Sustainable Production Systems for Agriculture Development in Mountains of Himachal Pradesh, India

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Authors’ contributions

This work was carried out in collaboration between all authors. Author AK designed the study, wrote the protocol and organized the review paper with the help of authors AD and JS. All authors read and approved the final manuscript.

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ABSTRACT

The paper examined the existing production systems in the mountains of Himachal Pradesh and suggested further improvement on the existing, which can help farmers to sustain. The study undertaken in low and mid hills of Himachal Pradesh is based on both primary and secondary data collected from 160 farmers (80 farmers from each zone). Under rainfed farming, maize-wheat was the main cropping system, but returns were better in maize-peas (Rs 71,239/ha). In irrigated areas, tomato-tomato-peas was the most profitable farming (Rs 5,02,378/ha). Consumption of fat was the biggest gap in all categories of farmers.

Keywords: Production systems; average yield; gaps; mountains.

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1. INTRODUCTION

Himachal Pradesh (H.P) has emerged as leading state for development in the country and also leading ahead in hill agriculture and horticulture revolution. Economic growth in the state predominantly governed by agriculture and its allied activities; but showed not much fluctuation during nineties as the growth rate remains more or less stable. Agriculture is the main occupation in Himachal Pradesh and provides direct employment to 69 per cent of the total workers of the state, where around ninety-two per cent of the population of 6.1 million lives in 17000 rural villages [1]. The farming community of the state holds an area of 9.79 lakh hectares which is run by 8.63 lakh farmers out of the total geographical area of 55.673 lakh hectares, wherein, 87.03% of the total holdings are of small and marginal farmers. [2]. But the state harbours several ‘niche’ or specific situations/products, with potential comparative advantages over plains. This has led to transformation and diversification of agriculture in certain valleys and mountain areas of the state placed at the advantageous position in terms of producing certain commodities like temperate fruits and off-season vegetables. However, the process of diversification of agriculture has remained confined to a narrow production-base due to lack of necessary backward and forward linkages [3,4,5]. Majority cultivators are mainly growing food grains to meet subsistence needs. Moreover, the unplanned agricultural transformation in many areas of the state has also started facing second-generation problems threatening the overall sustainability of the system. Over the years, agricultural sector has adopted a diversification approach that demands for a focus on production of off-season vegetables that include potato, ginger, soybean, oilseeds, and pulses. At present, about 58,743 hectare constitutes production of 13.98 lakh tone in vegetables. The farmers focus more on growing cash crops for higher revenue earning as it suits the agro-climatic conditions in Himachal Pradesh [6].

But still there is need to develop location specific optimum farming systems which will be helpful to raise the standard of living of farm families by ensuring enough employment opportunities to them and to lead better quality life. The priority needs to be accorded to regional development by exploiting the agricultural potential of the region for which it has the comparative advantages. With this background, present study is an effort to study the economic viability of existing production system in targeted areas and to suggest viable modules of production systems suitable in a longer and sustainable manner.

1.1 Hypotheses to be Tested

To achieve the desired results the following hypotheses were formulated and tested through appropriate economic, mathematical and statistical tools.

a) The existing production systems are different than the optimum production system.

b) The existing level of income could be increased by following optimum production systems.

c) The optimum sustainable production systems will provide food, nutritional and livelihood security to the farmers of Himachal Pradesh.

2. MATERIALS AND METHODS

Himachal Pradesh has been divided into four agro-climatic zones, two zones, namely low hills sub-tropical (zone-I) and mid-hills sub-humid (zone-II) were purposively selected. Keeping in mind available resources and time three-stage stratified random sampling technique was employed to select the final sample on the basis of zones, districts and blocks in the state. Una and Mandi districts were selected, respectively in zone-I and zone-II. Una district has five developmental blocks, namely, Amb, Bangana, Gagret, Una and Haroli, Out of these five blocks, two blocks namely Bangana and Una were randomly selected. And Mandi district has ten developmental blocks, namely, Sadar, Balh, Sundernagar, Gohar, Seraj, Karsoog, Gopalpur, Dharmpur, Chauntra and Drang. Out of these, two blocks, Sadar and Sundernagar blocks were chosen. Further a sample of 40 farmers in each block (80 in each zone) was proportionally allocated, thus making a total of 160 final respondents. Farmers were further categorized into small, medium and large categories using cumulative cube root frequency method according to the size of their land holdings.

Study is based on both primary as well as secondary data. The primary data were collected on well-designed pre-tested schedule by personal interview method, whereas, secondary data were collected from various offices and publications. The primary data were collected
from respondent farmers, progressive entrepreneurs, traders, scientists, veterinary officers, revenue officials, and other officials of Government of H.P. Simple statistical tools and Linear Programming Model was tried to fulfill the objectives of study.

### 3. RESULTS AND DISCUSSION

#### 3.1 Section-I

**3.1.1 Major crop area at farm level**

The existing distribution of area under different crop groups was studied and it revealed that cereals dominated the cropping at farm level (Table 1). Rice, wheat, maize and barley was the main cereals, where wheat (27-34 per cent) followed by maize and rice was the main practice. Pulses were mostly grown on medium and large farms. The fodder crops like sorghum in *Kharif* and *Baraseem* in winter were the important fodder crops. Over the years, vegetable production has become one of the leading practices, as promoted by research organization and also by state government, because of short duration and secured price in the market. Ladyfinger and tomato were the important vegetable crops grown in *kharif*. And peas, cauliflower, cabbage and potato were the main crops grown in *rabi* season. The area under vegetable crops ranged between 10-14 per cent on different categories of farms.

**3.1.2 Average yields of crops of sampled farms**

Average yield of different crops has been computed on different size of farms and presented in Table 2. The average yield showed a decline with the increase in the size of farm which could be attributed to the management problem. Average yield revealed that these were lower than the potential yields mentioned in the package and practices of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur [7]. Hence, there existed ample scope for improvement with integrated package.

**3.1.3 Existing production systems**

In the study area, the size of holding of small, medium and large farms was worked out to be 0.25, 0.70 and 2.36 hectares respectively (Table 3). The major share of the area was allocated to foodgrains like wheat, maize and paddy. The total cropped area on small, medium and large farms was worked out to be 0.52, 1.39 and 4.46 hectares, respectively. The cropping intensity decreased with the increase in the size of farm and was worked out to be 206, 197 and 189 per cent on small, medium and large farms, respectively. This decrease in cropping intensity may be due to the reasons that big farmers are going for non-farm avenues. The important trees of farm forestry in the region were Khair (*Acacia Catechu*), Kikar (*Acacia arabica*), bamboo (*Dendrocalamus strictus*), biul (*Grewia optiva*), tuni (*Tuna ciliata*), Shisham (*Delbargia sisoo*), Khirak (*Celtis australis*) and Simble (*Bombax ceiba*). Khair trees were mostly in pasture land and are sold for *Katha* processing.

The rainfed farming was most common accounting for about 80 per cent of the total operational holding. Fruits occupied only a small percentage of area. The field crops, mainly foodgrains, covered more than 50 per cent of the cultivated area. The commercial production of sub-tropical fruits like citrus, mango, guava, litchi and other sub-tropical fruits was almost negligible because of less favourable environment for these crops in selected villages. The female labour played the dominant role in farming particularly in case of small farmers and accounted for more than 60 per cent of the total labour engaged in farming. This might be due to the fact that male labour was mainly engaged in other off-farm avenues of employment and income generation due to small size of holding.

| Sr. no | Particulars                  | Size of farmer |          |          |
|-------|----------------------------|----------------|----------|----------|
|       |                             | Small          | Medium   | Large    |
| 1     | Cereals                     | 65.42          | 56.12    | 52.47    |
| 2     | Pulses                      | 3.80           | 5.75     | 6.73     |
| 3     | Vegetables                  | 11.54          | 14.39    | 10.31    |
| 4     | Oilseeds                    | 7.7            | 8.63     | 17.71    |
| 5     | Miscellaneous crops         | 11.54          | 15.11    | 12.78    |
| 6     | Total cropped area over which percentages have been worked out (ha) | 0.52 (100) | 1.39 (100) | 4.46 (100) |

*Source: Field Survey*
The farmers of these zones generally used tractor hiring for first and second ploughing after harvesting the crop. However, sowing was mostly done with pair of bullocks.

### Table 2 Average yield of major cops in sampled farms (q/ha)

| Sr. No | Crops          | Average yield |
|-------|----------------|---------------|
|       |                | Small | Medium | Large |
| A. Rainfed |                |       |        |       |
| 1.    | Maize          | 40    | 39     | 36    |
| 2.    | Sugarcane      | 300   | 260    | 260   |
| 3.    | Jowar-bajra    | 297   | 286    | 268   |
| 4.    | Wheat          | 30    | 28     | 27    |
| 5.    | Barley         | 30    | 28     | 24    |
| 6.    | Potato         | 150   | 146    | -     |
| B. Irrigated |                |       |        |       |
| 1.    | Paddy          | 45    | 41     | 39    |
| 2.    | Maize          | 45    | 43     | 38    |
| 3.    | Mash           | 11    | 10     | 9     |
| 4.    | Ladyfinger     | 158   | 156    | 147   |
| 5.    | Ginger         | 125   | 120    | 115   |
| 6.    | Bajra-Jowar    | 380   | 372    | 358   |
| 7.    | Tomato         | 375   | 297    | 288   |
| 8.    | Pumpkin        | -     | -      | 294   |
| 9.    | Cucumber       | 200   | 182    | 175   |
| 10.   | Bottle gourd   | -     | 250    | 243   |
| 11.   | Bitter gourd   | -     | -      | 150   |
| 12.   | Wheat          | 40    | 39     | 38    |
| 13.   | Barley         | 39    | 38     | 36    |
| 14.   | Potato         | 166   | 158    | 156   |
| 15.   | Pea            | 195   | 190    | 183   |
| 16.   | Cauliflower    | 300   | 290    | 278   |
| 17.   | Cabbage        | 250   | 243    | 225   |
| 18.   | Mustard        | 40    | 38     | 44    |
| 19.   | Radish         | -     | 150    | 133   |
| 20.   | Lentil         | -     | 14     | 12    |
| 21.   | Barseem        | 391   | 382    | 350   |
| 22.   | Potato         | 200   | 175    | 172   |

Source: Field Survey

Under rainfed farming, maize-wheat was the main cropping system. The other systems were maize and wheat grown mixed with pulses and oilseeds. Maize-toria-wheat cropping system was followed on approximately 5 per cent of area. Under irrigated conditions, paddy-wheat and chari-berseem were the two main cropping systems followed by the cauliflower-radish-potato cropping system. The other intensive vegetable cropping systems followed in these zones were, tomato-tomato-peas and tomato-bottle gourd-peas. The most intensive cropping system of four crops, namely potato-capsicum-spinach-cauliflower was also followed by the farmers owing tube-wells. Sugarcane-ratoon cropping system was followed on small proportion of irrigated area for home consumption purpose.

The buffalo and cows were major dairy animal accounting for about 90 per cent of the total dairy animals. Three sub-systems of animal rearing viz; stall feeding-cut and carry, complete grazing and partly by grazing and stall feeding were prevalent in the study area. The number of mules and ponies was negligible due to very less use of beasts of burden due to larger expansion of roads and availability of motor transportation in these zones.

The gross returns and net returns for different production systems at existing level have been depicted in Table 3. The most remunerative cropping system under rainfed condition was found to be maize + peas. Under rainfed conditions, second highest gross and net returns were in case of maize-toria-wheat cropping system which were Rs 14,186 and Rs. 12,593 and Rs. 11,811 per hectare on small, medium and large farms, respectively. Maize-wheat cropping system was the least efficient cropping system under dry farming conditions. Under irrigated production system, tomato-tomato-peas cropping system was most profitable yielding gross and net income of Rs. 6,22,863, Rs. 5,12,495 and Rs. 5,02,378 on small, medium and large farms respectively. The other remunerative cropping systems were tomato-cauliflower and tomato-radish-peas.

### 3.2 Section-II

#### 3.2.1 Food and nutritional security

The National Policy on Agriculture seeks to actualize the vast untapped growth potential of Indian agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro business, create employment in rural areas, secure a fair standard of living in terms of food, nutritional and livelihood security for the farmers and agricultural workers and their families. It also aims to attain growth that is sustainable technologically, environmentally and economically.

The farm families in mountains are facing not only the scarcity of food but also imbalance and malnutrition in their diet [8,9,10]. Therefore, the food security to rural poor means providing them adequate and quality food on sustainable basis. For achieving it, farm diversification and intensification can be regarded as the major objectives of the production systems approach which helps to improve their quality of life by providing them sufficient food and nutritional security.
Table 3. Existing production systems at farm level

| Farming system                  | Small Gross returns (Rs/ha) | Small Net returns (Rs/ha) | Medium Gross returns (Rs/ha) | Medium Net returns (Rs/ha) | Large Gross returns (Rs/ha) | Large Net returns (Rs/ha) |
|---------------------------------|-----------------------------|---------------------------|----------------------------|---------------------------|-----------------------------|---------------------------|
| A. Rain fed farming(Rs/ha)      |                             |                           |                             |                           |                             |                           |
| 1. Maize – Wheat                | 1,08,550                    | 10,066                    | 1,02,750                    | 8,653                     | 95,250                      | 7,691                     |
| 2. Maize + Pulses – Wheat       | 1,33,860                    | 13,816                    | 1,26,238                    | 11,865                    | 1,17,766                    | 10,819                    |
| 3. Maize – Toria - Wheat        | 1,26,850                    | 14,186                    | 1,19,275                    | 12,593                    | 1,13,550                    | 11,811                    |
| 4. Jowar + Bajra – Barley       | 91,800                      | 11,335                    | 87,000                      | 5,934                     | 79,800                      | 3,357                     |
| 5. Maize – Peas                 | 1,86,700                    | 78,920                    | 1,79,550                    | 72,831                    | 1,69,950                    | 71,239                    |
| 6. Sugarcane                    | -                           | -                         | -                           | -                         | -                           | -                         |
| B. Irrigated farming(Rs/ha)     |                             |                           |                             |                           |                             |                           |
| 1. Maize – Wheat                | 1,32,600                    | 28,635                    | 1,27,900                    | 27,122                    | 1,19,750                    | 19,633                    |
| 2. Paddy – Wheat                | 1,35,150                    | 25,114                    | 1,27,900                    | 21,542                    | 1,23,300                    | 18,463                    |
| 3. Paddy – Barseem              | 1,14,300                    | 21,593                    | 1,07,800                    | 15,270                    | 1,00,500                    | 13,919                    |
| 4. Chari – Bajra – Barseem      | 1,11,150                    | 18,857                    | 1,08,600                    | 14,969                    | 1,01,700                    | 14,519                    |
| 5. Maize – Potato – Potato      | 2,88,700                    | 68,211                    | 2,57,550                    | 38,631                    | -                           | -                         |
| 6. Cauliflower – Radish –       | -                           | -                         | 3,49,000                    | 1,37,612                  | -                           | -                         |
| Potato                          |                             |                           |                             |                           |                             |                           |
| 7. Cauliflower – Turnip –       | 3,25,000                    | 1,30,974                  | 3,07,400                    | 1,30,708                  | 3,02,600                    | 1,25,071                  |
| Wheat                           |                             |                           |                             |                           |                             |                           |
| 8. Tomato – Radish – peas       | 6,04,000                    | 4,05,017                  | 5,32,100                    | 3,49,996                  | 5,15,000                    | 3,41,870                  |
| 9. Tomato – Wheat               | 3,75,000                    | 2,40,346                  | 3,10,500                    | 1,87,080                  | 3,01,200                    | 1,82,408                  |
| 10. Tomato – Tomato – Cauliflower | 7,80,000                  | 5,60,632                  | 6,43,200                    | 4,53,917                  | 6,27,600                    | 4,43,979                  |
| 11. Tomato – Tomato – Peas      | 8,34,000                    | 6,22,863                  | 7,03,200                    | 5,12,495                  | 6,80,400                    | 5,02,378                  |
| 12. Tomato – Bottle gourd –     | -                           | -                         | 6,15,600                    | 4,29,452                  | -                           | -                         |
| Peas                            |                             |                           |                             |                           |                             |                           |
| C. Dairy Milch animals (Rs/animal) |                             |                           |                             |                           |                             |                           |
| 1. Cross-bred Cow               | 45,060                      | 14,515                    | 47,524                      | 18,801                    | 50,672                      | 18,775                    |
| 2. Buffalo                      | 45,444                      | 13,018                    | 48,740                      | 17,540                    | 51,012                      | 18,038                    |
| 3. Local Cow                    | 35,247                      | 8,742                     | 36,412                      | 10,494                    | 37,510                      | 10,898                    |
| D. Fruits (Rs/ha)               | 86,652                      | 51,271                    | 84,017                      | 50,398                    | 81,617                      | 49,824                    |

Source: Field Survey

An attempt has been made to estimate per capita per day consumption on the different categories of farms and to find the extent of gap between the existing and recommended levels of nutrition intake (Table 4 - Table 7).

3.3 Section-III

3.3.1 Employment generation for livelihood security

The different crop enterprises have a different potential of generating income and employment. Vegetable crops are labour intensive and provide gainful employment to marginal and small farmers along with other categories. In areas where irrigation facility is available the land could be intensively used, if vegetable crops are taken-up. In a short time they provide income, employment and nutrition to farmers. The employment generated by different crop enterprises has been presented in Table 8. All those enterprises which created more than 140 days/ha of employment were regarded as labour intensive crops with respect to more labour needed. The crops in this category were sugarcane, paddy, ladyfinger, ginger, tomato, wheat, peas, cauliflower, cabbage, potato and radish.

3.4 Section – IV

3.4.1 Optimum production systems

The optimized resource-use enhances the farm income by employing them gainfully. It also reduces the disguised unemployment on the farms. The commercial crops if properly grown can give five to ten times more returns than cereals. Farmers attain food, nutritional and livelihood security by diversifying their farm
business. The agricultural production being biological process is affected by physical, biological factors and uncertain market conditions. The physical factors include weather events, such as rainfall, temperature, humidity, evaporation, frost, hailstorms and strong winds. All these factors are responsible for the biological hazards like the incidence of diseases, attack of insect-pests and consequently uncertain market situations. Therefore, farmers experience sharp fluctuations in their income from season to season and year to year. The lack of know-how about such changes and fluctuations has adverse effect on production and marketing. The decisions for making optimal use of all farm resources are difficult, unless correct predictions of yields, prices and resource availability are made. The diversification of the system not only enhances income but also reduce risk.

Table 4. Per day Consumption of different commodities and their nutritive value on small farms

| Product          | Consumption (g/ml) | Energy (Kcal) | CHO (g) | Fat (g) | Protein (g) | Calcium (mg) | Iron (mg) |
|------------------|--------------------|---------------|---------|---------|-------------|--------------|-----------|
| Maize            | 138                | 472           | 91      | 5       | 15          | 14           | 6         |
| Paddy            | 169                | 583           | 132     | 0.85    | 11.5        | 17           | 1.2       |
| Pulses           | 28                 | 102           | 14      | 1.58    | 7.52        | 44.2         | 1.72      |
| Wheat            | 150                | 521           | 108     | 2.26    | 17.8        | 61.9         | 8         |
| Vegetables       | 220                | 123           | 24.12   | 0.50    | 7.43        | 140.7        | 6.33      |
| Fruit            | 21                 | 9.88          | 2.42    | 0.22    | 0.24        | 4.94         | 0.120     |
| Sugar            | 44                 | 175           | 44      | 0.00    | 0.044       | 5.28         | 0.068     |
| Spices & Condiments | 0.08            | 0.2           | 0.44    | 0.014   | 0.011       | 0.44         | 0.019     |

Source: Field Survey

Table 5. Per day Consumption of different commodities and their nutritive value on medium farms

| Product          | Consumption (g/ml) | Energy (Kcal) | CHO (g) | Fat (g) | Protein (g) | Calcium (mg) | Iron (mg) |
|------------------|--------------------|---------------|---------|---------|-------------|--------------|-----------|
| Maize            | 152                | 520           | 101     | 5.47    | 16.87       | 15.2         | 6.23      |
| Paddy            | 163                | 565           | 127.46  | 0.81    | 11.08       | 16.3         | 1.14      |
| Pulses           | 29                 | 105           | 13.43   | 1.47    | 7.69        | 41.33        | 1.60      |
| Wheat            | 146                | 505           | 104     | 2.19    | 17.22       | 59.86        | 7.73      |
| Vegetables       | 243                | 143           | 28.08   | 0.58    | 8.66        | 163.8        | 7.37      |
| Fruit            | 23.39              | 11            | 2.57    | 0.23    | 0.25        | 5.26         | 0.13      |
| Sugar            | 41                 | 163           | 41      | 0.00    | 0.041       | 4.92         | 0.064     |
| Spices & Condiments | 0.08            | 0.2           | 0.44    | 0.014   | 0.011       | 0.44         | 0.019     |

Source: Field Survey
Table 6. Per day Consumption of different commodities and their nutritive value on large farms

| Product          | Consumption (g/ml) | Energy (Kcal) | CHO (g) | Fat (g) | Protein (g) | Calcium (mg) | Iron (mg) |
|------------------|-------------------|--------------|---------|---------|-------------|--------------|-----------|
| Maize            | 163               | 557          | 108     | 5.9     | 18          | 16.3         | 6.68      |
| Paddy            | 181               | 624          | 142     | 6.5     | 20          | 18.1         | 7.42      |
| Pulses           | 35                | 127          | 18      | 1.96    | 10.22       | 54.95        | 2.13      |
| Wheat            | 163               | 564          | 116     | 2.44    | 19.23       | 66.83        | 8.63      |
| Vegetables       | 257               | 157          | 30.84   | 0.64    | 9.50        | 179.9        | 8.09      |
| Fruit            | 23.37             | 10.51        | 2.57    | 0.23    | 0.25        | 5.25         | 0.12      |
| Sugar            | 40.85             | 163          | 40.60   | 0.00    | 0.041       | 4.9          | 0.06      |
| Spices & Condiments | 0.09              | 0.22         | 0.5     | 0.00    | 0.016       | 0.5          | 0.021     |

Source: Field Survey

Table 7. Gap between recommended and existing level of nutrition-nutritional security gap on different categories of farms

| Particular | Unit | Recommended | Small | Medium | Large | Small | Medium | Large |
|------------|------|-------------|-------|--------|-------|-------|--------|-------|
| Energy     | Kcal | 3362        | 2368  | 2372   | 2611  | 30    | 24     | 12    |
| Protein    | g    | 55          | 65    | 68     | 83    | -18   | -24    | -51   |
| Carbohydrates | g | 450         | 416   | 455    | 459   | 8     | -1     | -6    |
| Fat        | g    | 20          | 50    | 48     | 60    | -150  | -140   | -200  |
| Iron       | mg   | 29          | 24    | 25     | 33    | 17    | 14     | -14   |
| Calcium    | mg   | 400         | 324   | 348    | 393   | 19    | 13     | 2     |

Source: Field Survey

Table 8. Labour employed for different crops (Per Hectare)

| Sr. No | Crops          | Rainfed | Man days |
|--------|----------------|---------|----------|
| A.     |                |         |          |
| 1.     | Maize          | 138     |          |
| 2.     | Sugarcane      | 168     |          |
| 3.     | Jowar-bajra    | 115     |          |
| 4.     | Wheat          | 132     |          |
| 5.     | Barley         | 99      |          |
| 6.     | Potato         | 136     |          |
| B.     |                |         |          |
| 1.     | Paddy          | 164     |          |
| 2.     | Maize          | 139     |          |
| 3.     | Mash           | 115     |          |
| 4.     | Ladyfinger     | 143     |          |
| 5.     | Ginger         | 145     |          |
| 6.     | Bajra-Jowar    | 140     |          |
| 7.     | Tomato         | 173     |          |
| 8.     | Pumpkin        | 108     |          |
| 9.     | Cucumber       | 102     |          |
| 10.    | Bottle gourd   | 113     |          |
| 11.    | Bitter gourd   | 92      |          |
| Sr. No | Crops          | Man days |
|-------|----------------|----------|
| 12.   | Black gram     | 115      |
| 13.   | Wheat          | 189      |
| 14.   | Barley         | 113      |
| 15.   | Potato         | 126      |
| 16.   | Pea            | 140      |
| 17.   | Cauliflower    | 144      |
| 18.   | Cabbage        | 157      |
| 19.   | Mustard        | 64       |
| 20.   | Radish         | 147      |
| 21.   | Lentil         | 98       |
| 22.   | Barseem        | 108      |
| 23.   | Potato         | 203      |

Source: Field Survey

Table 9. Suggested farming system for rainfed and irrigated production systems for small, medium and large farms in the study area

| Farming system | Unit | Size of farm |
|----------------|------|--------------|
|                |      | Small | Medium | Large |
| A. Rain fed farming(Rs/ha) |      |       |        |
| 1. Rainfed | | | |
| I. Maize – Wheat | Percent | 16.12 | 16.92 | 18.86 |
| II. Maize + Pulses – Wheat | Percent | 3.10 | 3.78 | 4.16 |
| III. Maize – Toria - Wheat | Percent | 12.71 | 13.40 | 14.19 |
| IV Maize – Peas | Percent | 33.22 | 34.75 | 36.33 |
| Sub-Total | Percent | 65.15 | 68.85 | 73.54 |
| 2. Irrigated | | | |
| I. Paddy – Wheat | Percent | 10.09 | 6.90 | 4.12 |
| II. Chari – Barseem | Percent | 1.03 | 1.32 | 1.90 |
| III. Paddy – Barseem | Percent | 1.04 | - | - |
| IV Tomato – Tomato – Cauliflower | Percent | 8.04 | 7.63 | 6.18 |
| V. Tomato – Tomato – Peas | Percent | 11.10 | 10.40 | 8.68 |
| Sub-Total | Percent | 31.30 | 26.25 | 20.88 |
| 3. Fruits | Percent | 3.55 | 4.90 | 5.58 |
| 4. Operational holding | Hectare | 0.253 | 0.707 | 2.360 |
| Cropping intensity** | Percent | 210 | 215 | 219 |
| 5. Dairy | | | |
| Buffalo | - | 1.00 | 2.00 |
| Cross – bred Cow | 1 | 2.00 | 4.00 |

4. CONCLUSION

It reveals from the study that cereals dominated the cropping pattern among all categories of farmers. Average yield of majority crops was lower than potential yield, highlighting the need for strong extension services needed for bridging the gap at different levels. The rainfed farming accounts for majority (more than 80%) of operation holding, and maize-peas gave maximum return under all categories of farms. Suggested farming system under rainfed farming is maize-peas, followed by maize-wheat and tomato-peas, followed by paddy-wheat under irrigated conditions. The optimized resource-use will enhances the farm income by employing them gainfully. Commercial crops if grown properly can give five to ten times' higher return than cereals. Farmer also faces the problem of lack of awareness as major constraints for low yield of their crops.

COMPETING INTERESTS

Authors have declared that no competing interest exists.

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