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# Explaining the Livelihood Strategies Based on Sustainability and Vulnerability in Drought Conditions in Kurdistan Province

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K E Y W O R D S: Drought, Sustainable Livelihoods, Livelihood Strategies, Farmer's Decision, Kurdistan Province.

**ABSTRACT**: The main aim of this study was to explore the livelihood strategies of sustainability and vulnerability in drought conditions. For this purpose, the research population consisted of all small-scale farmers in Kurdistan province (N=112000). By using of Morgan table, 402 beneficiary farmers by multi-stage stratified sampling method were selected. The main study instrument was a questionnaire which its validity and reliability was confirmed by a panel of experts and Cronbach's alpha, respectively ($\alpha > 0.7$). Data were submitted to $SPSS_{win19}$. The results showed that there was observed significant differences among different cities based on stability so that the city of Dehgolan and Sanandaj had the highest and lowest levels of stability, respectively. Mathematical model of vulnerability showed that drought had various effects on different cities. Eventually, the results of decision tree indicated that farmers who had the greater stability and less vulnerable, used diversification strategy more and migration strategies less, so that the model is likely (69.7 percent) able to classify farmers in two different classes according to diversification and migration strategies.

## Introduction

The majority of the population employed in agriculture in developing countries especially Iran work in small-scale operating system. According to IFAD report, approximately 450 million smallholder farmers living around the world provide the subsistence of two billion people (FAO, 2015: VSF Europa, 2012). Smallholder or small-scale farmers have high proportion of food production needed in developing countries so that 90 percent of farmers who have farms of less than 2 ha, live in developing countries (World Bank, 2008). Thus, smallholder farmers are considered as the core of global food security (Horlings and Marsden, 2011: Chappell and LaValle, 2011: Tscharntke et al., 2012). However, the climatic phenomena such as drought stress have adverse effects on all aspects of rural life from income to food security and even environmental degradation and the national economy (Meinke et al., 2006). In fact, the drought due to its significant economic losses, is considered as the most hazardous natural disaster that damages agriculture and water resources of the country (Karali et al., 2011: Risbey et al., 1999: Vignola et al., 2010). Therefore, in the current condition of drought, water scarcity and its adverse effects on agricultural production and economic development is a global concern (Liu et al., 2008). In many countries, drought results in insecurity of farmer's livelihoods and makes major challenges on the sustainability of their livelihood (Berg, 2010), and this value will be highlighted for countries, which have small-scale subsistence (Alpizar, 2007: Endfield et al., 2004). Hence, only relying on agriculture is impossible to survive or improve people's lives of the rural areas, but various strategies are required to stabilize livelihoods in critical situations (Thieme, 2006). In general, stabilizing livelihoods approach includes economic, social, environmental and other aspects that directly and indirectly as predictable and unpredictable factors affects the welfare of people, because the stabilization of livelihood family is an effective strategy to omit the poverty in these critical conditions (Hal et al., 2009). Sustainable rural livelihoods are approaches attempting to solve the problem of poverty and vulnerability of households on the centrality of human beings (Phillips & Potter, 2003). This approach in recent years has been the best way to address the issues of poverty and empowering the poor against natural disasters (Dearden et al., 2002).

One of the most important definition of sustainable livelihood belongs to Chambers and Conway (1992), which states that livelihood consists of required capabilities, properties (resources and rights to access them) and activities (jobs) which are necessary for life. A sustainable livelihood is a livelihood that can adapt against pressures and shocks and of course recovers

from it, it should also improve its capabilities and provide sustainable livelihood opportunities for next generations (Chambers & Conway, 1992). In this regard if we define livelihood as live, being alive, abilities, properties and activities, we should pay more attention in determining livelihood strategies (McDonagh and Bunnig, 2009). Livelihood strategies in drought conditions are the activities used by households to survive. In studies which are related to sustainable livelihood against critical conditions, three types of strategies are used by households that clarify the importance of holistic point of view (Ashley, 2000: Bebbington, 1999a: Carr, 2014: Mcsweeney, 2004). The first strategy is livelihood diversification, which is defined as a process in which households apply a set of various activities and supportive capabilities to improve the standards of their lives. For instance, a rural household can combine set of livelihood activities like agricultural production, laboring, ranching etc. in order to fulfill livelihood needs. This combination of activities relies on household's capability against risk, famine, market failure and some other coping conditions against shocks. Although it can be seen how a large number of households diversify their livelihood strategies, empirical assessment of this type of livelihood diversification is very difficult to generalize the effects and consequences (Hussein & Nelson, 1998: Lashgarara, 2009: Sharafkhani, 2011). The second strategy is "Deep Agriculture". Deep agriculture (concentrated or intensive) can improve rural livelihoods by increasing agricultural production over the time. Researchers define deep agriculture as the growth in average data and inputs or in capital or labors in a small range to enhance the value of its output per hectare. This type of agriculture is known because of increasing usage of natural or chemical fertilizers, genetically modified seeds, mechanization, multiple cropping and changes such as changes in irrigation methods or soil conservation actions (TIffen et al., 1994: Benjamin et al., 2009: Lire et al., 2006). The third strategy in the period of crisis is migration. Migration has an important role in the resilience of farmer's livelihoods against drought. In fact, migration is one of the livelihood strategies that rural households increasingly utilize it. Migration also plays an important role in analyzing the resilience of rural livelihoods in critical situations that links micro and macro-economic levels. The effect of livelihood crisis can represent decision to migrate in sustainable livelihood analysis, it can also represent how migrations can be combined with social institutions and other strategies. Pursuing migration patterns and decision makings with other coping strategies can represent relationships between migration and local institutions (Eriksen et al., 2009). In this regard this research aimed to determine the general livelihood strategies considering sustainability and vulnerability in drought conditions in Kurdistan province. To achieve this goal, following specific purposes are considered:

Analysis of sustainable livelihoods among small-scale farmers in drought conditions

Analysis of vulnerability among small-scale farmers in drought conditions

Determination the general livelihood strategies considering farmers sustainability and vulnerability in drought conditions.

**Methodology**

The nature of this research is quantitative, and it is a practical research. This research is also descriptive and correlational based on the method of data collection. The study population consisted of all small-scale farmers in Kurdistan province (N=112000). By using Krejcie & Morgan Table 402 people were selected in Sanandaj, Divandarreh, Qorveh, Dehgolan and Marivan cities. This selection was conducted by multistage sampling method (cities were considered as class factor). The main research tool was a pre-tested questionnaire. The questionnaire consisted of three sections. The first part included 35 indicators to measure the sustainability of farmer's livelihood in drought situations, at the next step the validation of indicators was confirmed and then they were chosen based on three criteria (Comprehensibility, measurement capability and Policy value) (Mohammadi, 2013). After choosing the indicators, their scale bias eliminated through division by mean, then indicators were weighted by Shannon Enthropy method and after turning negative indicators to positive, the Composite Index (CI) was formed.

$$CI= \sum_{i=1}^{n} \frac{Xij}{\bar{x}} . Wij$$

CI: Sustainability index

Xij: Index amount i related to the operation j

$\bar{x}$ : Index average Xi

Wij= weight of index I (Kalantari, 2012).

The second part of the questionnaire was related to the assessment of farmer's vulnerability during drought, this assessment was done using Me-Bar and Valdez (2005) mathematical model. For implementing this part, some parameters were extracted based on vulnerability dimensions (economic, social, environmental and psychological aspects). For each parameter, five options were set as a scenario that demonstrated the farmer's situation in drought conditions. In other words the first option shows the best occasion and less vulnerability, and the fifth option shows the worst condition and the most vulnerability. At the next step for weighting the parameters, some questionnaires were set and presented to the agricultural experts (Managers and heads of agriculture agency) to weight them from 0-10, based on their importance in vulnerability in drought conditions. The important point is that the relationship is established on the total weight of each factor of vulnerability.

$\sum Wi = C_0$

$C_0 = (Wmax \times n) /2$

$C_0 < Wmax \times n$
$\sum Wi = (Wmax \times n) /2$
$W_{Max}$: Maximum weight of each parameter
n: Parameters number of operating

Finally, the mean weight of each parameter is obtained for the relative importance of the parameters considered in the overall vulnerability. Finally, calculate the vulnerability of each factor is calculated using the following formula:

$V = 1 / C_0 (\sum_{i=1}^{n} PiWi$

In this equation; V (Vulnerability), Pi (amount of each parameter), Wi (weight of each parameter) and C (Total weight of vulnerability).

Finally the third part of the questionnaire, evaluated the three strategies (diversification, intensive agriculture and migration) and at the end this section was analyzed by decision tree. This statistical technique try to make an organized model based on the decision tree. This method will organize observation into groups and obtain the predicted values of dependent variable, based on the values of independent values. This method is a valid tool for analyzing classification in an exploratory or confirmatory way. There are various ways for decision tree, the interactive automatic splitting chi-square method is the most useful one. To evaluate the model's prediction accuracy the risk coefficient statistic is used, in this coefficient the value higher than 1 is proposed. In the presented model in the strategies subsection 1. Diversification strategy, 2. Intensive agriculture strategy and 3. Migration strategy exist. In the sustainable livelihood subsections 1. Low sustainability 2. Medium sustainability and 3. High sustainability exist and finally in vulnerability subsection 1. Low vulnerability 2. Medium vulnerability and 3. High vulnerability exist. In order to estimate the reliability of questionnaire, Cronbach's alpha coefficient and split-half method was used, the alpha value for sustainability was 0.82 and for vulnerability it was 0.77 and the split-half reliability coefficient for sustainability strategies was 0.84 Hence the questionnaire has a good reliability cause the Cronbach's alpha for each part of the questionnaire was higher than (0.7). For analyzing data in descriptive and analytical sections, $SPSS_{win19}$ software was used.

**Result**

***Analysis of livelihood sustainability among small-scale farmers in drought conditions***

The results of the comparison demonstrated that among all the Kurdistan province cities, Qorveh had the highest level of livelihood sustainability and Sanandaj had the lowest level. This comparison was based on the economic dimension. The social dimension of the comparison showed that Marivan and Dehgolan have the highest level of livelihood sustainability. Based on the environmental dimension, Divandarreh had the highest level of livelihood sustainability and Qorveh had the lowest level. And finally based on the institutional dimension, Marivan and Sanandaj had the highest level and lowest level of livelihood sustainability respectively. In terms of the combined sustainability (Total sustainability), Dehgolan city had the highest level of livelihood sustainability and Sanandaj city had the lowest level (Table 1).

Table 1. Sustainable livelihoods in cities of Kurdistan Province

| City | Economic Sustainability | Social Sustainability | Environmental Sustainability | Institutional Sustainability | Total Sustainable |
|---|---|---|---|---|---|
| Sanandaj | 4.33 | 5.76 | 14.55 | 21.14 | 45.78 |
| Divandarreh | 4.88 | 5.98 | 15.87 | 21.33 | 48.08 |
| Qorveh | 5.10 | 5.64 | 14.21 | 21.33 | 46.27 |
| Dehgolan | 5.08 | 6.22 | 16.26 | 23.36 | 50.92 |
| Marivan | 4.68 | 6.00 | 15.66 | 24.32 | 50.62 |

The results of the study illustrated that there is a significant difference between the total sustainability of the cities, for example there is a significant difference between Sanandj and Divandarreh, Dehgolan, and Marivan at 0.05 level. In other words, Sanandaj sustainability level was much lower than other cited cities (Table 2).

Table 2. Mean comparison of livelihood sustainability in the cities of Kurdistan Province

| F | First City | Mean | Second and Third City | Mean | Mean Difference | Std. Error | Sig |
|---|---|---|---|---|---|---|---|
| $9.22^{**}$ | Sanandaj | 45.75 | Divandarreh | 48.08 | $-1.78^{*}$ | 0.42 | 0.004 |
| | | | Dehgolan | 50.92 | $-2.12^{*}$ | 0.53 | 0.003 |
| | | | Marivan | 50.62 | $-2.07^{*}$ | 0.49 | 0.003 |

$^{**}$Significant at 1% level; $^{*}$Significant at 5% level

***Analysis of vulnerability among small-scale farmers in drought situations.***

In order to study the conditions of farmer's economic vulnerability in drought situations, eight parameters were used. Table 3 shows the results of the vulnerability level in studied cities. This table indicated that "Poverty and deprivation" and "Farm income" have the highest weight (relative importance) among economic factors related to cities vulnerability. The results also showed the highest and lowest level of economic vulnerability was obtained in Sanandaj and Qorveh respectively.

Table 3. Amount and weight of the economic parameters of agricultural livelihoods in the studied cities

| Parameter Weight | Economic Parameters | Parameter Amount | | | | |
|---|---|---|---|---|---|---|
| Wi | | Divandarreh Pi | Qorveh Pi | Dehgolan Pi | Sanandaj Pi | Marivan Pi |
| 6.48 | Poverty and Deprivation | 2.85 | 2.25 | 3.38 | 3.45 | 4.02 |
| 4.32 | Saving | 3.36 | 2.78 | 3.25 | 4.12 | 3.85 |
| 5.12 | Malnutrition | 3.17 | 2.84 | 2.88 | 2.25 | 2.08 |
| 3.23 | Crop losses | 3.64 | 2.32 | 3.75 | 3.29 | 3.38 |
| 4.36 | Renovation of lands | 3.58 | 3.16 | 2.74 | 3.49 | 3.44 |
| 4.19 | Insurance Products | 1.28 | 2.85 | 1.46 | 2.28 | 2.24 |
| 6.45 | Farm income | 4.05 | 4.12 | 3.85 | 4.25 | 4.14 |
| 5.85 | Non-farm income | 4.02 | 3.76 | 3.36 | 3.42 | 2.98 |
| Total Economic Vulnerability | | 3.5 | 2.92 | 3.12 | 3.28 | 3.25 |

Pi: Amount of each parameter on a scale of 1 (vulnerability Lowest) until 5 (vulnerability highest)
Wi: Relative importance of each parameter 0 (weight lowest) until 10 (weight highest)

In studying the status of social vulnerability, five cities were examined based on seven parameters. Table 4 indicates the importance of "life stability" and "commuting crimes" parameters in social vulnerability assessment. The results also indicated that Qorveh and Dehgolan had maximum and minimum social vulnerability level respectively.

Table 4. The amount and weight of the social parameters of agricultural livelihoods in the cities studied

| Parameter Weight | Social Parameters | Parameter Amount | | | | |
|---|---|---|---|---|---|---|
| Wi | | Divandarreh Pi | Qorveh Pi | Dehgolan Pi | Sanandaj Pi | Marivan Pi |
| 6.02 | Commuting Crimes | 3.38 | 4.12 | 2.80 | 3.98 | 3.58 |
| 5.26 | Cultural Celebration | 4.02 | 3.78 | 2.56 | 4.16 | 3.62 |
| 6.06 | life Stability | 3.45 | 3.62 | 2.84 | 3.86 | 3.44 |
| 4.24 | Children Immigrant | 3.72 | 4.08 | 3.88 | 3.46 | 4.11 |
| 4.36 | Local Alliance | 3.08 | 3.32 | 2.42 | 2.56 | 2.74 |
| 4.61 | Social Status | 2.86 | 2.64 | 2.48 | 3.18 | 3.28 |
| 4.45 | Dependence on Government | 3.68 | 3.35 | 3.34 | 3.32 | 3.28 |
| Total Social Vulnerability | | 3.46 | 3.58 | 2.88 | 3.55 | 3.44 |

Pi: Amount of each parameter on a scale of 1 (vulnerability Lowest) until 5 (vulnerability highest)
Wi: Relative importance of each parameter 0 (weight lowest) until 10 (weight highest)

Qorveh has the highest environmental vulnerability level and Dehgolan has the least environmental vulnerability level and in this regard "Cropping pattern" and "irrigation system" were the most effective parameters in determining environmental vulnerability variance (Table 5).

Table 5. The amount and weight of the environmental parameters of agricultural livelihoods in the studied cities

| Parameter Weight | Environmental Parameters | Parameter Amount | | | | |
|---|---|---|---|---|---|---|
| Wi | | Divandarreh Pi | Qorveh Pi | Dehgolan Pi | Sanandaj Pi | Marivan Pi |
| 4.22 | Resistant Varieties | 4.24 | 3.56 | 3.24 | 3.52 | 4.42 |
| 3.98 | Soil Erosion | 3.31 | 3.42 | 3.14 | 3.82 | 4.02 |
| 5.25 | Water Quality | 2.85 | 3.66 | 3.28 | 3.66 | 3.86 |
| 4.86 | Dust | 3.45 | 3.29 | 3.42 | 3.82 | 3.45 |
| 6.13 | Cropping Pattern | 3.24 | 4.36 | 3.44 | 3.78 | 3.40 |
| 5.56 | Irrigation System | 2.84 | 4.24 | 3.26 | 3.45 | 2.82 |
| Total Environmental Vulnerability | | 3.28 | 3.79 | 3.30 | 3.76 | 3.56 |

Pi: Amount of each parameter on a scale of 1 (lowest vulnerability) until 5 (highest vulnerability)
Wi: Relative importance of each parameter 0 (lowest weight) until 10 (highest weight)

Finally the study of psychological vulnerability status was conducted based on six parameters (Table 6). The most important parameters in this section were "social hilarity" and "right and decisive decision". Marivan had the most psychological vulnerability and Dehgolan had the least psychological vulnerability.

Table 6. The amount and weight of the psychological parameters of agricultural livelihoods in the studied cities

| Parameter Weight | Psychological Parameters | Parameter Amount | | | | |
|---|---|---|---|---|---|---|
| Wi | | Divandarreh Pi | Qorveh Pi | Dehgolan Pi | Sanandaj Pi | Marivan Pi |
| 4.74 | Self-Esteem | 2.28 | 3.52 | 2.84 | 3.56 | 3.28 |
| 4.28 | Self-Efficacy | 3.36 | 3.45 | 3.36 | 3.33 | 3.12 |
| 5.34 | Hopefulness | 3.42 | 3.58 | 3.42 | 3.46 | 3.35 |
| 4.43 | Risk Taking | 2.86 | 2.68 | 3.18 | 2.98 | 3.56 |
| 5.48 | Right and Decisive decision | 4.18 | 3.45 | 3.74 | 3.58 | 3.80 |
| 5.73 | Social Hilarity | 4.04 | 3.84 | 3.68 | 3.72 | 3.69 |
| Total Psychological Vulnerability | | 3.40 | 3.44 | 3.39 | 3.45 | 3.48 |

Pi: Amount of each parameter on a scale of 1 (vulnerability Lowest) until 5 (vulnerability highest)
Wi: Relative importance of each parameter 0 (weight lowest) until 10 (weight highest)

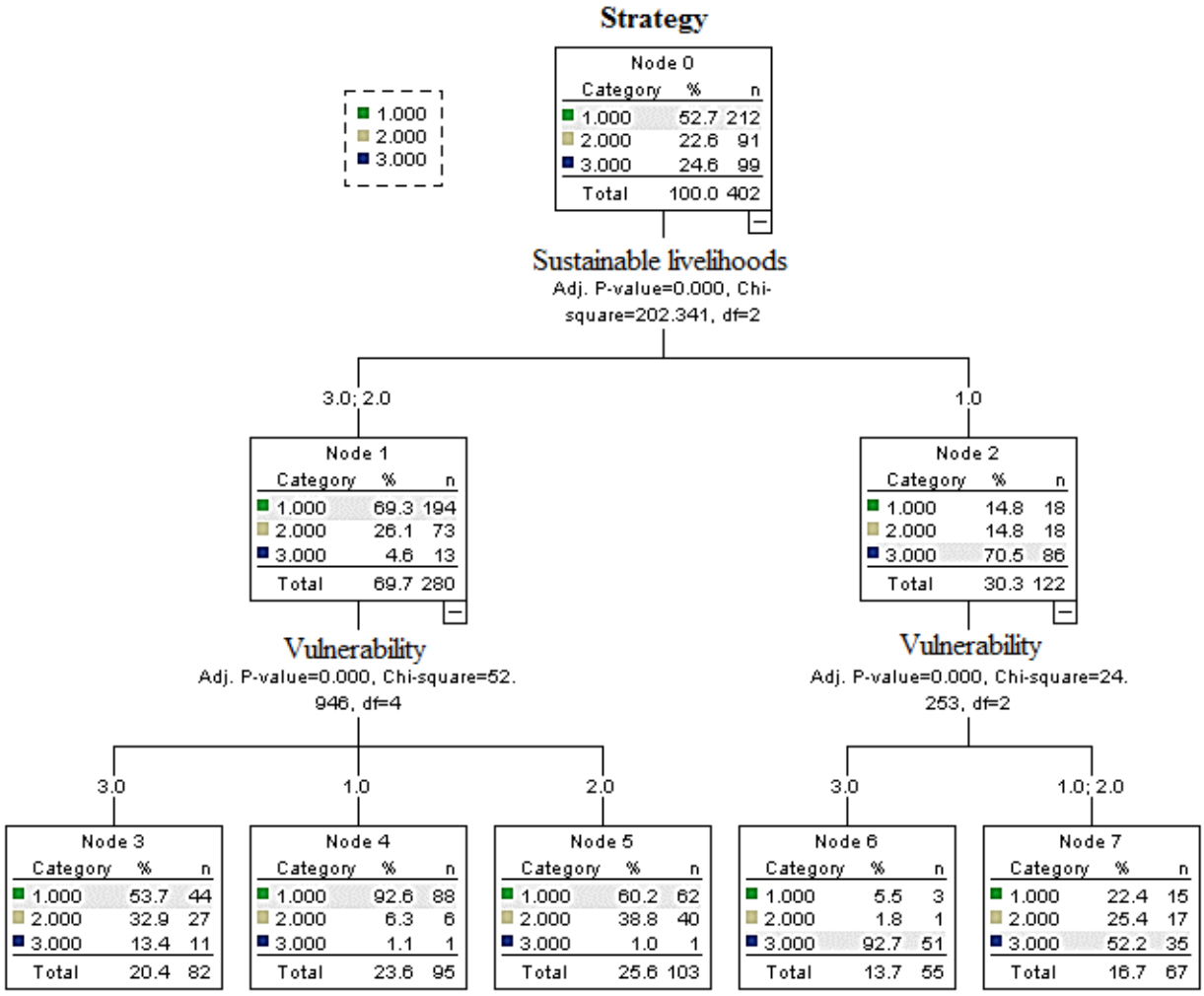
***Explaining the livelihood strategies in drought situations through sustainability and vulnerability***

As previously mentioned, farmers usually use strategies like livelihood diversification, intensive agriculture and migration in drought situation. Therefore in this section the decision tree was used based on livelihood sustainability and vulnerability variables. The results showed that 212 of the 402 farmers (%52.7) use the first strategy (diversification), 91 farmers (% 22.6) use the second strategy (intensive agriculture) and 99 farmers use migration as an strategy in drought situation (model 1). Each decision tree usually has several nodes or terminal. Terminal 1 indicates that farmers that have medium (2) and high (3) livelihood sustainability usually choose their strategies as follows: 69.7 percent of them choose diversification strategy, 26.1 percent choose intensive agriculture and 4.6 percent choose migration strategy. On the other hand, in farmers that have less sustainability (1), 14.8 percent choose diversification, 14.8 percent choose intensive agriculture and 70.5 percent of them choose migration. The turning point in the decision tree in in terminal 4, in fact this terminal indicates the less vulnerability level, in other words it states farmers that have less vulnerability (1) use the first strategy more and farmers that have average (2) and high (3) vulnerability use “intensive agriculture “ and “ migration” more. The vulnerability of farmers that is located in unsustainability (Terminal 6 and 7) use migration strategy more, because the vulnerability level of this section will be more by placing in unsustainability subsector.

Risk standard coefficient of model 1 decision tree is 0.303 and this value is acceptable for expressing decision tree fitness because the reported value is more than the standard value (0.1). It will also show that the standard error is 0.023. Furthermore, the results of decision tree indicates that livelihood sustainability and vulnerability variables were successful in distinguishing the livelihood diversification and migration strategies, but they weren’t successful in recognizing the intensive agriculture strategy. Based on findings, the accuracy of presented decision tree is 69.7 percent and it illustrates that this decision tree can distinguish farmers with almost 70 percent accuracy (Table 7).

Table 7. The prediction accuracy of the decision tree livelihood strategies in drought conditions

| Observed | Predicted Livelihood Diversification | Intensive Farming | Emigration | Percent Correct | Risk Estimate | Std. Error |
|---|---|---|---|---|---|---|
| | | | | | 0.303 | 0.023 |
| Livelihood Diversification | 149 | 0 | 18 | 91.5 | | |
| Intensive Farming | 73 | 0 | 18 | 0 | | |
| Emigration | 13 | 0 | 86 | 86.9 | | |
| Overall Percentage | - | - | - | 69.7 | | |




Model 1: Decision trees livelihood strategy and the relationship between sustainability and vulnerability in drought conditions

**Conclusion and Recommendation**

A review on agricultural development plans in Iran can clarify that increasing productivity has been always considered by policymakers and even in critical situations like drought they have not ignored this process. In drought situations, livelihood of farmer's especially small-scale ones is extremely vulnerable, because only a small percentage of people can cope against drought. This level of coping ability is far lower in developing country, therefore with multiple studies in this field it can be understood that due to the size of small-scale farmers vulnerability, they need more stabilization. In this regard, a Prerequisite for any planning in order to stabilization is analyzing the current situation and identifying the optimal strategies. The approach of this research was crossing the pass of livelihood strategies through sustainability and vulnerability. The results illustrated that among Kurdistan cities, Dehgolan city has the highest level of sustainability and Sanandaj has the lowest level of sustainability. The analysis in this field showed a significant difference among Kurdistan cities. In vulnerability assessment based on the mathematical model, the results indicated that drought has different impacts on farmer's livelihood. Finally the decision tree model clearly stated that farmers with high level of sustainability and low level of vulnerability have used livelihood diversification more. This model can distinguish farmers with the certainty of 69.7 percent based on their strategies. Due to the importance of diversification in small-scale farmer's livelihood, it is recommended that government provide non-farm occupations like additional processing industries, dairy processing industries etc. in rural areas to make farmers more sustainable and less vulnerable.

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