Central Asian Journal of Environmental Science and Technology Innovation **3**(3): 88-97 (2022)

RESEARCH PAPER

Plantation process, a conservation and local community empowerment approach to climate change in western Iran

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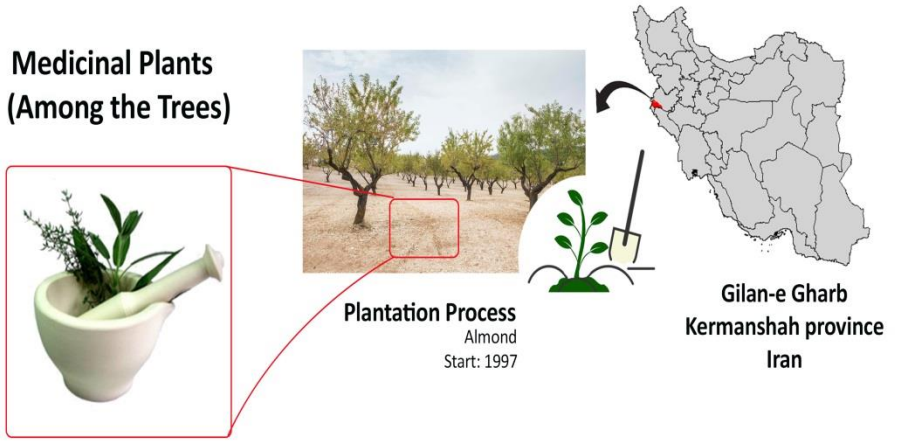
Highlights

- Agroforestry is a comprehensive term for land use and there is usually an economic and ecological relationship between system components (tree, crop and livestock).
- In many areas of Gilan-e Gharb city, various types of plantation have been carried out, which have not been examined quantitatively and qualitatively.
- The purpose of this study is to study the most important plantations in Gilan-e Gharb.

Graphical Abstract



Article Info

Receive Date: 04 January 2022
Revise Date: 07 March 2022
Accept Date: 14 March 2022
Available online: 28 May 2022

Keywords:
Plantation
Climate change
Almonds
Boost production
Empowerment
Nature conservation

Abstract

Plantation characteristics include production of two or more crops while conserving natural resources, use of trees and shrubs, a period of more than one year, suitability for a sensitive environment, and low input. Plantations can also have high social and cultural value compared to other forest management systems and are more complex in structure and application than monoculture farming. The objective of this study is to investigate the existing plantation system in Gilan-e Gharb city. In order to study the plantations in the study area, the almond cultivation unit of Sha'eran village in Cheleh district was identified. The type of plantation, its area, the type of species used, etc. were studied. The almond cultivation projects of Poshteh Samavat, Abdulaziz and Sha'eran villages are located on the national and agricultural lands on the north side of Gar Kouchak hill, which has an area of about 20 hectares. The project was started in 1997 by the residents themselves and with the cooperation of the Natural Resources Department of Gilan-e Gharb City with the planting of almond seeds. The trees in the project area are now about 20 years old. The project is now economically viable and has the opportunity to plant medicinal plants within the project area (among the trees). Planting can serve as a solution for sustainable development in this region so that farmers can maximize production based on the principle of continuous production and the approach of increasing income to conserve forests.

10.22034/CAJESTI.2022.03.00

E-ISSN: 2717-0519
P-ISSN: 2717-4034

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1. Introduction

In the period of climate change, plantation and agroforestry consist of great importance. Plantation is a comprehensive term for land use. In which woody perennials (trees and shrubs) along with herbaceous plants (crops and pastures) are grown permanently (or with livestock) in temporal or spatial order or in both. There is usually an economic and ecological relationship between the components of the system (tree, crop and livestock) (Bolívar-Santamaría and Reu, 2021). The oldest modern plantation system dates back to 1856. When Burmese farmers used the Teungya method to plant Teak (*Tectona grandis*) along with crops. This method later became popular in parts of India. In Indonesia, Teak planting by Intercropping method became common. These measures were on a small scale but in large numbers, which was the result of the beginning of the movement of private foresters. Later, the Teungya system was abandoned altogether, and some farmers, who considered forest intrusion to be the right thing to do by intercropping forest trees, tended to mono-cropping and produce crops (Rabbani and Safdary, 2021).

Plantation systems can be classified according to the following criteria: 1) Structure: The study of the composition of the components includes the spatial composition of the wooden component, the vertical arrangement of the components and the ground arrangement of the different components. 2) Task or operation of the system: This criterion is determined based on the task or general role of the system and mainly the role of trees (production role, protection, etc.). 3) Socio-economic: Paying attention to the level of input management or the intensity and scale of management and business goals. 4. Ecological basis: Considering environmental conditions, assuming that certain systems can be more suitable for certain ecological conditions (Von Carlowitz, 1989). Plantation features include the production of two or more crops while preserving natural resources, emphasizing the use of trees and shrubs, a period of more than one year, suitable for sensitive environments with low inputs. Other features include high social and cultural value compared to other forest management systems and being more structurally and functionally more complex than mono-cropping (Bouyoucos, 1962). Vital areas for plantation also include encroached forest lands, abandoned and marginal lands with various properties, including river or delta banks, watersheds with acute conditions (such as slopes that can be terraced), and shifting cultivation.

Ecological benefits of plantation include ecological restoration, soil fertility, wind-breaker and shelterbelt, soil conservation, bio-drainage, increasing soil water capacity for the crop, Nitrogen fixing soil by planting Legum family. Other benefits include nutrient enhancement due to the addition of materials resulting from Litter decomposition, water logging and soil salinity. Also completing the soil nutrient cycle due to root access to different parts of the soil, better protection of the ecological status of the upstream lands (due to stabilization of agriculture and tree planting), prevention of surface water wastage and soil leaching, soil nutrients and erosion is. Other benefits include improved microclimate by lowering soil surface temperature and reducing evaporation (due to the composition and amount of litter decomposition, tree shade, and lowering of surface water) (Lehmann et al., 2020; Zargaran Khouzani and Gharineh, 2021).

The social benefits of plantation include employment, increasing the culture of conservation of natural resources, raising the income level of the villagers, a good source of fuel and energy for the villagers, producing fodder and food for the animals. Other social benefits include the provision of agricultural and rural industries, the optimal use of abandoned land and degraded land, the settlement of rural communities (prevention of immigration), the reduction of pressure on forests and the provision of recreation values (Nerlich et al., 2013). Plantation methods include breeding fallow in intermittent agriculture (Tuba plan and public participation). Although fallow is good and restores lost nutrients, it can lead to deforestation, forest degradation, and finally erosion and destabilization of the ecosystem, especially in sloping lands. The Teungya system consists of Taung meaning hill and Ya meaning planting. After land preparation, crops are planted under trees for 1-3 years. When trees become denser and shade increases, cultivation is repeated in other parts of the land (Nair, 1993). In the multispecies tree gardens system of plantation, different types of (fruitful) garden tree species are cultivated. The main goals of this system are to produce food, fodder and wood products for home use and income.

The Alley crapping system is also known as Hedgerow intercropping. In the strip or corridor between rows of woody trees, crops are planted uniformly. Nitrogen-fixing trees are essential where nitrogen is needed to produce crops. The main objectives of this system include planting corridors including maintaining or increasing crops, improving soil microclimate (by reducing evaporation), and weed control (by surface mulching). Other goals include providing wood products (firewood, wooden beams for buildings, food, medicine and fodder) and preventing erosion (due to the establishment of trees and shrubs and their branches) (Spiegelaar et al., 2013). The goals of the Silvo-Pastural System (tree + pasture and / livestock) include the production of woody plants in combination with pasture. Other goals of this system include improved rangeland in mixing with tree species-simultaneous planting of Gramineae (or a mixture of Gramineae and legumes or legumes) with perennial woody plants. This system is the best management system for abandoned (barren) lands that are poor.

In the protein banking system, a variety of multi-purpose trees (rich in protein) are planted in barren or arable lands and cultivated forage (Ritvo et al., 2003). In order to meet the nutritional needs of cattle in winter. In the live fence system, fodder-producing trees and chaparral plants and fodder trees are planted as live fences at the border of the plots. In the system of trees and shrubs in the pasture, different species of trees and shrubs are considered regularly and irregularly to provide supplementary forage (Kalaba et al., 2010). The Homestead plantation system is one of the oldest integrated cultivation systems widely used in rainy areas in tropical South and Southeast Asia. In India, it grows in humid tropical regions where coconut is the main crop. In this system, a diverse set for raising livestock (cattle, buffalo, goats, sheep, and poultry) is created through the cultivation of forage plants and legumes, as well as the surplus of human food. Livestock manure is also used as fertilizer for crops (Pinho et al., 2012).

Despite the significant measures and efforts taken by the Forests, Rangelands and Watershed Management Organization for the protection, restoration, development and sustainable exploitation of natural resources. Rarely can one trace the scientific documentation of these measures in order to provide appropriate information and create learning centers and generalize successful experiences. Thus, if based on a result-oriented action, the purpose of the process of identifying and documenting the best practices is to introduce lessons learned. Which can be generalized and can be used as a model to convince stakeholders and related stakeholders, including users and implementers of natural resource projects to change behavior and better performance. It must be said that we have not been very successful in this regard. The mission of education and promotion requires that the initiatives and effective measures taken for the sustainable management of the land, the responsible government departments or by the local communities be properly identified and evaluated and made available to others. Applying evaluation in this process is important in order to convince others in the generalization process that these actions take precedence over conventional methods. In many areas of Gilan-e Gharb city, various types of plantation have been carried out, which have not been examined quantitatively and qualitatively. Therefore, the purpose of this study is to study the most important plantation in Gilan-e Gharb.

2. Materials and methods

2.1. Area of study

The study area is Gilan-e Gharb city, which is located in Kermanshah province. Gilan-e Gharb is located from the north to Sarpol-e-Zahab and Dalahu from the north, from the northeast, east and southeast to Islamabad-e-Gharb, Sarablah, Ivan-e-Gharb and Ilam, and from the south and southwest to Sumar and Mandali (Iraq) and the west is Qasr-e-Shirin (Fig. 1). Gilan-e Gharb is located at an altitude of 804 meters above sea level and the city center is one of the warm regions of Kermanshah province. The further east and north of the city, the higher the altitude and the colder the air, and the further south and west and the Iraq border, the warmer the air and the lower the altitude. For example, from the center of the city to Islamabad-e-Gharb or Kermanshah, after 15 km from the height of 800 meters, the city reaches an altitude of 1100 meters in the surrounding villages in the village of Cheleh, and after 68 km, in the Govaver section, it reaches an altitude of

1500 meters. On the contrary, as you move towards Iraq or Qasr-e-Shirin, it gradually reaches an altitude of 500 meters and even 290 meters at the Sumar border.

Fig. 1. Location of the study area.

In order to investigate the plantation in the study area, the almond cultivation unit of Sha`eran village in Cheleh district was identified. The type of plantation performed, its surface, the type of species used in them, etc. were studied.

3. Results and Discussion

3.1. Successful project title

Rainfed almond cultivation project for sustainable land management in Poshteh Samavat, Abdolaziz and Sha`eran villages. The rain-fed almond cultivation project of the villages of Poshteh Samavat, Abdolaziz and Sha`eran is located in the national and agricultural lands on the northern side of the hill known as Gar Kochak. The coordinates of the four corners of the project site are as described in the map below and its area is about 20 hectares (Fig. 2).

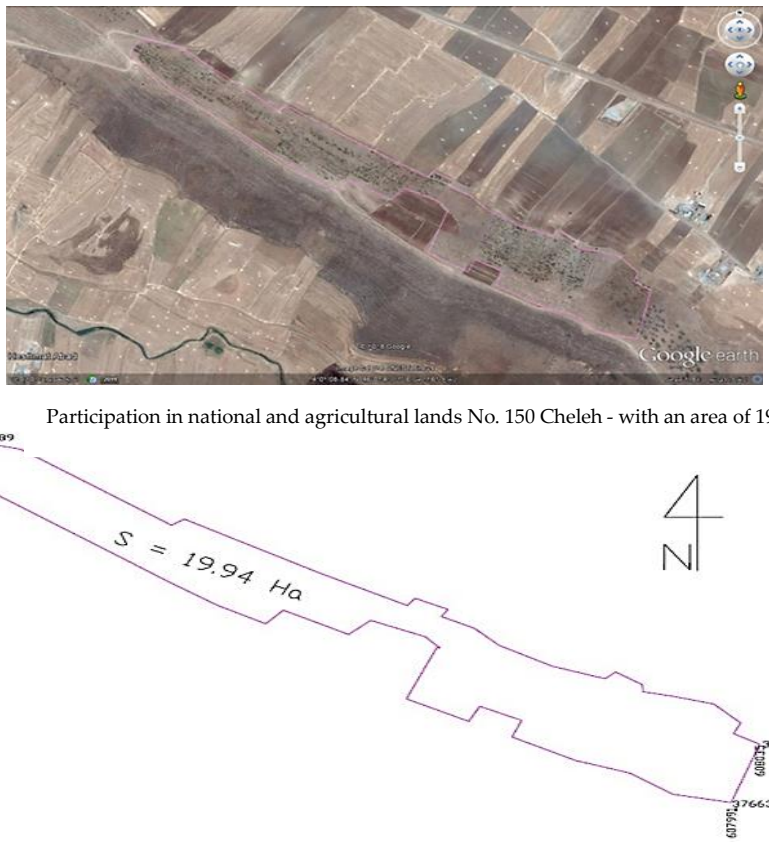

Fig. 2. Image of the study area from the top view (Photo source: Google Earth).

This project was started by the people themselves and with the participation of the Natural Resources office of Gilan-e Gharb city in 1997 by planting almond seeds, and now the trees in the project area are about 20 years old (Fig. 3).

3.2. Natural and biophysical condition (climate, soil, topography, etc.)

Average annual rainfall of the Sha`eran in 2001: 591 mm, soil type: Silty clay loam, altitude: 1270-1230 m, climate based on the Ambergeh method: semi-humid cold (Table 1).

Table 1. Atmospheric characteristics per month.

January	January, like December, is another chilly winter month with average temperature varying between -4.3°C (24.3°F) and 6.5°C (43.7°F). January is the coldest month, with an average high-temperature of 6.5°C (43.7°F) and an average low-temperature of -4.3°C (24.3°F)
February	February, the last month of the winter, is another chilly month, with average temperature fluctuating between -3°C (26.6°F) and 8.9°C (48°F). In Kermanshah, the average high-temperature in February is relatively the same as in January - a still frosty 8.9°C (48°F).
March	The first month of the spring, March, is a moderate month with average temperature varying between 1.2°C (34.2°F) and 14.3°C (57.7°F). In March, the average high-temperature increases, from a frosty 8.9°C (48°F) in February, to a moderate 14.3°C (57.7°F).
April	April is an enjoyable spring month, with average temperature fluctuating between 5.1°C (41.2°F) and 19.7°C (67.5°F). In April, the average high-temperature increases, from a mild 14.3°C (57.7°F) in March, to a comfortable 19.7°C (67.5°F)
May	The last month of the spring, May, is a moderately hot month with average temperature ranging between max 25.8°C (78.4°F) and min 8.2°C (46.8°F). In May, the average high-temperature increases, from a comfortable 19.7°C (67.5°F) in April, to a moderately hot 25.8°C (78.4°F)
June	The first month of the summer, June, is a tropical month with average temperature ranging between min 11.4°C (52.5°F) and max 33.3°C (91.9°F). In Kermanshah, the average high-temperature in June increases, from a warm 25.8°C (78.4°F) in May, to a tropical 33.3°C (91.9°F).
July	July is a sweltering summer month, with temperature in the range of an average high of 37.8°C (100°F) and an average low of 16.1°C (61°F). With an average high-temperature of 37.8°C (100°F) and an average low-temperature of 16.1°C (61°F), July is the warmest month. Months with the lowest humidity in Kermanshah are July and August, with an average relative humidity of 23%.
August	August, the last month of the summer is another very hot month, with average temperature fluctuating between 15.4°C (59.7°F) and 37°C (98.6°F). In Kermanshah, the average high-temperature in August is essentially the same as in July - a still very hot 37°C (98.6°F).
September	September, the first month of the autumn, is still a hot month, with average temperature ranging between max 32.5°C (90.5°F) and min 10.6°C (51.1°F). In September, the average high-temperature slightly decreases, from a sweltering 37°C (98.6°F) in August, to a hot 32.5°C (90.5°F)
October	October, is a moderately hot autumn month, with average temperature varying between 25°C (77°F) and 6.4°C (43.5°F). In October, the average high-temperature drops, from a tropical 32.5°C (90.5°F) in September, to a warm 25°C (77°F).
November	November, the last month of the autumn, is another comfortable month, with average temperature fluctuating between 1.8°C (35.2°F) and 16.7°C (62.1°F). In November, the average high-temperature significantly decreases, from a warm 25°C (77°F) in October, to a comfortable 16.7°C (62.1°F).
December	The first month of the winter, December, is still a chilly month with average temperature fluctuating between 9.7°C (49.5°F) and 1.7°C (35.1°F). In December, the average high-temperature drops, from a comfortable 16.7°C (62.1°F) in November, to a frosty 9.7°C (49.5°F).

Fig. 3. Overview of almond cultivation done in the vicinity of agricultural lands.

3.3. Vegetation

Dominant rangeland plants in this area include Bromus (*Bromus secalinus*), Agropyron (*Agropyron cristatum*), Acantholimon (*Acantholimon lycopodioides*), Acanthophyllum Sp., Onobrychis sativa, Alopecurus sp., Thyme sp., Fabaceae sp., Glycyrrhiza glabra and Grasses species**.**

3.4. Status of water resources

Average annual rainfall of the Sha`eran: 591 mm, groundwater condition: poor, irrigation: using rainfall (Table 2).

Table 2. Precipitation status from 1998-2017.

Year/Month	1	2	3	4	5	6	7	8	9	10	11	12
1998	23.5	20.1	29.4	33.4	34.2	31.4	25.2	19.9	15.9	11.2	10.4	12.2
1999	15.6	18.1	30.9	31.4	32.5	27.3	24.5	16.6	10.2	8.2	7.4	9.4
2000	19.3	24.9	29.6	34.7	35.7	29.7	24.9	15.5	10.9	9.1	7.8	12.6
2001	18.8	23.6	28.5	31	35.9	30.1	25.8	17.5	11	9.3	9	13.2
2002	15.1	19.7	27.4	31.8	31.3	27.8	26.7	18.1	11.1	7.6	8.8	10.9
2003	15.6	21.8	27.9	31.3	31.7	28.2	25.7	17.3	11.4	9.3	9	12.8
2004	16	20.7	27.7	31.5	31.2	29.5	27.1	18.8	7.7	8.2	6.4	11.5
2005	15.8	21.8	27.7	31.1	32.3	28.5	24	15.4	16.2	7.9	8.2	13.2
2006	16.5	22.3	29.6	30.6	33.1	29.3	23.6	15.7	9.6	5.7	9.2	11
2007	14.2	21.6	29	31	33	30.6	25.7	18.6	9.9	4.6	4.6	12.8
2008	19.7	23.2	27.8	31.5	32.5	31.1	24	16.1	11.3	7	10	11.5
2009	13.5	21.8	28.6	30.9	31.4	28.4	23.9	17.3	10.3	12.3	11.5	14.3
2010	16.0	21.2	29.2	31.3	34.4	31.2	25.8	20.0	14.8	9.4	7.4	11.9
2011	16.2	20.5	28.6	32.2	33.7	29.2	23.6	15.2	10.2	9.5	8.0	8.9
2012	16.4	24.0	28.9	31.7	33.3	29.8	25.9	18.7	11.1	8.4	10.9	13.0
2013	17.5	19.7	26.6	31.8	31.3	28.9	22.3	16.4	10.4	8.6	8.5	13.4
2014	16.3	24.3	28.6	32.2	32.9	30.0	23.7	16.2	12.7	8.3	12.1	12.1
2015	16.2	23.6	29.4	31.9	34.5	31.8	26.2	15.8	10.9	9.3	8.8	14.5
2016	14.8	23.6	27.2	33.3	33.3	31.5	24.5	19.9	9.6	9.6	6.7	12.0
2017	15.6	23.4	28.0	33.9	34.8	32.6	24.0	20.3	12.0	12.2	11.4	14.2
2018	19.1	20.9	28.8	32.5	32.4	31.6	27.0	16.5	12.3	8.5	9.5	9.9
2019	14.7	20.6	30.6	31.6	33.0	30.1	26.9	17.9	12.3	9.9	8.1	14.3
Long-term mean	16.7	21.9	28.6	31.9	33.1	29.9	25.0	17.4	11.4	8.8	8.8	12.2

3.5. The prevailing socio-economic situation of local people

A village was adjacent to the plantation area (Fig. 4).

Fig. 4. The Sha`eran village location to Almond plantaion (Photo source: Google Earth).

3.6. Income level

The income of rural households in the village is low to medium levels. According to the results, the average annual income of a rural household was 114,233 thousand rials (Table 3).

3.7. Main and secondary sources of income

The predominant situation of the poor people, mostly farmers and ranchers (Table 3).

Table 3. Average annual total income of a rural household in 2013-2018 (thousand rials).

Years	Total income	Change Compared to the Previous Year (%)
2013	121091	-
2014	139051	14.8
2015	161038	15.8
2016	176866	9.8
2017	201842	14.1
2018	233114	15.5

3.8. Land ownership

It is state property, it is only the right of exploitation with the executor, but in the form of transfer of Article 3, measures are being taken.

3.9. Explanation (capacities and potentials, target group, etc.)

Has a total area of about 20 hectares, 20 hectares of rain-fed almonds have been planted. The project is now economically viable and has the capacity to plant medicinal plants within the project area (between trees). Planting and exploiting rainfed almonds using local knowledge and scientific methods.

3.10. Successful project criteria

Carrying out plowing activities to protect the soil in sloping areas, constructing pans and planting seeds with the participation of the people and the economic efficiency of the project are currently on the project implementers. Directing runoff in seeded pits, preventing livestock from entering the field, protecting and

creating this culture among the villagers, holding watershed management and natural resources training classes. Economic index with increasing income and human index.

3.11. Problems (direct and indirect causes) and the goals of a successful project

The entry of livestock into the project area and the lack of familiarity of the implementers with the principles of horticulture and the lack of rainfall in recent years. Land degradation, soil erosion, drought, social problems, surplus livestock and improved animal diversity.

3.12. Issues related to sustainable development and productivity

Optimal use of pasture without damage to soil and water.

3.13. Identify the executive goals of project:

Prevent soil erosion, increase productivity, increase the economic power of the operator. Improving living conditions - Preventing soil erosion - Employment - Increasing plant and animal diversity - Creating a model for garden cultivation and increasing horticulture in the region - Promoting the preservation of a culture of sustainable natural resources.

3.14. A brief description of the main activities

The project has been completed and is under development and has largely achieved the project objectives.

3.15. Technical characteristics of the technology, methods and policies:

Full cooperation of the project manager and close cooperation of the Natural Resources Department with him in order to treat and plant almond seeds.

3.16. Associated actions with the project. The governmental and non-governmental organizations that participate in this process.

Yes, in partnership with the Natural Resources and Watershed Management Authority.

3.17. The role of those involved in the design, introduction, application, and maintenance of technology

Purchasing suitable and high quality inputs (seeds), providing technical guidance on how to treat and plant seeds and perform operations.

3.18. Did locals pepole play a function in the successful design process? How?

Yes. Efforts to implement the plan.

3.19. Efficiency and effectiveness of the project (i.e. production improvement, and environmental impacts)

Significantly improve the natural environment and create a green forest surface, improve production.

3.20. The effects of a plan on improving the livelihood and economic situation?

With the fall of the trees and their fruitfulness, the economic situation of the people has improved due to the sale of the product of the project.

3.21. The effects of a plan on raising the empowerment of local communities

Increasing the financial strength of executives - positive effects on neighbors and encouraging local people to develop rain-fed almonds.

3.22. The economic and financial evaluations performed for the successful plan.

Increasing the financial power of presenters.

3.23. Considerations can the successfully introduced plan be generalized to other regions

Yes, by justifying the beneficiaries and training classes and people visiting other areas of the project area.

3.24. Three main conditions result in the success of the project/ technology

The willingness of the implementers on the progress of the project- Close relationship with the Department of Natural Resources and implementation of technical recommendations of experts- Positive extension issues of the city and the General Administration.

3.25. The lessons learned from successful human resource planning, policy making, techniques, and financial aspects

Increasing the financial strength of facilitators and educational classes.

4. Conclusion

The plantation system has more capabilities in terms of ecology and agriculture than other farming systems. In this system, the movement of water and wind is reduced and soil erosion is minimized and causes soil fertility. Therefore, this article is based on the study and classification of conventional plantation systems and ecological and economic impacts in order to develop sustainable agricultural production. It is now clear that any increase in food production, instead of increasing the area under cultivation, should be done by increasing the fertility of arable land. A large part of the current low-yield lands must be removed from cultivation for ecological and economic reasons. Since agricultural land is declining and some land is occupied by roads, housing and industry, soil care should be a fundamental task. In general, tree cultivation can have more significant and beneficial effects, and this action should be considered and implemented as a national program. But this program will be applicable only when the cultivation of trees is combined with the most important system of agricultural land use, namely agriculture. If plantation is considered as an important land-use system, man will not only be able to meet his food needs but will also protect this beautiful land from destructive environmental events.

This management system should be used in terms of the cultural, economic, social, ecological characteristics of the region. In other words, plantation is a comprehensive term in the land use system and technology, based on which trees, crops and animals are used optimally by creating the spatial and temporal arrangement. Unfortunately, in our country, there are still no resources on plantation issues and various plantation systems that play a decisive role in sustainable agriculture. While the use of plantation systems in many parts of Iran, considering that Iran is located on the arid and semi-arid belt of the world in terms of classification and multi-purpose land management in it is very important. In addition to preventing the destruction of forests and vegetation, it can play a very effective role in protecting water and soil, fertility of agricultural lands and in combining trees, agriculture and livestock, and thus in increasing farmers' incomes. The main plantation systems in the country are found in the western region and the margins of Zagros forests. Because deforestation is abundant on the outskirts of villages, and marginalized people are heavily dependent on these forests. Zagros forests cover about 40% of the country's forests and have arid and semi-arid conditions, which reflects the special conditions of these forests and reveals the importance of studies in these areas. Therefore, plantation can be a solution in managing sustainable development in this region so that farmers can achieve maximum production according to the principle of continuous production and the approach of increasing income in order to preserve forests. The first step in the scientific development of plantation systems is the identification and classification of experimental systems in each region to enable the expansion and modification of these systems.

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How to cite this paper:
Javanmiri Pour, M., 2022. Plantation process, a conservation and local community empowerment approach to climate change in western Iran. *Cent. Asian J. Environ. Sci. Technol. Innov.*, **3**(3), 88-97.