"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".**<<is there any reason to re-type the title of the manuscript in this section?>>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_2) and Kufri Sinduri variety (V_1) 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_3 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^{-2} day^{-1}, 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_3 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^{-1}(Anonymous, 2022a ?? a cite is required). Potato occupies about 42,584 hectares area in Chhattisgarh with total production of 652,225 tonnes and productivity is 15.32 tonnes per hectare. The highest area (7,416 ha) and production (10,2371 tonnes) is recorded in Surguja district followed by Balrampur and Raigarh district of Chhattisgarh (Anonymous, 2022b?? a cite is required).

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^{-1} was applied. The study aimed to improve agricultural practices in the region.

Cost of cultivation (Rs ha^{-1})

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^{-1})

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^{-1})

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.

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

B:C ratio

Based on the current price of input used and produce seed income the net profit ha^{-1}.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 AND DISCUSSION:

The observation data economics parameters of potatowere 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^{-1}), gross return (₹ha^{-1}), net return (₹ha^{-1}), and the benefit-cost ratio (B: C ratio).

Treatment S_1, which involved sole potato cultivation, incurred a cost of ₹ 106,189 and ₹ 249,802 ha^{-1} in 2021-22 and 2022-23, respectively. The gross return was ₹ 283,474 and ₹ 143,613 ha^{-1} for the respective years, resulting in net returns of ₹ 177,286 and ₹ 210,958 ha^{-1}, with a mean B:C ratio of 1.67. Treatment S_2, where peach was intercropped with potato, had higher costs of cultivation at ₹ 147,169 and ₹ 735,658 ha^{-1} in 2021-22 and 2022-23, respectively. The gross return for these years was ₹ 782,599 and ₹ 588,489 ha^{-1}, leading to net returns of ₹ 635,430 and ₹ 682,372 ha^{-1}, with a mean B:C ratio of 4.32.

Regarding crop varieties, V_1 (Kufri Sinduri) exhibited a cost of cultivation of ₹ 126,679 ha^{-1} and gross returns of ₹ 577,259 and ₹ 406,245 ha^{-1} in 2021-22 and 2022-23, respectively. Its net returns were ₹ 450,580 and ₹ 494,916 ha^{-1}, with a mean B:C ratio of 3.33.V_4 (Lady Rosseta) had a cost of cultivation of ₹ 126,679 ha^{-1} and gross returns of ₹ 501,758 and ₹ 337,607 ha^{-1} in 2021-22 and 2022-23, respectively. Its net returns were ₹ 375,079 and ₹ 412,551 ha^{-1}, with a mean B:C ratio of 2.75.<<re-arrange all this data in: Tables, Graphics, or composite>>

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_2) 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±) 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).

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

Treatments details	Cost of Cultivation (₹ ha^{-1})	Gross Return (₹ ha^{-1})			Net Return (₹ ha^{-1})			B:C Ratio		
		2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Factor A (Production system)										
S_1-Sole potato	106189	249802	317147	283474	143613	210958	177286	1.35	1.99	1.67
S_2-Peach + potato	147169	735656	829540	782599	588489	682372	635430	4.00	4.64	4.32
SEm±	-	**5119**	**5501**	**5291**	**5119**	**5501**	**5291**	**0.04**	**0.04**	**0.04**
CD = (P=0.05)	-	**15212**	**16346**	**15722**	**15212**	**16346**	**15722**	**0.12**	**0.13**	**0.12**
Factor B (Crop varieties)										
V_1-Kufri Sinduri	126679	532923	621595	577259	406245	494916	450580	2.98	3.68	3.33
V_2- Kufri Lalit	126679	488184	567908	528046	361506	441230	401368	2.65	3.28	2.96
V_3-Kufri Arun	126679	475923	553195	514559	349245	426516	387881	2.55	3.16	2.85
V_4-Lady Rosseta	126679	464286	539230	501758	337607	412551	375079	2.45	3.04	2.75
V_5-Kufri Khyati	126679	502331	584789	543560	375653	458111	416882	2.76	3.41	3.08
SEm±	-	**8095**	**8698**	**8366**	**8095**	**8698**	**8366**	**0.06**	**0.07**	**0.07**
CD = (P=0.05)	-	**24052**	**25845**	**24858**	**24052**	**25845**	**24858**	**0.18**	**0.20**	**0.19**

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

Interaction (SxV)										
S_1V_1	106189	273243	345276	309259	167054	239088	203071	1.57	2.25	1.91
S_1V_2	106189	250087	317489	283788	143898	211300	177599	1.36	1.99	1.67
S_1V_3	106189	237737	302669	270203	131548	196480	164014	1.24	1.85	1.54
S_1V_4	106189	226218	288846	257532	120029	182658	151344	1.13	1.72	1.43
S_1V_5	106189	261724	331454	296589	155535	225265	190400	1.46	2.12	1.79
S_2V_1	147169	792604	897913	845258	645435	750745	698090	4.39	5.10	4.74
S_2V_2	147169	726281.89	818327	772305	579113	671159	625136	3.94	4.56	4.25
S_2V_3	147169	714110	803721	758916	566942	656553	611747	3.85	4.46	4.16
S_2V_4	147169	702354	789614	745984	555185	642445	598815	3.77	4.37	4.07
S_2V_5	147169	742938	838125	790532	595770	690957	643363	4.05	4.70	4.37
SEm±	**-**	**11448**	**12301**	**11832**	**11448**	**12301**	**11832**	**0.09**	**0.10**	**0.09**
CD = (P=0.05)	**-**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

**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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