watermelon, which they are clearly illustrated in Figure (2,3).

Table 3. Crops Farmers Revenue and Self-Sufficiency Ratio (SSR)

Fruit and Vegetable	(7) Revenue (JD/Ton)	(8) SSR Current level of insects	(9) SSR Absence of Insects
Fruit:			
Almond	458.5	45.5	15.8
Apples	168.5	53.0	18.6
Lemons	12.0	82.4	77.9
Orange	16.7	60.9	57
Mandarin	8.9	112	106.4
Clementine	8.7	105	99.8
Grape Fruit	6.3	103	97.9
Pummelors	9.6	101.8	96.7
Figs	71.6	96	72
Peach	178.3	100	35
Bananas	22.9	52.9	50.3
Plums, Prunes	225.3	101	35.4
Apricots	372.6	122.9	43.0
Pomegranate	80.0	74	55.5
Pears	382.6	44	15.4
Guava	114.9	78	58.5
Nectarine	209.4	60	21.0
Cherry	532.9	88	32.4
Vegetable:			
Eggplant	28.4	328.6	246.5
Tomatoes	5.3	201.2	191.7
Squash	201.6	188.0	9.4
Hot pepper	12.4	122	115.9
Sweet pepper	10.6	348	330.6
Broad Bean	51.1	99.2	74.4
Okra	160.2	100	75
Radish	69.2	100	35
Onion ,Green	14	100	95
Onion Dry	6.8	31.1	29.5
Parsley	207.5	104	36.4
Sweet Melon	227.9	131.0	6.6

Fruit and Vegetable	**(7) Revenue (JD/Ton)**	**(8) SSR Current level of insects**	**(9) SSR Absence of Insects**
Watermelon	104.2	108.3	5.4
Cucumber	135.7	186.4	65.9
Snake Cucumber	145.8	100	35

Where:

(7): Revenue that producers (Farmers) could gain (JD) for each (Ton) was produced in case of insects pollination = (MVIP÷ the crop production 2010).

(8): Self-Sufficiency Ratio for each crop category based on (DOS) and (MOA) published and unpublished reports (2010).

(9): Self-Sufficiency Ratio for each crop category in case of the absence of insect's pollination scenario (Pollination Loss).

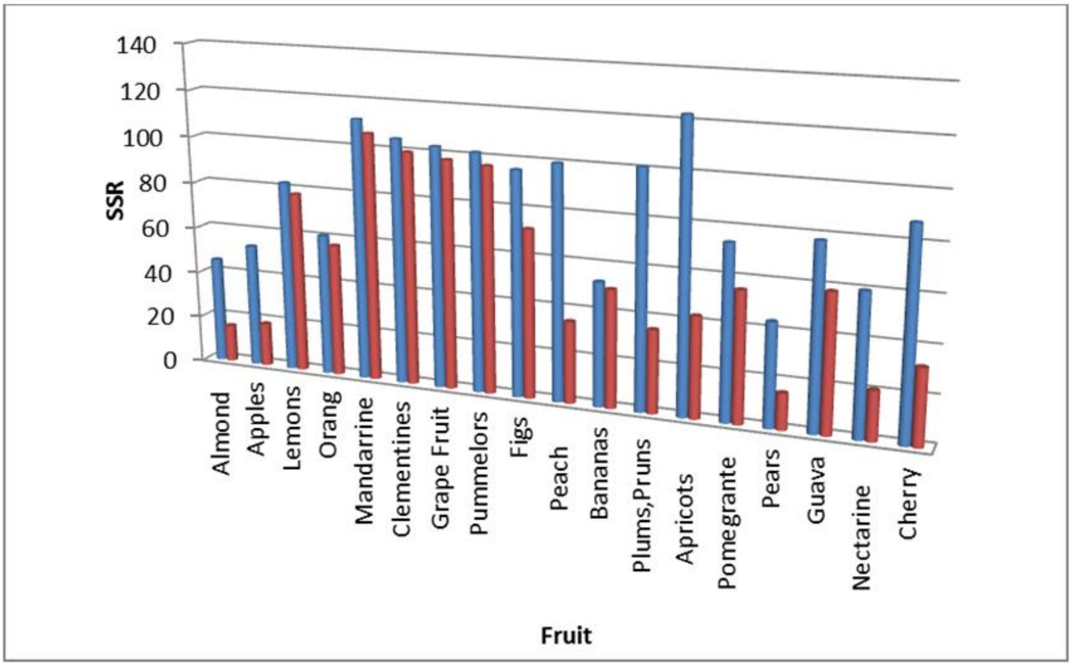

Fig. 2. Changing in Self-Sufficiency Ratio (SSR) for fruit production due of the absence of pollination scenario.

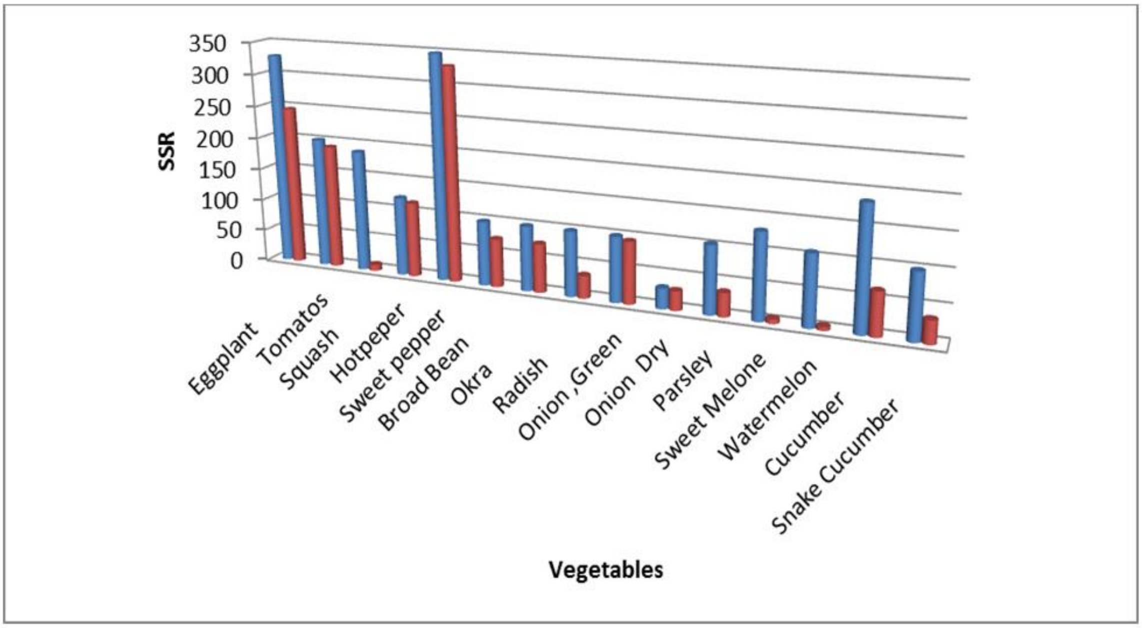

Fig.3. Changing in Self-Sufficiency Ratio (SSR) for vegetable production due to the absence of pollination scenario.

D. The Vulnerability ratio:

The vulnerability ratio (RV) was calculated as a quotient of the total monetary value of pollination (Numerator) for each crop category which divided by the total crop value (Denominator).

This ratio can be interpreted as an indicator of the value of pollination service relative to the other factors that contribute to agricultural production (Gallai et al.,2009). The results of (RV) showed total (34) selected crops which faced with pollinator decline were about (33%). Fruit crops reached to (23%), while vegetable crops reached to (37%). The agricultural vulnerability to pollinator decline related to crop dependence to pollinators and farmers' capacity to adapt to pollinator decline (Gallai et al.,2010).

E. The Role and Value of Honey Bee Contribution:

1-The role of honeybee contribution:

The contribution of honeybees as a pollinator became a standard example of positive externality (Ghani et al., 2007**),** There are numerous factors such as, other insects, birds, animals and wind that carry out pollination, while honeybees, mainly "*Apis mellifera*", remain the most economically valuable pollinators of crops in monocultures worldwide (McGregor, 1976; Klein et al., 2007**)**, and the most significant for specific crops, because of the efficiency of its foraging abilities (Gibbs and Muirhead,1998). When wild bees do not visit agricultural fields, managed honeybee hives are often the only solution for farmers to ensure crop pollination (Klein et al., 2007**).** The economic benefit of insect pollination in the United State of America and Europe is clear for farmers therefore, the market of colony rental is well developed and organized for honeybees (Sumner and Boriss,2006; Carreck et al.,1997) as well as, for bumble bees (Velthuis and Van Doorn,2006 ; Gallai et al., 2009**).**

The rented prices range from some US $100 per honeybee hive per season to US$300 per bumble bee colony per crop (Mburu and Hein, 2006**)**. Furthermore, studies are (cost-benefit analysis) performed by official Canadian Gov, that Quebec province indicated that each dollar spent in rental fees for crops producers realized gain $ 185 (Ghani et al., 2007).

The crucial concern point is the abundance and diversity of wild bees as well as abundance of honeybee is now declining and some species are clearly at risk (Biesmeijer et al., 2006; NRC, 2007; Olroyd, 2007; Stokstad, 2007; Gallai et al., 2009**).** This issue raised about the future availability of honeybee pollination services (Potts et al, 2010); the growth rate in the global supply of managed bees is less than the growth rate in the global demand for pollination services, therefore the potential for future shortages of pollination services on a global scale is highly expected (Aizen and Harder, 2009; Bauer and Wing, 2010).

2-Approximated value of Honeybee contribution :

The lack of common valuation methods for pollination services cause for a range the amount of the honeybee's value to agriculture (Mburu and Hein,2006); for example, in the USA was estimated to lie between US$6-19 billion per year (Levin, 1984; Morse and Calderone, 2000; Southwick and Southwick, 1992**;** Mburu and Hein,2006 **;** Mwebaze et al., 2010**).**

Most accepted estimates indicate that Honeybees account for at least (80%) attribute of all insects pollination (Levin, 1986 ,Eckert and Shaw, 1960; Barclay and Moffett 1984; Grady, 1987).The same acceptance were adopted by Carreck and Williams (1998) in order to estimate the value of honeybee pollination for UK selected crops which amounts reached to **£**137.8 million.

By applying the same method of Carreck and Williams (1998), for an approximate value of pollination due to honeybee contribution for the (34) selected crops. Therefore, the conducted results were about J.D (13.7) million for fruit, and J.D (59.9) million for vegetables. Thus, the total pollination value reached to JD (73.6) million which equivalent to (27%) of the total value of production (chosen crops) according to farm-Gate (constant price).

Moreover, a crucial indicator showed that the total value of pollination due to honeybee contribution was about (26.3) times of the total value of domestic honey production in Jordan (186 Ton ≈ 2.8 million JD) (Department of Statistics, 2010).

CONCLUSION AND RECOMMENDATION

The value of ecosystem services provided by insects for (34) chosen crops in Jordan economy was estimated JD (91.9) million, (2010) which could be annually. Thus, this amount is not less than (20%)[1] of total production value of agriculture sector that reached to (JD 371.1 million) at a constant price.

Therefore, improving the crops quality and productivity, due to insects pollination, could be achieved by better decision-making, and regarding maintaining of the ecosystem services, that could enhance agricultural sector for a more contributions to the GDP, which was not more than (4%) at constant price (2010).

With the growing concerns of substantial losses of pollinators in many regions of the world, and with the strongest evidences come from Europe and North America (Potts et al.,2010**),** further researches on other continents must be supported in order to chart the omnipresence of this phenomenon, and taking into account of integration, corporation programs, existing national and local monitoring data information.

A new insight policies are recommended in Jordan in

[1] T he intermediate consumption for vegetables was about 9.1 % of the total vegetables production, While fruits intermediate consumption was 5% of the total fruits production due to published analysis'' reports (Input – output) model (National account, Dos,2011).

order to activate the role of agriculture extension and NGOs(environment Interest's associations) for a better understanding; by indicating the importance of the mutual interest between the crop producers on one side and the ecosystem services provided by insects on the other side, and more focusing on the need to spread the knowledge of 'positive externalities' on honeybees for pollination which is reflected by a monetary value that should be aware by stakeholders. Therefore, pollination could play a role as a crucial input in order to improve the efficient allocation of resources within Jordan agricultural economy.

REFERENCES

Allen-Wardell, G., Bernhardt, P., Bitner, R., Burquez, A., Buchmann, S., Cane, J., Cox, P.A.,Dalton, V., Feinsinger, P., Ingram, M., Inouye, D., Jones, C.E., Kennedy, K., Kevan, P., Koopowitz, H., Medellin, R., Medellin-Morales, S., Nabhan, G.P., 1998. The potential consequences of pollinator declines on the conservation of biodiversity and stability of food crop yields. ***Conservation Biology***, 12, 8–17.

Aizen, M.A. and Harder, L.D., 2009. The global stock of domesticate honey bees is growing slower than agricultural demand for pollination." ***Current Biology*** 19:915-918.

Balmford, A., Bruner, P., Cooper, R., Costanza, S., Farber, R.,Green, M., Jenkins, P., Jefferiss, V., Jessamay, J.,Madden, K., Munro, N., Myers, S., Naeem, J., Paavola, M.,Rayment, S.,Rosendo, J.,Roughgarden, K., Trumper, and R.K. Turner ,2002. Economic reasons for conserving wild nature. ***Science*** 297:950-953.

Bauer, D. and Wing, I. 2010. Economic Consequences of Pollinator Declines: A Synthesis. Agricultural and Resource Economics, ***Northeastern Agricultural and Resource Economics Association***. 368–383.

Barclay ,J.S.,and Moffett J.O., 1984. The pollination value of honey bees to wildlife. ***American Bee J***. 124:497-489.

DOS.,2010.Department of Statistic, Agricultural Annual Reports, Jordan http://www. dos.gov.jo/ dos_ home_a/ main/index.htm

Kluser, S. and P. Peduzzi ,2007. *Global Pollinator Decline: A Literature Review*.UNEP/ GRIDEurope.http:// www.grid.unep.ch/products/3_Reports/Global_pollinator_decline_literature_review_2007.pdf

Biesmeijer, J.C., Roberts, S.P., Reemer, M., Ohlemueller, R., Edwards, M., Peeters, T., Schaffers, A., Potts, S.G., Kleukers, R., Thomas, C.D., Settele, J., Kunin, W.E.,2006. Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. ***Science*** 313, 351–354.

Brading,P., El-Gabbas,A., Zalat,S., Gilbert ,F.,2009. The Value of Pollination Services to Egypt . ***Egyptian Journal of Biology***, Vol. 11, pp 46-51.

Carreck, N. L. and Williams, I.H., 1998.The economic value of bees in the UK. Bee World. 79:115-123.

Carreck, N.L. and Williams, I.H., Little, D.J., 1997. The movement of honey bee colonies for crop pollination and honey production by beekeepers in Great Britain. ***Bee World*** 78, 67–77.

Eckert,J.E. and. Shaw F.R,1960. Beekeeping. Macmillan, New York.

Gallai, N., Salles, JM., Settele, J., Vaissière, B.E.,2009. Economic valuation of the vulnerability of world agriculture confronted to pollinator decline. ***Ecological Economics*** 68:810-21.

Gallai,N.,Salles,J.,Carre,J.,Morison,N.,Vaissire,B.,2010, Monetary Valuation of the Pollination Service Provided by Insects to European Agriculture ,in : Atlas of Biodiversity Risk,Chapter 8, edited by Settele.J , Penev.L, Georgiev.T, Grabaum.R,Grobelink .V, Hamen.V, Klotz.S,Kotarac. MandKuhn.I, Pensoft Publishers, Sofia, Bulgarian, http://www.pensoft.net/ about.php.

Ghani A.L., Ftayeh .M.A., Shammout A.O., 2007. The Value of Honeybee as Pollinators to Selected Crops In Jordan , R. J. of Aleppo Univ. ***Agricultural, Science Series, No***. 62 -2007.

Gibbs D.M. and Muirhead I.F. 1998. The Economic Value and Environmental Impact of the Australian Beekeeping Industry, a report prepared for the Australian beekeeping Industry, http://www.capilano.com.au/beekeeping_report.pdf

Grady,J.H. 1989. Market failure in the provision of honeybee pollination: a heuristic investigaton. Ms. thesis Univ. Vermont.

Haddad N., Brake M., Megdade, H., De Meranda J., 2008. The First Detection Honeybee Viral Diseases in Jordan using the PCR. ***Jordan Journal of Agricultural Sciences***. 4(30) 57-61.

Haddad N.,2010. Honeybee viruses, diseases and hive management in the middle east and their relation to the colony collapse disorder and bee, Uludağ Arıcılık Dergisi - ***ARI BĐLĐMĐ / BEE SCIENCE***, 17-24.

Kasina, J.M., Mburu, J., Kraemer, M. and Holm-Mueller, K., 2009. Economic benefit of crop pollination by bees: a case of kakamega smallholder farming in Western Kenya. ***Journal of Economic Entomology*** 102 (2):467-473.

Klein, A.M., Steffan-Dewenter, I., Tshcarntke T., 2003. Fruit set of highland coffee increases with the diversity of pollinating bees. ***Proceedings of the Royal Society of London Series B*** 270:955-961.

Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I.,Cunnigham, S.A., Kremen, C., Tscharntke, T., 2007. Importance of pollinators in changing landscapes for worldcrops. ***Proceedings of the Royal Society*** 274, 303–313.

Kuldna , P., Peterson ,K., Poltimäe ,H., Luig J.,2009. An application of DPSIR framework to identify issues of pollinator loss. ***Ecological Economics*** 69. 32–42.

Kuussaaria,M., Hyvönenb,T., Härmäc,O., 2011. Pollinator insects benefit from rotational fallows, Agriculture, Ecosystems and Environment, journal homepage: www.elsevier.com/locate/agee.

Levin,M.D.,1986. Using honeybee to pollinate crops U.S Dept, Agr.,Agr.Res.Serv. and Extn.Serv.Lflt.549.

Levin, M.D., 1984. Value of bee pollination to United State agriculture. ***American Bee Journal*** 124, 184–186.

Losey, J.E. and M. Vaughan, 2006.The economic value of ecological services provided by insects. ***BioScience*** 56:311-323.

Mburu, J. and Hein, L.G., 2006. Economic valuation of pollination services: Review of methods. Tools for conservation and use of pollination services. FAO, Rome, pp. 43.

McGregor, S. E. 1976. Insect pollination of cultivated cropplants. U.S.D.A. Agriculture Handbook No. 496, 93–98. Version with some updated information for some crop species available at http://gears.tucson.ars.ag.gov/book/.

MOA., 2010.Ministry of Agriculture, Annual Reports, and unpublished reports. http://www.moa.gov.jo/

Morse, R.A. and Calderone, N.W., 2000.The value of honey bees as pollinators of U.S. crops in 2000. ***Bee Culture*** 1–15.

Mwebaze,P., Marris,G., Brown,M., Potts,S., Breeze,T., Macleod ,A.,2010. Quantifying the value of ecosystem services: A Case study of Honeybee Pollination in the UK. Contributed Paper for the 12th Annual BIOECON Conference.

NRC., National Research Council of the National Academies, 2007.Status of Pollinators in North America. National Academy of Science, Washington, D.C. Pp.303.

Olroyd, B.P., 2007. What's killing American honey bee? PLoS Biology 5(6):e168. http:// www. plosbiology.org/ article/ info:doi/10. 1371/journal.pbio.0050168

Potts, S.G., Biesmeijer, J.C., Kremen, P., Neumann, O., Schweiger, and W.E. Kunin, 2010. Global pollinator declines: trends, impacts and drivers.” ***Trends in Ecology and Evolution*** 25:345-353.

Robinson W.S., Nowogrodzak I., Morse R.A., 1989.The

Value of Honey Bee as Pollinators of U.S Crops, part 2. ***American Bee J.*** 129:477-487.

Roubik, D.W.,2002. The value of bees to the coffee harvest, ***Nature*** 417:708.

Shammout , A.O.,2009.***The Economics of Beekeeping in Jordan***, Ph.D. Dissertation, Faculty of Agriculture Engineering, Agri. Economics, University of Aleppo, Aleppo, Syria .

Southwick, E.E., Southwick, L., 1992. Estimating the economic value of honey-bees (Hymenoptera, Apidae) as agricultural pollinators in the United States. ***Journal of Economic Entomology*** 85, 621–633.

Steffan-Dewenter, I., Potts, S.G., Packer, L., 2005. Pollinator diversity and crop pollination services are at risk. ***Trends Ecol. Evol***. 20, 651–652.

Stokstad, E., 2007. The case of the empty hives. Science 316,970–972.

Sumner, D.A. and Boriss, H., 2006. Bee-conomics and the leap in pollination fees. ARE update, Univ. California, Giannini Foundation 9(3). 2006. http://www.agecon.ucdavis.edu/uploads/update_articles/v9n3_3.pdf).

Velthuis, H.W. and Van Doorn, A., 2006. A century of advances in bumblebee domestication and the economic and environmental aspects of its commercialization for pollination. ***Apidologie*** 37, 421–451.

القيمة النقدية للنظام "الايكلوجي" الخاص بدور الحشرات: دراسة تطبيقيـة لمحاصيل مختارة في الأردن

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ملخص

تهدف الدراسة إلى تقييم المنافع المشتقة من دور الحشرات (من بينها النحل) في عملية التلقيح الذي يقدمه النظام البيئي بوفرة، إذإن هذه المنافع تتمثل في قيمة نقدية إضافية للمنتجات الزراعية من حيث زيادة الإنتاجية والتحسين النوعي للثمار. وأظهرت النتائج أن القيمة النقدية بلغت نحو 91.9 مليون دينار أردني (أي ما يعادل 130 مليون دولار أمريكي)، نتيجة تلقيح 34 محصولا تمت دراستها في الأردن، وشكلت هذه القيمة ما نسبته 33% من إجمالي قيمة المحاصيل التي تم اختيارها. وتبين أن قيمة التلقيح الناجمة من دور النحل كتقدير تقريبي وصل الى 73.6 مليون دينار، حيث يمثل نحو 27% من القيمة الكلية للمحاصيل المدروسة (34 محصول) بالأسعار الثابتة لباب المزرعة، اضافة الى أن القيمة أعلاه تشكل نحو (26.3) ضعفاً من قيمة منتجات النحل من العسل من العام نفسه 2010 البالغة نحو 2.8 مليون دينار أردني (186) طن. وتبين نتيجة مخرجات الدراسة في حال" سناريو " زوال الحشرات ان هناك على الاقل 35% من المحاصيل المدروسة لا يمكن للطلب المحلي تلبيتها كما كان سابقاً؛ ويتضح ذلك من انخفاض نسبة الاكتفاء الذاتي لتلك المحاصيل. وأخيراً، فقد أوصت الدراسة بضرورة تقديم سياسات حكيمة من الجهات المعنية من أجل تعزيز مفهوم أهمية المنفعة المتبادلة بين أصحاب الحقول (المنتجين) من بينهم مربو النحل والحشرات من أجل المحافظة على النظام الايكلوجي وذلك بتفعيل دور الجهاز الإرشادي سواء في وزارتي الزراعة والبيئة أو في مؤسسات أخرى حكومية وغير حكومية معنية.

الكلمات الدالة: القيمة النقدية، تلقيح ، حشرات ، نحل العسل ، النظام الايكلوجي، الاردن.

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