A Local Community Participatory Approach as a New Policy toward a Complementary in situ Conservation of the Agrobiodiversity in Saint Katherine, South Sinai- Egypt

Reda Rizk[1]*, Ibrahim Elgamal[2] and Sami Rabei [3]

[1]National Gene Bank, Egypt and Arab Organization for Agricultural Development, [2]Saint Katherine protectorate , Nature Conservation Sector, Egyptian Environmental Affairs Agency, Cairo, [3]Botany and Microbiology Department, Faculty of Science, Damietta University, New Damietta, Damietta, Egypt

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Abstract: Changes in social lifestyles and fruit diversity occur gradually at Saint Katherine. Saint Katherine was more isolated during the occupation period (1967-1982). This study provides a significant and brief description of the most important features of the society study in Saint Katherine concerning the effects of location and the natural properties on the conservation of the agrobiodiversity. The sources of horticulture crop propagules are mainly from the local nurseries as native breeds and/or from nurseries outside the governorate. The study recorded fifteen fruit crops in the horticulture garden of Saint Katherine.The situational factors impose some sort of separation or isolation making that the exchange of genetic assets for cultivated horticulture crops limited. People had to use the existing genetic resources or ones imported from abroad. So, genetic resources of the cultivated crops become adapted to the local environment. After 1982, some cultivars were introduced from an Agricultural Nursery. For such reason, Saint Katherine is considered as a unique store for specific fruit cultivars. Horticulture crop diversity is also in decline and continues to be threatened by drought, climate change, habitat destruction, rain-floods, unsustainable use of natural resources, and by the replacement of the native cultivars with unsuitable new cultivars.

Key word: Agrobiodiversity, Genetic resources adaptation, Horticulture crop diversity, Local community, Participatory approach, Saint Katherine, Egypt.

Introduction

Traditional home gardens tend to preserve higher levels of plant diversity; cultivating a variety of crops in gardens can provide food security year-round, while the gardens are being protected against environmental change actions such as drought and pest outbreaks, as one crop partially compensates the loss of another (Fernandes and Nair, 1986; Jose and Shanmugaratnam, 1993). In addition to having practical benefits from the farmers' perspective, diverse agro-ecosystems can maintain natural processes on which farmers can rely, such as ecosystem services that maintain soil fertility (Munyanziza *et al*., 1997), water retention (Roose and Ndayizigiye, 1997), pollination (Klein *et al*., 2003; Jha and Vandermeer, 2010), and pest control (Trujillo-Arriaga and Altieri, 1990).

The cultivated lands of south Sinai reach about 14,000 feddans, which rely on rainwater for irrigation. The Governorate is famous for the cultivation of olive trees and fruits. Ferran is the most important agricultural area, known for a long time for the cultivation of fruit and olive trees. It contains many springs and wells (State Information Service).

*Corresponding author:
dr.redarizk@gmail.com

By using remote sensing, some 500-600 farms were believed to occur in the Saint Katherine region. In the mountains and towns, they form a dense network of farms that run along the base of mountain valleys, but in the low desert, they are, more or less, sparse reflecting the lower availability of natural water sources (Norfolk *et al*. 2013).

In the Saint Katherine's Protectorate of South Sinai, Egypt, Bedouins have traditional knowledge of agriculture and goat herding. They have been cultivating mountain gardens for more than one thousand years (Zalat and Gilbert, 2008). These mountain gardens are arid land that depend on runoff rainwater for the growth of a variety of mountainous garden products as well as vegetables and herbs (Norfolk *et al*., 2012). A system of walls and dams captures the runoff rainwater, giving it time to leak into the bedrock where it recharges the underground water and can be accessed through wells, and is used for year-round irrigation (Perevolotsky, 1981).

Due to these rainwater-harvesting techniques, the gardens have a higher potential for plant growth and appear as oases of greenery in the arid mountains. This unusual distribution of resources creates a unique location for studying the diversity effects of agroecosystems and the complementary effects on the national action plan for genetic resources' conservation in addition to the impact of geographic, social lifestyles, and political barriers on the conservation of genetic resources at Saint Katherine.

Material and Methods

Study Area

Saint Katherine Protectorate is situated in the southern part of Sinai and is part of the upper Sinai massif. In 1996, by Prime Ministerial Decree No. 904, Saint Katherine of the largely mountainous terrain in South Sinai, was formally declared as a protected area which contains a unique ingathering of natural resources, in particular high-altitude ecosystems with surprisingly diverse fauna and flora and with proportions of endemic taxa. Saint Katherine Protectorate, located in the arid North African belt, is characterized by a Saharan-Mediterranean climate. Though the altitude moderates the temperature regime, summers are relatively hot, with a mean maximum temperature of 36^{o} C during August, while winters are relatively cool with a mean minimum temperature of -7.8 ^{o}C during February (Omar *et al.,* 2012).

Saint Katherine Protectorate is classified as a hyper-arid region, with mean annual rainfall ranging between 10 mm/year and 60 mm/year in the high mountains. The topography of the high mountains allows for an additional orographic precipitation. This orographic precipitation often comes in the form of snow, and at times this can amount to 300 mm. annually (Grainger, 2003). Rainfall is sporadic, occurring usually between October and May. When it rains, the entire annual rainfall can often fall within a few days and tends to result in heavy flash floods. However, there are fluctuations in precipitation as rainfall is not an annual occurrence and having two or three consecutive years or more without precipitation is common. Precipitation takes the form of sporadic flash floods or limited local showers; thus, a highly spatial heterogeneity because of the received moisture is also common (Omar, 2017).

The study was conducted over the period between April and June, 2019 in the Saint Katherine area, South Sinai, Egypt. Thirty-five gardens from nine areas were selected for studying the horticulture crops of Saint Katherine (Table 1).

Genetic Resources

Fifteen horticulture genetic resources were addressed in Saint Katherine gardens (Table 2).

Methodology

The study depends mainly on the information gathered, using a householder questionnaire, from the studied samples of communities at Saint Katherine. A proper questionnaire

Table 1. Number of sites of the study area

No.	Region	Elevation (a.s.l) in meter	No. of Gardens
1	El Arbeen	1700	1
2	El Esbaia	1600	3
3	El Rasis	1560	11
4	El Shamia	1560	1
5	Wadi El telaha	1500	2
6	Wadi El Raha	1500	4
7	Wadi Gebal	1800	7
8	El Sheikh Awad	1100	2
9	El Tarfa	1200	4
	Total		35

Table 2. The fruit crops cultivated in Saint Katherine.

	No. of trees/ farm		**Production**		Date of cultivation
	No.	range	Kg/tree	range	
Olea europaea	23.58±29.69	(3-120)	17.63±8.54	(8-35)	(1970-2017)
Malus domestica	5.68±5.83	(2-25)	8.05±6.11	(2-25)	(1940-2018)
Prunus armeniaca	5.2±4.70	(2-20)	10.05±9.13	(2-30)	(1970-2017)
Prunus persica	6.86±5.87	(3-18)	9.14±8.21	(3-25)	(1978-2014)
Prunus domestica	3.375±2.39	(2-9)	6.63±7.84	(2-25)	(1978-2018)
Pyrus communis	3.00±1.41	(2-5)	7.50±8.43	(2-20)	(1985-2018)
Punica granatum	4.50±4.19	(2-20)	16.78±9.28	(4-30)	(1955-2018)
Vitis vinifera	11.72±16.66	(2-70)	12.08±9.64	(3-35)	(1940-2018)
Citrus aurantiifolia	1.60±0.82	(1-3)	1.00±0.50	(1-2)	(2007-2017)
Cydonia oblonga	2.77±2.45	(1-10)	10.92±9.67	(2-25)	(1940-2017)
Citrus Singensis	4.00±1.00	(3-7)	5.33±1.53	(4-7)	(2008-2016)
Pistacia vera	14.14±12.86	(4-40)	1.71±0.76	(1-3)	(1980-2017)
Juglans regia	1.00±0.00	(1-1)	1.25±0.35	(1-1.5)	(1978-1985)
Prunus dulcis	13.26±14.00	(1-50)	4.74±3.13	(2-15)	(1945-2017)
Morus sp.	1.20±0.42	(1-2)	4.10±1.79	(2-7)	(1940-2016)

was planned in line with the study objective for data collection to determine and analyse the horticulture crops and sustainable plant genetic resources at Saint Katherine. In this regard, various personal meetings with heterogeneous groups in nine regions were held. Also, the type of horticulture crops, the number of cultivated individuals, date of cultivation, sources of crop propagules and production per tree as well as the soil characteristics s and types of Erosions were all collected to determine the study outline, and identify the most affected crops with different barriers.

Results and Discussion

Fifteen horticulture genetic resources have been recorded in Saint Katherine gardens (Table 3). Older horticulture crops at Saint Katherine were planted before the occupation period (before 1967). Some cultivars including *Malus domestica, Vitis vinifera, Cydonia oblonga and Morus sp.* (Figure 1) have been planted since 1940. Other cultivars such as *Prunus dulcis* have been planted since 1945 and *Punica granatum* has been planted since 1955. The oldest cultivars (100%) recorded were seven horticulture crops, namely: *Olea europaea* (Figure 2), *Prunus armeniaca, Prunus persica, Prunus domestica, Vitis*

Figure 1: An old tree of *Morus* sp. at Saint Katherine

Figure 2 An old tree of *Olea europaea*.

Table 3. The older fruit crops cultivated in Saint Katherine.

	Old cultivars	New cultivars
Olea europaea	100.00	0.00
Malus domestica	73.68	26.32
Prunus armeniaca	100.00	0.00
Prunus persica	100.00	0.00
Prunus domestica	100.00	0.00
Pyrus communis	50.00	50.00
punica granatum	27.78	66.67
Vitis vinifera	100.00	0.00
Citrus aurantiifolia	25.00	75.00
Cydonia oblonga	100.00	0.00
Citrus Singensis	0.00	100.00
Pistacia vera	42.86	57.14
Juglans regia	100.00	0.00
Prunus dulcis	96.30	3.70
Morus sp	60.00	40.00

vinifera, Cydonia oblonga,and *Juglans regia* followed by *Prunus dulcis* (96.30) and *Malus domestica* (73.68) (Table 3).

Olive trees constituted the maximum number of trees that is 100 and 120 at El Rasis of location (28.56361 N, 33.95375 E, 1545m) and (28.54041 N, 33.99191 E, 1641m) respectively. The minimum number of olive trees was three - five, recorded in different traditional gardens.

The most adaptive horticultural crops at Saint Katherine are the vegetatively propagated plants and plants propagated by seeds. Recently, the farmers and Bedouins contacted the agricultural nursery at Ismailia governorate, Desert Research Centre, and Agricultural Research Centre for new cultivars of horticulture crops (Table 4). Few propagules of *Prunus armeniaca* were planted in 1970 during the occupation period of Saint Katherine. These propagules were delivered from abroad. The characteristics of this cultivar resemble those of the cultivars planted in Palestine.

The recent cultivation of most horticulture crops has started since 2014 and is ongoing right now. While the most recent plantation of *Juglans regia* was during the seasons of 1985.

The predominant apparent soil type is the sandy and the sandy and gravelly soils. The sandy loamy soil was apparently recorded at the site of Telaha-1 (Table 5). The slope of soil has no effect on the cultivation of horticulture fruits due to the excellent land preparation before plantation.

The soil is subject to low wind erosion at the small traditional gardens, while water erosion threatens the large garden being close to water running in the wades during the flash flood, especially those surrounded by a weak fence (Table 5).

Farmers and Bedouins believe that drought threatens the agrobiodiversity of horticultural crops the most at Saint Katherine. It is followed by the threat of wild birds to *Malus domestica, Pyrus communis, Vitis vinifera, Cydonia oblonga,* and *Morus* sp. Some other factors which threaten the agrobiodiversity of St. Katherine include insects, pests, fruit worms, rot diseases, gummosis of trees and the attack of bats.

The Bedouins of Saint Katherine need more agricultural extended service package to combat all these factors threatening the agrobiodiversity (Table 6). There are no marketing problems, because most of

Table 4. The origin of fruit crops cultivated in Saint Katherine.

	Origin of tree				
	Propagation in St. Katherine	Agricultural Nursery	Seed propagation	Desert research centre	NA
Olea europaea	16.67	-	-	-	83.33
Malus domestica	-	26.32	-	-	73.68
Prunus armeniaca	-	-	70	-	30.00
Prunus persica	57.14	-	28.57	-	14.3
Prunus domestica	-	-	12.50	-	87.50
Pyrus communis	25.00	50.00	-	-	25
punica granatum	-	66.67	-	-	27.78
Vitis vinifera	64.00	-	-	-	36.00
Citrus aurantiifolia	-	75.00	-	-	25.00
Cydonia oblonga	-	-	46.15	-	53.8
Citrus Singensis	-	100.00	-	-	-
Pistacia vera	14.29	57.14	28.57	-	0.00
Juglans regia	-	-	-	-	100
Prunus dulcis	-	-	51.85	3.70	44.44
Morus sp	30.00	40.00	-	-	30

Table 5. The apparent soil characteristics and types of erosions in the targeted areas of Saint Katherine

	Apparent soil characteristics				Type of erosion			Water salinity
	sandy	sandy-loamy	sandy-Gravelly	Erosion	wind	water	All factors	EC µS/cm
Olea europaea	79.17	4.17	16.67	low	100.00	-	-	(125-830)
Malus domestica	78.95	-	21.05	low	100.00	-	-	(125-830)
Prunus armeniaca	85.00	-	15.00	low	100.00	-	-	(125-830)
Prunus persica	100.00	-	-	low	100.00	-	-	(125-520)
Prunus domestica	75.00	-	25	low	100.00	-	-	(125-370)
Pyrus communis	100.00	-	-	low	100.00	-	-	(193-255)
punica granatum	72.22	-	27.78	low	100.00	-	-	(125-584)
Vitis vinifera	80.00	-	20.00	low	100.00	-	-	(125-830)
Citrus aurantiifolia	75.00	-	25.00	low	100.00	-	-	(370-830)
Cydonia oblonga	84.62	-	15.38	low	100.00	-	-	(125-830)
Citrus Singensis	66.67	-	33.33	low	100.00	-	-	(370-1005)
Pistacia vera	85.71	-	14.29	low	100.00	-	-	(125-830)
Juglans regia	100.00	-	-	low	100.00	-	-	(255-319)
Prunus dulcis	77.78	-	22.22	low	92.59	3.70	3.70	(121-830)
Morus sp	70.00	-	30.00	low	100.00	-	-	(135-830)

the horticulture crops planted in the small gardens are consumed as family food. The farmers and Bedouins only sell surplus fruit products. From spring to late autumn, there are always some seasonal fruits in the Sinai Mountains where the weather is wetter and cooler than the rest of the desert. The valleys of the mountainous region around Saint Katherine contain over 500 ancient orchards. Many are abandoned today, but one can still find a lot of beautiful gardens that are cared for. On one hand, the Bedouins in the Saint Katherine Mountains must deal with the deficiency of water and with the effective flash floods that occasionally sweep through the valleys on the other. Therefore, the walls

Table 6. The threats to the studied horticultural crops at Saint Katherine.

	Threats						
	Climatic factors (drought)	Insect and pests	Gummosis of trees	Bats	Wild birds	Fruit worm	Rot disease
Olea europaea	100.00	29.17	-	-	-	-	-
Malus domestica	100.00	5.26	-	31.58	10.53	-	-
Prunus armeniaca	100.00	-	20.00	-	-	-	-
Prunus persica	100.00	-	-	-	-	28.57	-
Prunus domestica	100.00	-	-	-	-	-	-
Pyrus communis	100.00		-	-	50.00	-	-
punica granatum	100.00	83.33	-	-	-	83.33	83.33
Vitis vinifera	100.00	-	-	-	64.00	-	-
Citrus aurantiifolia	100.00	-	-	-	-	-	-
Cydonia oblonga	100.00	-	-	-	69.23	-	-
Citrus Singensis	100.00	-	-	-	-	-	-
Pistacia vera	100.00	-	-	-	-	-	-
Juglans regia	100.00	-	-	-	-	-	-
Prunus dulcis	100.00	-	25.93	3.70	-	-	-
Morus sp	100.00	-	-	-	50.00	-	-

of the gardens are built stoutly, to help the gardens survive during the flash floods and to hold the soil. At the same time, the presence of holes in the walls and channels also helps redirect the water to wells and reservoirs. The gardeners are experts in grafting. They put branches of better yielding fruit varieties on local cultivars and /or trees that are more resistant to drought. In some instances, up to three different fruit species were grafted on a single tree.

Changes in social lifestyles and fruit diversity are gradually happening at Saint Katherine. Saint Katherine was more isolated during the occupation period (1967-1982). The only road between Saint Katherine and the surrounding areas was towards the east. These situational factors impose some sort of isolation or separation making the exchange of genetic assets for cultivated crops limited. People had to use the existing genetic resources or ones imported from abroad. The native genetic resources of the cultivated crops become completely adapted to the local environment. After the end of the occupation period, some cultivars were introduced from agricultural nurseries. For this reason, Saint Katherine is considered as a unique store for specific fruit cultivars including olives, grapes, pomegranate, lemons, apples, apricots, peaches, oranges, guava and almonds.

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