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# Potential of Horticultural Farming in Livelihood Sustainability and Development: A Geo-Empirical Study of the Upper Minjiang River Basin, Sichuan Province, China

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***Abstract:*** **This paper examines the potential of horticultural farming in livelihood sustainability and development in the upper Minjiang River basin of Sichuan Province, China. Horticultural farming mainly, cultivation of fruits is the main occupation of the people and they are fully dependent on its farming to carry their livelihoods. Suitable agro-climatic conditions characterize this region that enhances the production and productivity of fruit crops. Diversity of crops depends upon the altitude, as it is high in the low altitude (<1600 m). There are 13 types of fruits and 19 types of vegetable grown. In terms of area, production and productivity, it is higher in the high altitude. Tourism is the other promising sector in livelihood sustainability. This region is also rich in growing medicinal plants. Meanwhile, the landscape is fragile and natural hazards are quite active. Development of horticulture will enhance the economy and restore the fragile landscape. This study reveals that the future sustainability of livelihoods is dependent on all the given options.**

***Keywords*****: Horticulture; farming; livelihood; development; upper Minjiang River basin.**

## 1. INTRODUCTION

The economy of mountain regions is largely dependent on the farming of agricultural and horticultural crops. Above 70% population is directly and indirectly dependent on the output from the traditionally grown crops to carry their livelihoods. Meanwhile, the mountain regions have abundant of natural resources base in the forms of water, forest and land, and ecosystem services are tremendous. The geographical conditions such as climate and panoramic landscape provide a suitable base for the development of horticultural farming and tourism. Further, there are many ideal conditions to harness water resource through construction of micro-level hydropower projects.

The upper Minjiang River basin has abundance of natural resources – land, forest and water. Further, the climatic conditions are very feasible for the production of various horticultural crops. Meanwhile, the landscape is fragile and slope gradient is high. The whole area is vulnerable to terrestrial and atmospheric hazards – earthquake and flashfloods. Rural settlements are sparsely located, mostly in the valleys and on the mid-altitudes. Farming practices are the mainstay of the populace. In China, more than 615 million people are dependent on natural resources and on primary occupation for their livelihoods (Fang *et. al.*, 2014a). However, in the upper Minjiang River basin, about 60% of rural households are still dependent on agriculture (Fang *et. al.*, 2014b). Practicing farming is the basic social and economic unit and its development has a decisive effect on the well-being of society (Chen *et al*., 2007). It is also a major source of income in the study area where per capita income is of average level (Fang *et al*., 2012).

Cultivation of fruits; mainly cherry (all varieties), apple, plum, peach, pear, apricot, grapes (all varieties) and walnut are dominating in the farming systems and it is the major source of livelihoods in the study villages. Area under fruit crops is

the main farming land use pattern. Bao, *et al*., (1990a) estimated that about 3.3 million ha land is under apple cultivation in China, which is half of the total apple cultivation of the world. Similarly, the Sichuan province accounts 3.5% of the countries production. The study area; Hengduan Mountain and Maoxian County have about 18% area and 16% yield of apple cultivation in Sichuan province. In this region, there are 20 apple based intercropping types were identified by the late 1990s (Bao, *et al.*, 1990b). Pleasant climatic conditions, mostly during the summer season, attract a large number of tourists to visit this region. It assists to enhance income and economy of the region. This study examines the potentials of horticultural farming for livelihood sustainability in the case studied villages.

## 2. THE STUDY AREA

The three villages, which were selected for the case study, are village Muka (MK) located at an altitude of 1580 m, in Lixian County; village Le Shi (LS) located at an altitude of 1878 m in Mao County and village Hui Long (HL) located at an altitude of 2000 m also in Mao County. These villages fall in the upper Minjiang River basin **(Figure 1)**. The upper course of Minjiang River has about 24000 $km^2$ area and it is the transitional zone between the Tibet plateau and the Sichuan basin (Pu 2000; Li *et. al.*, 2003). The climate is monsoon type; the wet season from May to October and the dry season between November and April (Zhang *et. al*. 2002a). Warm temperate climate, low rainfall and long dry season are the prime characteristics. Mean annual temperature is $11^o$ C and mean annual precipitation is 495 mm. Drought is the major factor affecting agriculture (Bao *et. al.*, 2000). Rain mainly occurs during the two months of summer season – June and July. This season is hot and moist. December and January are the coldest months and medium to heavy snow fall occurs during this period of time. The other months remain dry. The altitude of the case study villages ranges from 1500 m to 2100 m. Impact of surrounding mountain ranges (height 3000 m) on climatic conditions is enormous. This mountain is called Long Meng, which is very rich in bio-diversity resources. There are ten national level natural reserves in this mountain. More than 200 hydropower projects are located within 100 km distance, along the Minjiang River. Each hydropower project is producing from 100 kw to 100 mw electricity. Topography of this region is complex. Soil types vary according to variations in altitude (Zhang *et. al*. 2002b; Chang *et. al*., 2003). The major types of soil are mountainous, brown and coniferous forest soil, originating from limestone phyllite and basalt (Cui, *et. al*., 2012). The dominant vegetation types are meadows, coniferous forests and scrublands and they occupy 90% of the land cover (Zhang *et. al*., 2008). Economy of the people is dependent on the production of horticultural farming, mainly cultivation of fruits. Sub-temperate and temperate fruits are grown largely and their production and productivity is significantly high.

Out of the total surveyed HHs in the tree villages, 74.4% workforce is engaged in the horticultural farming. This percentile of farming workforce varies from village to village, according to an altitude. The highest workforce in the horticultural farming is from village HL with 86.4%. This figure is followed by LS (78%) and MK (68.9%). It means, with the increase in altitudes, working force on horticultural farming is increasing. When we see the people working with other activities in these three villages, it is opposite of the previous figure. The highest workforce in the other activities is in MK villages with 29% followed by village LS 10% and village HL 5%. Table 1 shows salient features of the case study villages.

**Table 1: Salient Features Of The Case Study Villages**

| Variables | Villages | | |
|---|---|---|---|
| | MK | LS; Cluster of four villages | HL; Cluster of three villages |
| Location | Lixian county; on the road head; two km away from service centre (Muka town) | Mao county; on the road; 6 km way from the service centre (Feng Yi town) | Mao county; 1.5 km away from road and 2.5 km way from service centre (Feng Yi town) |
| River Basin | Zagunao; tributary of Minjiang River | Yang Wu; tributary of Minjiang River | Mo stream; tributary of Minjiang River |
| Altitude | 1580 m (average) | 1878 m (average) | 2000 m (average) |
| Coordinates | N31$^o$34'; E103$^o$21' | N 31$^o$38'; E 103$^o$51' | N 31$^o$40'; E 103$^o$52' |
| Climate | Dry-sub-temperature | Temperate | Temperate |
| Rainy season | June-July (moderate variability) | June-July (moderate variability) | June-July (moderate variability) |
| Forest Types | Sub-temperate | Temperate forest: Spruce, | Temperate forest: Spruce, |

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| | | | |
|---|---|---|---|
| | | Masson pine, Locust | Masson pine, Locust |
| Soil type | Brown and alluvial | Brown and mountainous | Black and mountainous |
| Total Area | 11540 (arable/fallow/Forest) | 9721 mu; (arable/fallow/Forest) | 9150 mu (arable/fallow/Forest) |
| Total households | 115 | 1,100 (Second biggest village in the county) | 134 |
| Total Population | 400 | 6,100 | 445 |
| Major Economic Activities | Farming (Fruits and vegetables) and tourism | Farming (Mainly fruits) | Farming (Mainly fruits) |

***Source:*** **Primary collection of data (July 5-9, 2014)**

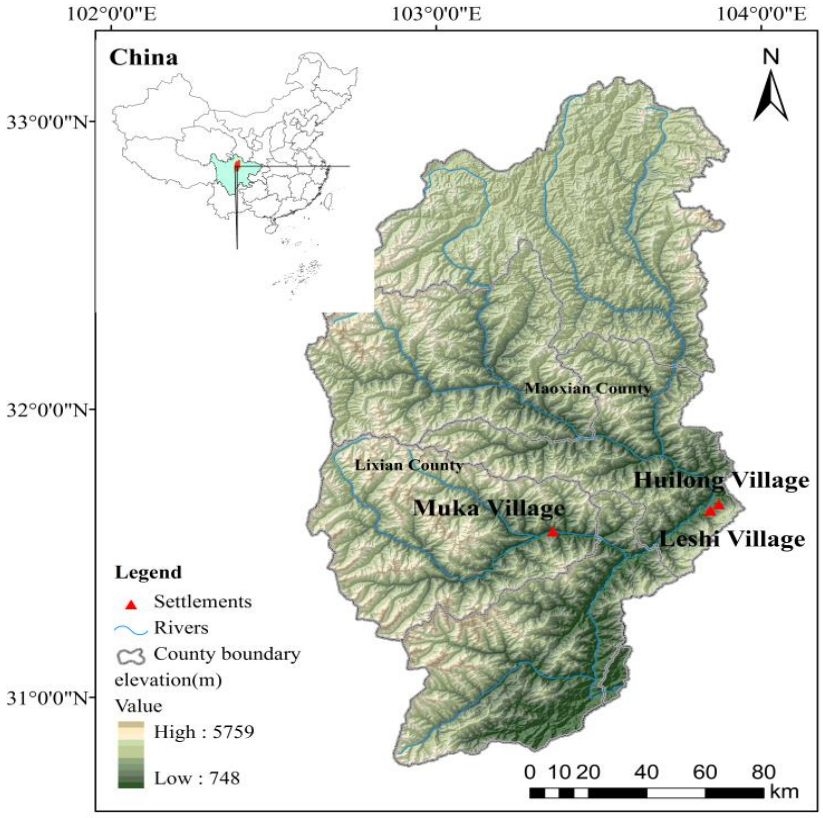


**Figure 1: Location map of three case study villages in the upper Minjiang River basin, Sichuan province, China**

## 3. METHODS

This study was carried out through the case studies of three villages of the upper Minjiang River basin of Sichuan Province, China. The study area was visited in the two different periods of time; first visit was made (17th and 18th June, 2014) to investigate the area for the selection of villages for the case study. Villages were selected on the basis on altitudes, distance from the road head and level of infrastructural facilities. After selection of the villages, households (HHs) level survey was conducted from 5th July to 9th July, 2014. Structured questionnaire was constructed for the HHs level survey. The major questions were framed on the different aspects of horticultural farming; diversity, typology, area under crops, production and productivity of crops. The other questions were framed on the population composition, education and working force; and on the infrastructural facilities. About 44.6% of the total HHs was surveyed. In village MK, the surveyed HHs percentage was 52.2, in village LS, it was 41.9 and in villages HL, it was 41%. The head of the three villages were interviewed on the different aspects of farming systems and overall village development. Mainly, qualitative approach was used to conduct this study. Collected data were interpreted. Area, production and productivity of crops were obtained. Data on changing agricultural land use before and after 2008 were calculated. Correlation among altitude, area, production and productivity was penetrated and descriptive data on the same were obtained.

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## 4. HORTICULTURAL DIVERSITY AND TYPOLOGY

Horticultural diversity is different in different altitudes. In the low altitudes it is higher than to the middle and higher altitudes. Similarly, typology of fruit crops varies according to variations in altitudes. In village KM, there are 13 fruit crops grown; dominated by cherry (Table 2). Cherry fruit has three varieties. These fruits are grown as intercropping. In other two villages, fruit are grown individually or in pairs. In village LS four typologies of fruits are found i.e. plum and pear; apple; plum and apple and walnut. Here plum is dominating crop. Similarly, in village HL fruit crops has four typologies – pear; plum; pear and plum and walnut. In these two villages of high altitudes, walnut is grown randomly and sparse. Table 2 shows typology of horticultural crops in the case study villages:

**Table 2: Typology of Horticultural Crops in The Case Study Villages**

| **Typology** | **Villages** | | |
|---|---|---|---|
| | **MK** | **LS** | **HL** |
| Fruit Orchards | Cherry I, II, III, plum, peach, pear, apple, walnut, grapes I, II, apricot, pomegranate, loquat | Plum and pear | Pear |
| | | Apple | Plum |
| | | Plum and apple | Pear and Plum |
| | | Walnut | Walnut |
| | N= 13<br>Intercropping of fruits<br>Cherry Dominating | N=4<br>Plum dominating | N=3<br>Pear dominating |
| Vegetables | Beans, cabbage, cabbage I and II, celery, chili, chives, cowpeas, cucumber, eggplants, garlic, green peas, lettuce, okra, potato, pumpkin, radish, tomato and water spinach | Celery, chili, cabbage I, cowpeas, cucumber, eggplant, golden melon, green beans, lettuce, potato, radish, soybean and tomato | Cabbage, celery, lettuce, potato, soybean and tomato |
| | N= 19<br>Intercropping: vegetables and fruits; Tomato and chili dominating | N= 13<br>Intercropping: vegetables and fruits; Celery and cabbage dominating | N= 6<br>Intercropping: vegetables and fruits; Celery and lettuce dominating |

***Source:*** **Primary data were gathered and then interpreted by the authors**

***A. Area, Production and Productivity of Horticultural Crops:***

Table 3 shows major fruit crops, area, production of productivity in the case study villages. Area (in Mu) is grouped into four group i.e. <1, 1-10, 10-50 and >50. In village MK, the lowest area is under peach, pear, grape I, grape II and cherry III. In village LS, area under walnut is the lowest while in village HL, pear and walnut occupy the lowest area. The highest area is under plum and apple in village LS and under Plum in village HL. In village MK, Cherry I and II, and plum obtain 10-50 mu area. In terms of production, it is also grouped into four group i.e., <800, 800-5000, 5000-10000 and >10000. Production is different in the different villages. In village MK, there are six fruits have the lowest production while villages LS and HL, only one fruit has <800 kg production. Grape I in village MK and pear and apple in village LS has the highest production i.e. >1600 kg. Similarly, productivity is categorized into four types - <500, 500-1000, 1000-1600 and >1600.

**Table 3: Major Fruit Crops, Area, Production and Productivity**

| Area in Mu | Major Fruits | | |
|---|---|---|---|
| | MK; N= 13 | LS; N= 4 | HL; N = 3 |
| <1 | Peach, pear, grape I, Grape II, Cherry III | Walnut | Pear, walnut |
| 1-10 | Apple, apricot, walnut, loquat, pomegranate | Pear | Nil |

| | | | |
|---|---|---|---|
| 10-50 | Cherry I, cherry II, plum | Nil | - |
| >50 | Nil | Plum and apple | Plum |
| Production (in KG) | | | |
| <800 | Loquat, pomegranate, peach, pear, grape II and cherry III | Walnut | Walnut |
| 800-5000 | Grape I, walnut, apricot and plum | Pear | Pear |
| 5000-10000 | Cherry I and apple, | Nil | Nil |
| >10000 | Cherry I | Plum and apple | Plum |
| Productivity | | | |
| <500 | Cherry I, plum, apricot, walnut, loquat, pomegranate, peach and pear | Walnut | Walnut |
| 500-1000 | Cherry II and apple | Nil | Nil |
| 1000-1600 | Grape II and Cherry III | Plum | Plum and pear |
| >1600 | Grape I | Pear and apple | Nil |

***Source:*** **Primary data were gathered and then interpreted by the authors**

Fruit wise detail has also been discussed. In village MK, highest area is under cherry I. which is 35.63 followed by cherry II (14) plum (11.93), apple (9.81) and apricot (4.15). Walnut and loquat have 3 and 2.1 area respectively. The area under other fruits is comparatively quite low. In terms of production, cherry I leads with 10390 kg, followed by apple (6692), cherry II (7285) and plum (3535). Walnut apricot and grape I have 1260, 1140 and 1000 production respectively. The highest productivity has been recorded from grape I i.e. 5000 followed by grape II and cherry second (1500 each). Other fruits have less than 1000 productivity. There are thirteen varieties of fruits grown. Cherry has three varieties and grape has two varieties. In villages HL, only two types of fruit grown. They are plum and peach. Area under plum is the highest i.e. 177.9 with the highest production 216500 kg while, productivity is 1216.98. Pear has only 1 mu area with 1250 production and productivity. In village LS, three types of fruits are grown such as plum, apple and pear. The highest area is under plum (228.1) followed by apple (58.8). Pear has only 2 mu land area. Plum has the highest production (361420) followed by apple (110200 kg). Pear has only 4000 kg production. In terms of productivity, pear has the highest i.e. 2000 followed by apple (1874.15) and plum (1584.48)

Table 4 shows area, production and productivity of major vegetables in the case study villages. As, it is shown in the fruit section; grouping of area, production and productivity was done of the vegetable crops. Area is grouped into four group <5, 5-10, 10-20 and >20. Production of crops is grouped <1000, 1000-10000, 10000-20000 and >20000. Similarly, productivity is grouped from <1000 to 1000-2000, 2000-10000 and >10000, as it is shown in table 4.

**Table 4: Area Production And Productivity Of Major Vegetables**

| Area in Mu | Major vegetables | | |
|---|---|---|---|
| | MK; N= 19 | LS; N= | HL; N = 6 |
| <5 | Beans, cabbage, cabbage I, cabbage II, celery, chives, cowpea, cucumber, eggplant, garlic, green-been, okra, potato, pumpkin, water-spinach, lettuce, radish and chili | Chili, cowpea, cucumber, eggplant, golden melon, green pea, radish and soybean | Cabbage and tomato |
| 5-10 | Tomato | Lettuce and tomato | Soybean |
| 10-20 | Nil | Celery and potato | Potato |
| >20 | Nil | Cabbage I | Celery (170.4) and lettuce (143.9) |
| Production (Kg) | | | |
| <1000 | Cucumber, eggplant and pumpkin | Celery, cabbage I, eggplant, golden melon, green beans, potato, radish and soybean | Cabbage and soybean |
| 1000-10000 | Beans, cabbage, cabbage I, | Chili and cowpeas | Tomato and potato |

| | | | |
|---|---|---|---|
| | cabbage II, celery, chili, chives, cowpeas, garlic green beans, lettuce, okra, potato, radish and water spinach | | |
| 10000-20000 | Tomato | Lettuce and tomato | Nil |
| >20000 | Nil | Nil | Celery and lettuce |
| Productivity | | | |
| <1000 | Cabbage I and cucumber | Celery, chili, cabbage I, cowpeas, cucumber, eggplant, green beans, potato, radish and soybean | Cabbage, potato and soybean |
| 1000-2000 | Cabbage, eggplant, lettuce, pumpkin, radish, | Tomato | Celery and tomato |
| 2000-10000 | Chili, green beans and tomato | Golden melon and lettuce | Lettuce |
| >10000 | Beans, cabbage II, celery, chives, cowpeas, garlic, okra, potato and water spinach | Nil | Nil |

***Source:*** **Primary data were gathered and then interpreted by the authors**

Vegetables are grown as intercropping with fruits in all the case study villages. Diversity in vegetable crops is high in village MK but the area (18.32) and production (76245) is comparatively less than the other two villages i.e. LS and HL. Area and production in two villages are 337.6 and 85.75, and 954335 and 39540 respectively. In village MK, the highest area is under tomato (5.3) and its production is also high i.e. 19125. It is followed by chili (3.1) with 7475 production. There are two types of cabbage grown. Area under cabbage I is 2.7 and production is 1100. All other vegetable crops have <1.1 area. In village LS, the highest area under vegetable crops is of cabbage (22.15), potato (17) and celery (15.55), followed by lettuce (8.6), tomato (7.3) and radish (4.95). Chili grows in 3.4 areas. Other crops are under <1 area. In terms of production, the highest production is from lettuce (18725) and subsequently, the productivity is also high (2177.2). Tomato followed in production and productivity i.e. 13600 and 1863, respectively. Meanwhile, the highest productivity is of golden melon and that is 2500. In village HL, the two vegetable crops have highest area. Celery has 170.4 and lettuce has 143.9 areas under vegetable. The other vegetables are potato (12), soybean (6) and tomato (2.8). Cabbage has only 0.5 lands under vegetable. Accordingly, the production of lettuce is the highest (665500) followed by celery (264500). Which shows that highest the area under crops, highest is the production. These crops have also highest productivity i.e. 4624.7 and 1552.2 respectively. Production of other crops is less. Although, potato has less production and productivity yet, it has high potential for the future sustainable development. Soybean is also a promising vegetable for productivity point of view in future, if utmost care is taken.

Further, table 5 shows area, production and productivity of fruits and vegetables in all three case study villages as a nutshell **(Figure 2a&b)**. Village LS obtains highest area under fruits i.e. 288.9 followed by HL 178.9. Village MK has only 83.51 areas under fruit crops. Similarly, production and productivity of fruit crops is the highest in village LS i.e., 475620 and 1646.31 respectively. It is followed by village HL with 217750 productions and 1217.16 productivities. Village MK has comparatively low production and productivity. Area under vegetable crops is the highest in village HL (335.6) with highest production (939335). Village LS follows it in area (85.75) while, village MK has 18.32 areas under vegetable crops. In term of production, it obtains second place while in productivity, it ranks first (4161.8).

**Table 5: Area, Production and Productivity Of Fruits And Vegetables**

| Fruits | | | | |
|---|---|---|---|---|
| Name of Village | Altitude (M) | Area (in Mu) | Production (Kg) | Productivity |
| MK | 1580 | 83.52 | 32787 | 392.56 |
| LS | 1878 | 288.9 | 475620 | 1646.31 |
| HL | 2000 | 178.9 | 217750 | 1217.16 |
| Vegetables | | | | |
| MK | 1580 | 18.32 | 76245 | 4161.8 |
| LS | 1878 | 85.75 | 39540 | 461.1 |
| HL | 2000 | 335.6 | 939335 | 2799.0 |

***Source:*** **Primary data were gathered and then interpreted by the authors**

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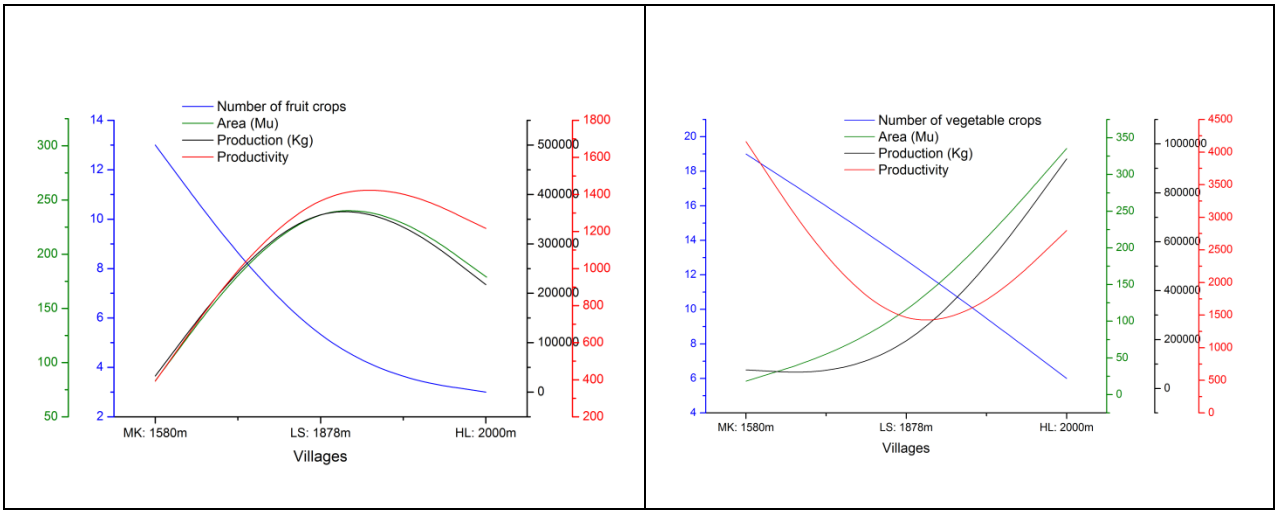


**Figure 2a: Number of fruit crops, area, production and productivity; 2b: Number of vegetable crops, area, production and productivity**

***B. Correlations between altitude, area, production and productivity of fruits and vegetables:***

Correlations of altitude, area, production and productivity of fruit and vegetable crops were penetrated. Pearson correlation method was used; where correlation is significant at the 0.05 level (2-tailed). It was hypothesised that higher the altitude, the number of fruits and vegetable crops (crops diversity) is high. But, the correlation was insignificant. Further, it was hypothesised that higher the area is production and productivity of fruit crops is high. Correlation was significant as area, production and productivity of fruit crops was high in the higher altitude. The village MK is located on the road-head; a large part of village land has been used for other developmental projects such as for the constructions of national high way and hydropower project. Therefore, the land under fruits farming is quite less than the other two villages, located in the highlands. In the case of vegetables, although the village MK has less area, production and productivity is high. Altitude and climate are not only the factors, which affect production and productivity of fruit crops, there are many other factors, such as access to road and market and availability of man power.

**Table 6: Descriptive Statistics**

| Variables | Fruits; N= 13 | | Vegetables; N= 19 | |
|---|---|---|---|---|
| | Mean | Std. Deviation | Mean | Std. Deviation |
| Area (Mu) | 183.77 | 102.77 | 146.56 | 167.15 |
| Production (Kg) | 2.42E5 | 222414.52 | 3.52E5 | 509231.88 |
| Productivity | 1085.34 | 637.18 | 2473.97 | 1871.63 |

***Source:*** **Primary data were gathered and then interpreted by the authors**

## 5. AGRICULTURAL LAND USE CHANGES BEFORE AND AFTER 2008

Table 6 (**Figure 3**) shows land covers change under agricultural land use before and after 2008. The benchmark of 2008 was especially taken into account because, in 2008, there was a catastrophic Wenchuan earthquake of >8 intensity. These villages were directly influenced and consequently, a large-scale change in cropping pattern was noticed from all three villages. Food crops have now fully been vanished. There were >80% decrease noticed in food crops. In village MK, area under fruit crops decreased -24.9%. Similarly, area under vegetable crops has also been decreased (-18.7%). The region behind decrease in crops land is that a large part of land has been utilized for construction of big houses, road and hydropower project. There is also an increase in forest land (49.3%). Land under fruit crops was increased in both the highlands villages. The increase percentage is 8.5 in LS and 1.1 in HL. Forest land has decreased -97.5% in village LS. Similarly, -45.6% lands decreased under vegetable crops. In the village HL, land has been increased under forest (30%) and vegetable (4.4%). One point was noticed from all three villages that land under settlement was increased about 32.1% in MK, 16.5% in LS and 19.4% in HL. The region behind this is that the government compensated a large cash amount to construct a house to each HH after the earthquake. Further, the government provided bank loan facility without interest for the same purpose.

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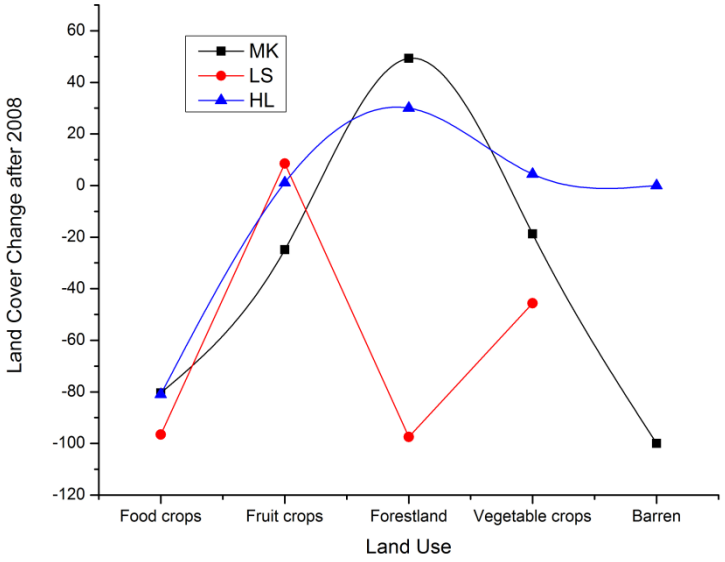


**Figure 3: Changes in agricultural land use before and after 2008**

**Table 7: Changes in Agricultural Land Use before and After 2008**

| Types | Land cover change (percentage of geographical area) | | |
|---|---|---|---|
| | MK | LS | HL |
| Food crops | -80.4 | -96.5 | -81 |
| Fruit crops | -24.9 | 8.5 | 1.1 |
| Forestland | 49.3 | -97.5 | 30 |
| Vegetable crops | -18.7 | -45.6 | 4.4 |
| Barren | -100 | - | 0 |
| Fallow | 662.9 | 0 | -12.3 |

***Source:*** **Primary data were gathered and then interpreted by the authors**

## 6. DRIVERS OF SUSTAINABLE HORTICULTURAL FARMING IN THE UPPER MINJIANG RIVER BASIN

The major driving forces for the sustainable horticultural farming are geo-environmental conditions that include landscape, altitude, climate and slope aspects; and management – access to market, water management, transportation, man power and institutional facilities. All these drivers are active/positive in the study area. Landscape is fragile. Plantation of fruits will have a greater impact on the economy and on the restoration of landscape and the farmers of the region are well acquainted with this fact. The economy of this region is known as tree economy because of the high level of production and productivity of fruits. A large area under horticultural farming will manifest to the livelihood sustainability. Climatic conditions are suitable for fruits cultivation mainly cherry and peach in the lower altitudes; and plum, apple and pear in the higher altitudes. Accessibility of market and transportation facilities is high in village MK, where fruits are easily sold out. In the other two villages – LS and HL, it is moderate. The foremost and important driver is institutional support. After the earthquake of 2008, the government support for the farmers was quite enough and they were enough to carry their livelihoods sustainably. Water resource management, from drinking water to irrigation, is noticeable. Both the community people and the government institutions work together and there is no water scarcity problem throughout the year. Tourism is other significant factor. The climate is sub-temperate and temperate in these villages with fresh natural air. During the summer season, the people from the Chengdu lowland visit this area for leisure and they help to enhance the economy of the people.

### *A. Horticulture and Livelihood Sustainability:*

Horticultural practices – cultivation of fruits and vegetables – are the main occupation of the populace of the upper Minjiang river basin. Every HH in the case study villages practice horticultural farming and carry his livelihoods. Here,

production and productivity of horticultural crops are quite high while, it varies with variations in altitude. Further, suitable agro-climatic conditions provide a base for horticultural farming. Cultivation of cherry and peach in the middle altitudes and plum, pear and apple in the high latitude will lead the way to further development of horticulture. Similarly, tomato in the middle altitudes and potato in the high altitudes is suitable vegetable crops. Bees and bee-keeping in all altitudes in this region has very high potential for further enhancement. Table 8 projects the suitability of crops in different altitudes and tourism practices for sustainable livelihoods. As mentioned, Cherry of all varieties is very suitable fruit crops in village MK (1580 m). The other fruits are grapes, pomegranates, peach and walnut. In vegetable crops, celery, okra, tomato, potato, cowpea, beans and chives are suitable. Fruit and vegetable crops can be grown as intercropping. In this area, tourism is a promising sector for livelihood sustainability. In village LS (1878), the major fruits crops can be grown are; plum, apple and pear. In vegetable crops, lettuce, tomato, potato, golden melon, cowpea, chili, soybean and cabbage can be grown largely. Fruit crops as separately and vegetable crops as intercropping with fruits can be practiced. Major fruits in village HS (2000), which can be grown largely are plum, pear and apple. In vegetables, lettuce, celery, tomato, potato, cabbage and soybean have the potential to grow substantially and to attend livelihood sustainability.

**Table 8: Suitability of Crops In Different Altitudes And Tourism Practices For Sustainable Livelihood**

| Villages | Altitude (M) | Suitable crops |
|---|---|---|
| MK | 1580 | Fruit crops: cherry - all varieties, grapes, pomegranates, peach and walnut |
| | | Vegetable crops: celery, okra, tomato, potato, garlic, cowpea, beans and chives (intercropping of fruits and vegetables) |
| | | Tourism: is the a promising livelihood option |
| LS | 1878 | Fruit crops: plum, apple, pear and walnut |
| | | Vegetable crops: lettuce, tomato, potato, golden melon, cowpea, chili and cabbage; soybean has also potential (Separate fruit orchards; intercropping with vegetable crops) |
| | | Tourism: a secondary livelihood option |
| HS | 2000 | Fruit crops: plum, pear, apple and walnut |
| | | Vegetable crops: lettuce, celery, tomato, potato and cabbage; soybean has the potential (Separate fruit orchards; intercropping with vegetable crops) |
| | | Tourism: a secondary livelihood option |

***Source:*** **Primary data were gathered and then interpreted by the authors**

***B. Horticulture and Tourism Development:***

Tourism is one of the promising sectors of development in the upper Minjiang river basin. Pleasant climatic conditions mainly during the summer season, when the other parts of Sichuan province receive hot weather, this region provides ample base to tourists to visit this area for leisure. This is the time when the major fruits start ripening. Cherry is the main fruit of this season. The other fruits are peach, plum, pear, grapes and apple. Village tourism has already been started in village MK, where every villager has constructed separate accommodation for the tourists. About 17% HHs have started earning from tourism. Here 4.6% of the total income in coming from tourism and it has forth rank in the major sources of income. The ideal location of the village, as it is located in the national high way, supports market to fruits. The farmers have shops on the road side near to village and every day they pluck fresh fruits and sell them on the roadside (Figure 2d). Village LS has the ideal location in terms of tourism practices. Here, temperate climate and panoramic landscape provides the suitable base for tourism development. The farmers of this village are willing to develop tourism here. In this village, income from the tourism activity is 1.2% and it also rank fourth in the total sources of income. Plum, pear and apple are the dominating crops in this village and their ripening period is also the summer season. Village HL has yet to start tourism practices. Winter tourism can also be developed in these villages as around three months during the winter season, snowfall occurs. Snow skiing has already been developed in the other parts of the highlands.

## 7. CONCLUSIONS

In this paper, potential of horticultural farming in livelihood sustainability in the three case study villages of the upper Minjiang River basin of Sichuan province was elaborated. It was penetrated from the study that the farming of horticultural crops particularly, fruit cultivation is the main occupation of the farmers of this region; and it has the

potentials to enhance livelihood sustainability. The quality of fruits is high as well as high production and productivity. Further, the study reveals that the agro-climatic conditions provide suitable base for horticultural farming. The infrastructural facilities such as irrigation, transportation and market are highly accessible and the farmers can access the market without the commission agents. The two issues emerged from the study are; the villages are lacking in cold storages and arable land is comparatively less under horticultural crops. There is a possibility of extension of arable land in the mountain niches. If these two things are met, the self-sufficiency in livelihood can be attended and because, cultivation of fruits in the fragile mountain niche will restore the environment. Tourism is another potential sector for the development of this region as the landscape is panoramic and climatic conditions are feasible. Its development at all level will enhance livelihood sustainability. Bees and bee-keeping is other potential areas for livelihood sustainability.

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