

# **“Economics of potato varieties (*Solanum tuberosum* L.) and soil health under peach-based agroforestry system in northern hills zone of Chhattisgarh”**

## **ABSTRACT:**

This study evaluates “Economics of potato varieties (*Solanum tuberosum* L.) and soil health under peach-based agroforestry system in northern hills zone of Chhattisgarh”. Two production systems (sole potato and peach intercropped with potato) and five potato varieties (Kufri Sinduri, Kufri Lalit, Kufri Arun, Lady Rosseta, Kufri Khyati) were investigated during the 2021-22 and 2022-23 *rabi* seasons. Parameters such as cost of cultivation, gross return, net return, and benefit-cost ratio (B:C ratio) were analyzed. The results indicate that the Peach + potato system (S<sub>2</sub>) and Kufri Sinduri variety (V<sub>1</sub>) yielded higher net returns and B:C ratio, attributed to organic matter from peach residues enhancing soil fertility and yield potential. Statistically significant differences in economics were observed due to production system and crop variety variations.

**Keywords:** Peach + potato, Economics, Kufri Sinduri, Kufri Lalit, Kufri Arun, Lady Rosseta, and Kufri Khyati.

## **1. INTRODUCTION:**

King of vegetable crop potato (*Solanum tuberosum* L.) is also known to be a shade-tolerant crop. As a C<sub>3</sub> plant, potato needs moderate irradiance conditions (Mariana and Hamdani, 2016). Especially in tropical and subtropical zones where potato can be grown throughout the year and radiation is up to 30 MJ m<sup>-2</sup> day<sup>-1</sup>, potato is quite often integrated in an agroforestry system. Fruit tree-based agroforestry is very popular in tropical and subtropical countries and it brings in a considerable amount of money (Ali *et al.*, 2018).

Potato has popularity with highly demandable vegetable crops in the world. It is grown well in a short-day, though it is a C<sub>3</sub> plant grown in the winter period, requires minimum sunlight (Demagante and Vander Zaag, 1988). It has emerged, as fourth most important food crop in India after rice, wheat and maize. Presently potato is grown in around 16.5 million ha with production of 359 million tonnes (FAOSTAT, 2021). India is the second largest potato producer in the world with an

area of 2.20 million ha with production of 56.17 million tonnes and productivity of 25.53 tonne ha<sup>-1</sup> (Anonymous, 2022a). Potato occupies about 42584 hectares area in Chhattisgarh with total production of 652225 tonnes and productivity is 15.32 tonnes per hectare. The highest area (7416 ha) and production (102371 tonnes) is recorded in Surguja district followed by Balrampur and Raigarh district of Chhattisgarh (Anonymous, 2022b).

Fruit-tree-based agroforestry system have been only modestly studied, especially in terms of quantification of biophysical interactions occurring in mixtures of fruit trees and crops (Bellow, 2004). In Himachal Pradesh temperate trees such as apple, apricot, peach, pear and plum are most commonly used in agroforestry system. The aspect and season also play a significant role in grain, straw and biological productivity of agricultural crops present in agri-horticulture and sole cropping system. In case of sloppy land sole agricultural practices are difficult, therefore different agroforestry combinations are preferred by the farmers. Retention of fruit trees on their agricultural fields for additional monetary gain from the fruits and therefore, agri-horticulture practice is the priority of high land holding farmers as the climatic and geographical situations also permit such practices (Bijalwan, 2012).

## **2. MATERIAL AND METHOD**

The investigation was conducted at Potato and Temperate Fruit Research Station, Mainpat, Chhattisgarh. It aimed to assess the production potential of five potato varieties under peach-based agroforestry (Peach + potato) and sole potato systems. Factorial RBD design with three replications and ten treatment combinations was employed. Each combination was randomly replicated thrice, totalling 30 plots. The potato varieties included Kufri Sinduri, Kufri Lalit, Kufri Arun, Lady Rosseta, and Kufri Khyati. Plots measured 5x5m, with row and plant distances set at 60cm and 20cm, respectively. RDF of 180:120:120 NPK kg ha<sup>-1</sup> was applied. The study aimed to improve agricultural practices in the region.

### **Cost of cultivation (Rs ha<sup>-1</sup>)**

Cost of cultivation is the total expenditure incurred for raising crop in a treatment. The cost of cultivation included human labours cost, field preparation cost (tractor cost) value of seed, manures, fertilizers, pesticides and herbicides and irrigation charges.

### **Gross return (Rs ha<sup>-1</sup>)**

Gross returns are the total monetary value of economic produce and by produce obtained from the crop raised in the different treatments. It is calculated based on the local market prices.

### **Net return (Rs ha<sup>-1</sup>)**

It is computed by subtracting the cost of cultivation from gross returns. It is a good indicator of the suitability of a cropping system since it represents the actual income of the farmer. Monetary returns for different treatments were calculated with the help of prevailing market rates of production and different inputs used in the experiments.

$$\text{Net profit (Rs ha}^{-1}\text{)} = \text{Gross income (Rs ha}^{-1}\text{)} - \text{Cost of cultivation (Rs ha}^{-1}\text{)}$$

### **B:C ratio**

Based on the current price of input used and produce seed income the net profit ha<sup>-1</sup>.and benefit cost (B:C) ratio was worked out by using the following formula:

$$\text{Benefit: cost ratio} = \frac{\text{Net income (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

## **3. RESULT:**

The observation data economics parameters of potato were affected by various treatments have been presented in Table 1 and 2.

### **Economics of potato**

The data Table 1 and 2 presents the economic analysis of potato cultivation based on different treatment production system and crop varieties. The data includes cost of cultivation (₹ha<sup>-1</sup>), gross return (₹ha<sup>-1</sup>), net return (₹ha<sup>-1</sup>), and the benefit-cost ratio (B: C ratio).

Treatment S<sub>1</sub>, which involved sole potato cultivation, incurred a cost of ₹ 106,189 and ₹ 249,802 ha<sup>-1</sup> in 2021-22 and 2022-23, respectively. The gross return was ₹ 283,474 and ₹ 143,613 ha<sup>-1</sup> for the respective years, resulting in net returns of ₹ 177,286 and ₹ 210,958 ha<sup>-1</sup>, with a mean B:C ratio of 1.67. Treatment S<sub>2</sub>, where peach was intercropped with potato, had higher costs of cultivation at ₹ 147,169 and ₹ 735,658 ha<sup>-1</sup> in 2021-22 and 2022-23, respectively. The gross return for these years was ₹ 782,599 and ₹ 588,489 ha<sup>-1</sup>, leading to net returns of ₹ 635,430 and ₹ 682,372 ha<sup>-1</sup>, with a mean B:C ratio of 4.32.

Regarding crop varieties, V<sub>1</sub> (Kufri Sinduri) exhibited a cost of cultivation of ₹ 126,679 ha<sup>-1</sup> and gross returns of ₹ 577,259 and ₹ 406,245 ha<sup>-1</sup> in 2021-22 and 2022-23, respectively. Its net returns were ₹ 450,580 and ₹ 494,916 ha<sup>-1</sup>, with a mean B:C ratio of 3.33. V<sub>4</sub> (Lady Rosseta) had a cost of cultivation of ₹ 126,679 ha<sup>-1</sup> and gross returns of ₹ 501,758 and ₹ 337,607 ha<sup>-1</sup> in 2021-22 and 2022-23, respectively. Its net returns were ₹ 375,079 and ₹ 412,551 ha<sup>-1</sup>, with a mean B:C ratio of 2.75.

The observed differences in the economics of potato cultivation can be attributed to various factors such as the production system and crop variety. The Peach + potato production system (S<sub>2</sub>) may have resulted in higher gross return, net return, and B:C ratio due to the addition of organic matter from the peach crop residues, which can enhance soil fertility and crop productivity. The different crop varieties used may have also differed in their yield potential and market value, with some varieties having a greater yield potential. The standard errors of the mean and the critical differences indicate that the observed differences in the economics of potato cultivation are statistically significant.

The standard error of the means (SEM<sub>±</sub>) and critical differences (CD) at a significance level of 0.05 are also provided to assess the reliability of the data. The economic analysis of potato cultivation and the different crop varieties in the study provide valuable insights in making informed decisions to optimize their crop management practices and economic returns. The results obtained in the present study is in accordance with the results of Chettri *et al.* (2005), Dash (2008), Amarananjundeswara *et al.* (2018), Amin *et al.* (2021), Banerjee and Dhara (2011) and Devi *et al.* (2023).

UNDER PEER REVIEW

**Table 1: Economics of potato asaffected by production system and potato varieties under peach-based agroforestry system**

| Treatments details                  | Cost of Cultivation (₹ ha <sup>-1</sup> ) | Gross Return (₹ ha <sup>-1</sup> ) |              |              | Net Return (₹ ha <sup>-1</sup> ) |              |              | B:C Ratio   |             |             |
|-------------------------------------|---|------------------------------------|--------------|--------------|----------------------------------|--------------|--------------|-------------|-------------|-------------|
|                                     |   | 2021-22                            | 2022-23      | Mean         | 2021-22                          | 2022-23      | Mean         | 2021-22     | 2022-23     | Mean        |
| <b>Factor A (Production system)</b> |   |                                    |              |              |                                  |              |              |             |             |             |
| S <sub>1</sub> -Sole potato         | 106189                                    | 249802                             | 317147       | 283474       | 143613                           | 210958       | 177286       | 1.35        | 1.99        | 1.67        |
| S <sub>2</sub> -Peach + potato      | 147169                                    | 735656                             | 829540       | 782599       | 588489                           | 682372       | 635430       | 4.00        | 4.64        | 4.32        |
| SEm±                                | -   | <b>5119</b>                        | <b>5501</b>  | <b>5291</b>  | <b>5119</b>                      | <b>5501</b>  | <b>5291</b>  | <b>0.04</b> | <b>0.04</b> | <b>0.04</b> |
| CD = (P=0.05)                       | -   | <b>15212</b>                       | <b>16346</b> | <b>15722</b> | <b>15212</b>                     | <b>16346</b> | <b>15722</b> | <b>0.12</b> | <b>0.13</b> | <b>0.12</b> |
| <b>Factor B (Crop varieties)</b>    |   |                                    |              |              |                                  |              |              |             |             |             |
| V <sub>1</sub> -Kufri Sinduri       | 126679                                    | 532923                             | 621595       | 577259       | 406245                           | 494916       | 450580       | 2.98        | 3.68        | 3.33        |
| V <sub>2</sub> - Kufri Lalit        | 126679                                    | 488184                             | 567908       | 528046       | 361506                           | 441230       | 401368       | 2.65        | 3.28        | 2.96        |
| V <sub>3</sub> -Kufri Arun          | 126679                                    | 475923                             | 553195       | 514559       | 349245                           | 426516       | 387881       | 2.55        | 3.16        | 2.85        |
| V <sub>4</sub> -Lady Rosseta        | 126679                                    | 464286                             | 539230       | 501758       | 337607                           | 412551       | 375079       | 2.45        | 3.04        | 2.75        |
| V <sub>5</sub> -Kufri Khyati        | 126679                                    | 502331                             | 584789       | 543560       | 375653                           | 458111       | 416882       | 2.76        | 3.41        | 3.08        |
| SEm±                                | -   | <b>8095</b>                        | <b>8698</b>  | <b>8366</b>  | <b>8095</b>                      | <b>8698</b>  | <b>8366</b>  | <b>0.06</b> | <b>0.07</b> | <b>0.07</b> |
| CD = (P=0.05)                       | -   | <b>24052</b>                       | <b>25845</b> | <b>24858</b> | <b>24052</b>                     | <b>25845</b> | <b>24858</b> | <b>0.18</b> | <b>0.20</b> | <b>0.19</b> |

\*Potato price 2021-22 = Rs. 15/kg and 2022-23 = Rs. 18/kg.

\*\*Peach fruit price in year 2021-22 and 2022-23 = Rs. 45.00/kg.

**Conti... Table 2: Economics of potato as affected by production system and potato varieties under peach-based agroforestry system**

| <b>Interaction (SxV)</b>          |        |              |              |              |              |              |              |             |             |             |
|-----------------------------------|--------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|-------------|
| <b>S<sub>1</sub>V<sub>1</sub></b> | 106189 | 273243       | 345276       | 309259       | 167054       | 239088       | 203071       | 1.57        | 2.25        | 1.91        |
| <b>S<sub>1</sub>V<sub>2</sub></b> | 106189 | 250087       | 317489       | 283788       | 143898       | 211300       | 177599       | 1.36        | 1.99        | 1.67        |
| <b>S<sub>1</sub>V<sub>3</sub></b> | 106189 | 237737       | 302669       | 270203       | 131548       | 196480       | 164014       | 1.24        | 1.85        | 1.54        |
| <b>S<sub>1</sub>V<sub>4</sub></b> | 106189 | 226218       | 288846       | 257532       | 120029       | 182658       | 151344       | 1.13        | 1.72        | 1.43        |
| <b>S<sub>1</sub>V<sub>5</sub></b> | 106189 | 261724       | 331454       | 296589       | 155535       | 225265       | 190400       | 1.46        | 2.12        | 1.79        |
| <b>S<sub>2</sub>V<sub>1</sub></b> | 147169 | 792604       | 897913       | 845258       | 645435       | 750745       | 698090       | 4.39        | 5.10        | 4.74        |
| <b>S<sub>2</sub>V<sub>2</sub></b> | 147169 | 726281.89    | 818327       | 772305       | 579113       | 671159       | 625136       | 3.94        | 4.56        | 4.25        |
| <b>S<sub>2</sub>V<sub>3</sub></b> | 147169 | 714110       | 803721       | 758916       | 566942       | 656553       | 611747       | 3.85        | 4.46        | 4.16        |
| <b>S<sub>2</sub>V<sub>4</sub></b> | 147169 | 702354       | 789614       | 745984       | 555185       | 642445       | 598815       | 3.77        | 4.37        | 4.07        |
| <b>S<sub>2</sub>V<sub>5</sub></b> | 147169 | 742938       | 838125       | 790532       | 595770       | 690957       | 643363       | 4.05        | 4.70        | 4.37        |
| <b>SEm±</b>                       | -      | <b>11448</b> | <b>12301</b> | <b>11832</b> | <b>11448</b> | <b>12301</b> | <b>11832</b> | <b>0.09</b> | <b>0.10</b> | <b>0.09</b> |
| <b>CD = (P=0.05)</b>              | -      | <b>NS</b>    | <b>NS</b>    | <b>NS</b>    | <b>NS</b>    | <b>NS</b>    | <b>NS</b>    | <b>NS</b>   | <b>NS</b>   | <b>NS</b>   |

\*Potato price 2021-22 = Rs. 15/kg and 2022-23 = Rs. 18/kg

\*\*Peach fruit price in year 2021-22 and 2022-23 = Rs. 45.00/kg

#### 4. CONCLUSION

In this study, the evaluation of potato production economics under different production systems and varieties revealed insightful findings. The Peach + potato agroforestry system ( $S_2$ ) exhibited higher gross return, net return, and B:C ratio compared to the sole potato cultivation ( $S_1$ ). This improvement can be attributed to the contribution of organic matter from peach residues, enhancing soil fertility and overall productivity. Among the potato varieties, Kufri Sinduri ( $V_1$ ) demonstrated better economic performance with higher net returns and B:C ratio, emphasizing its suitability for the agroforestry system. These findings underscore the importance of sustainable practices like agroforestry and proper variety selection in optimizing potato production and economic returns.

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