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Economics of High-Density Apple Orchards: A Comparative Analysis of Jammu and Kashmir, India and Trentino-Alto-Adige, Italy

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Abstract- **High-density apple orchards have substantially increased productivity as well as production worldwide. In India, High-Density Apple Plantation scheme was launched in 2015-16 in Jammu and Kashmir with root-stocks imported from Trentino-Alto-Adige, Italy. Trentino-Alto-Adige in Italy is one of the most important regions producing high-quality apples in Europe. This paper compares the yield, input costs and payback period of High-Density Apple Orchards of Jammu & Kashmir, India with Italian (Trentino-Alto-Adige) counterparts. The yield of high-density orchards has substantially improved and the payback period is just five years now, similar to the performance of Italian orchards. Lower gestation period gives the farmers a better leeway to profitability, but the high investment cost upfront is a challenge and thus, 95 percent of the farmers chose lower density apple orchards. The government should improve access to credit and establish Farmer Producer Organisation for cluster development of the sector in the region.**

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I. Introduction

The region of Jammu and Kashmir in India, continues to be an agrarian economy. Nearly 70 percent of the population of the Union Territory is directly or indirectly involved in agriculture. According to the latest data of Economic Survey, 2019-20, agriculture in Jammu & Kashmir, contributes 17.2 percent to the total Gross State Domestic Product- GSDP and its growth rate (9 percent) is substantially higher than the national average (2.9 percent). Amongst the agricultural activities, horticulture is the most important driver of the growth rate and contributes 40 percent to the total output value from agriculture in Jammu and Kashmir. (Readers' Digest, J&K, 2017-18). Nearly 3.3 million people are directly or indirectly involved in this sector (Jha et al, 2019). The government too acknowledging the importance of the sector has brought in various schemes like Mission for Integrated Development of Horticulture, Prime Ministers' Development Package, Mega Food Park Development and High-Density Apple Orchards. Infrastructural development like establishment of fruit-markets, controlled atmosphere storages and deployment of agricultural extension services to the rural farmers has also been on the anvil of the government.

Apple is the most important horticultural crop of the Union Territory contributing 60-65 percent to the total output of horticulture. Even on the national level, Jammu and Kashmir, produces 75 percent of the total apples in the country. (Mir et al, 2018, Hanan 2015). In terms of economy, the sector is ever-increasing with an annual export of 7500 crores from the fruits alone (Shaheen et al, 2019).

Apple crop has tremendously grown in Jammu and Kashmir in the last five decades. The area under apple crop has increased from 46 thousand hectares to 1.64 lakh hectares from 1974 to 2018-19. (Directorate of Horticulture, Jammu & Kashmir, 2019-20). Consequently, the production has increased from 1.9 lakh metric tonnes to 19 lakhs metric tonnes during the same time-period. The productivity has also increased from mere 4.12 tonnes/hectare in 1974 to 11.43 tonnes/ hectare in 2018-19. (Directorate of Horticulture, J&K 2019). Overall, the area and production in horticulture has witnessed tremendous growth during these years and as a result the Union Territory has emerged as a horticultural hotspot in the country.

The agri-climatic conditions of the Union Territory have also been favourable for the development of the sector. The Union Territory falls in three major agri-climatic zones, Sub-Tropical, Intermediate and the Temperate Zone. (Hanan, 2015). It is the temperate zone where horticultural production and acreage has been dominant. This majorly falls in the Valley of Kashmir, where crops like Apple, Pear, Walnut, Apricot, Peaches and Cherries are mostly produced. At 11.43 tonnes/hectare, the productivity in Union Territory is way ahead than 6.7 tonnes/hectare of Himachal Pradesh- the second largest producer of apple in the country. Naturally, since the conception of the development of Horticulture crops in the region, the region has witnessed higher productivity than the national average. However, on comparative basis this productivity is significantly lower than the productivity in developed economies like New Zealand (65-70 tonnes/hectare), Italy (70-75 tonnes/hectare) and Netherlands (75-80

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tonnes/hectare). (Fondazione Edmund Mach Conference, 2013). The reason for such high productivity is the application of scientific and modern-day farming like high-density apple orcharding (Ivey 1990), Meland 2005).

Italy witnesses one of the highest yields per hectare of apples in the world with Trentino-Alto-Adige and South Tyrol regions contributing 80-85 percent to the total production of Apple in the country. Trentino-Alto-Adige is an autonomous region in Northern Italy. The region owing to its mountainous topography shows resemblance with Jammu and Kashmir, India in terms of agri-climatic conditions. The region produces 67 percent of the total apples in Italy which is similar to 75 percent production of apples in Jammu and Kashmir, from a near similar acreage of 50 percent in both the regions (Giorgio De Ros, 2011, National Horticulture Board. 2019). According to National Government of Italy, Trentino is one of the most important growing areas of high-quality apples throughout Europe. The High-Density Apple Orchards in Trentino have considerably changed the face of the apple production in the region. These high-density apple orchards have phenomenally enhanced both production and productivity across the regions. In New Zealand, scientific management and effective supervision of these high-density apple orchards have substantially improved yield per hectare from last few decades (Cahn and Goedegebure, 1992). Further, there is direct relationship between tree-density in the orchards and their respective yield. With high-density of trees in the orchards, the yield increases proportionately.

Another striking feature of the High-Density Intensive Orcharding is that their economic efficiency is relatively higher. Early gestation period and high-quality of the produce makes them highly profitable for the farmers. Badiu et al (2015). In quantitative terms, the high-density orchards generate extremely high revenue than the traditional orchard-systems. (Clements, 2011). In Himachal Pradesh, the roll out of high-density apple orchards in 1990s have substantially increased the productivity of the apple crop. Large and middle farmers have largely benefited from these orchard systems and the total value of output of Apple from the Himachal Pradesh has also increased significantly. (Singh et al., 2012).

This paper is divided in two main parts- PART I and II. Part I presents economic analysis of the different densities of High-Density Apple Orchards in Trentino-Alto-Adige, Italy. There are three important areas discussed, first is the yield per hectare in different tree-densities. Second, is the establishment cost of the orchards upfront and third is the payback period of the total investment in different orchards. Part II compares the performance of the High-Density Apple Orchards in Jammu & Kashmir with the Trentino-Alto-Adige region of Italy. It depicts how the scheme has so far fared as compared to the Italian Orchards on three parameters-yield, establishment cost and the payback period. In the conclusion, the paper attempts to suggest reforms and aspects where the scheme can perform effectively in the Union Territory.

II. Data and Methodolgy

Primary data was collected from the sample of farmers who were the beneficiaries of the High-Density Apple Plantation Scheme in the first year. A sample of 50 farmers from Pulwama and Kulgam District was taken who undertook high-density apple orcharding in their respective farms. In the first year of the inception of the scheme, 60 hectares of land was used for the scheme. The farmers were divided according to their land size and each farm was identified with a certain tree-density combination. Nearly 80 percent of the farmers under the scheme were identified and interviewed through the questionnaire (see Table 1).

Table 1: Farm-size of the sampled orchardists.

Size of Farm	Number of Farms	Percentage with less than <1000 Trees/Ha	Percentage of farmers 1500 Trees/Ha	Percentage of farmers 2000 Trees/ha	Percentage of Farmers 3000 Trees/ha	Percentage of Farmers with 4000 Trees/ha
Marginal (<0.1 hectare)	10(20)	10	10	70	10	0
Small (0.1-1 hectare)	17(34)	11.7	11.7	64.71	11.7	0
Medium (1-2 hectares)	20(40)	0	15	75	10	0
Large (>2 hectares)	3(6)	0	25	75	0	0
Total Percent	50 No	6	14	70	10	0

Parenthesis Denote Percent

Data from the Horticulture Department regarding the cost per hectare was compared with the primary data collected from the farmers. This data was used to develop the relationship between the cost of the trees/hectare and the density of trees.

Payback period of the total investment was also calculated from the data. Cahn and Goedegebure (1992) had used the same concept of payback period in their analysis. Payback period refers to the time from which the orchardists starts earning profits from their farms. It is usually calculated as the year when the net cost is zero, that is the total investment equals to the total revenue earned during the years. We assessed the socio-economic conditions which included land-size and income of the farmers involved to understand the background of the region, as it also impacts the adoption of farm technology and level of investment on the farms.

Secondary Data from the Economic Survey of Jammu and Kashmir was used to analyse the growth and development of the horticultural sector in Jammu and Kashmir. To analyse the horticultural data from Trentino-Alto-Adige, Italy, we used different data sources from the Istituto Nazionale di Statistica and Ministry of Agriculture, Food and Forestry, Italy.

We chose High-Density Orchards from Trentino-Alto-Adige, of Italy for comparative analysis because the plantation scheme rolled out in Jammu and Kashmir, India had its origin from Trentino-Alto-Adige. These root-stocks were imported by the government in partnership with a private entrepreneur, who had thoroughly studied these Italian high-density apple orchards. Therefore, the analysis of the high-density apple orchards of Trentino-Alto-Adige, Italy becomes necessary to make an assessment of the performance of the high-density orchards developed in Jammu and Kashmir, India.

The establishment cost includes plant-material, development of trellis and anti-hail system, drip irrigation cost set-up, land-development, fencing and tree-training cost which includes the labour cost. It also includes the fertilizer and pesticides cost for the first year. For the payback period calculation, the maintenance cost per annum includes fertilizer and pesticides cost, tree-training, harvesting cost, transportation cost, interest cost for the credit taken upfront by the farmer and the land value (rental value of land per annum). These costs vary according to the tree-density of the orchards, as with the higher-density orchards the cost rises. Further, with each passing year the harvesting cost along with the subsequent attached costs increase with the increase in production of the apple.

Regression Analysis was performed on the establishment and the maintenance cost in the fifth year of the high-density orchards in Italy and Jammu and Kashmir simultaneously to provide an insight of the significance of the independent variables on the total revenue earned from the high-density orchard. Formula for regression analysis is:

$$\gamma = \beta_1 + \beta_2 X_2 + \beta_3 X_3 \dots\dots\dots\dots + \beta_n X_n$$

Where "γ" is the total revenue in the fifth year of the high-density orchard in Jammu and Kashmir and Italy, "β_2" is the coefficient of the cost of the plant-material, "β_3" is the coefficient of the cost of the land-development and fencing. "β_4" is the coefficient of the cost of trellis system, "β_5" is the coefficient of fertlizers and pesticides per annum and "β_6" is the coefficient of the supervision, harvesting and the cost of tree-training which includes the labour cost. Where "X_2" is the cost of the material, "X_3" is the cost of the land development and fencing, "X_4" is the cost of the trellis system, "X_5" is the amount of fertilizers and pesticides in kilograms, "X_6" is the cost of the supervision, harvesting and tree-training which includes labour cost.

III. Results and Discussion

a) Part I- Case of High-Density Apple Cultivation in Italy

The tree density and the yield show a linear relationship for each growing year. According to the scientific evidence, Year 7 is considered as the year of full production as the trees reach their maturity. Figure 1, shows the yields calculated for each year upto the seventh year with respective to three different tree densities. The graph shows that the yield per hectare keeps on increasing with each passing year. In 2000 trees/hectare category, there is a linear relationship between the yield and the tree density in the first few years. However, the increase in yield slows down post the second year in the other densities. Another important aspect is the late-upswing in the yields of two higher-density orchards- 3000 trees/ha and 4000 trees/ha. It implies that post the seventh year, the higher-density orchards show increased yield making them a long-term investment.

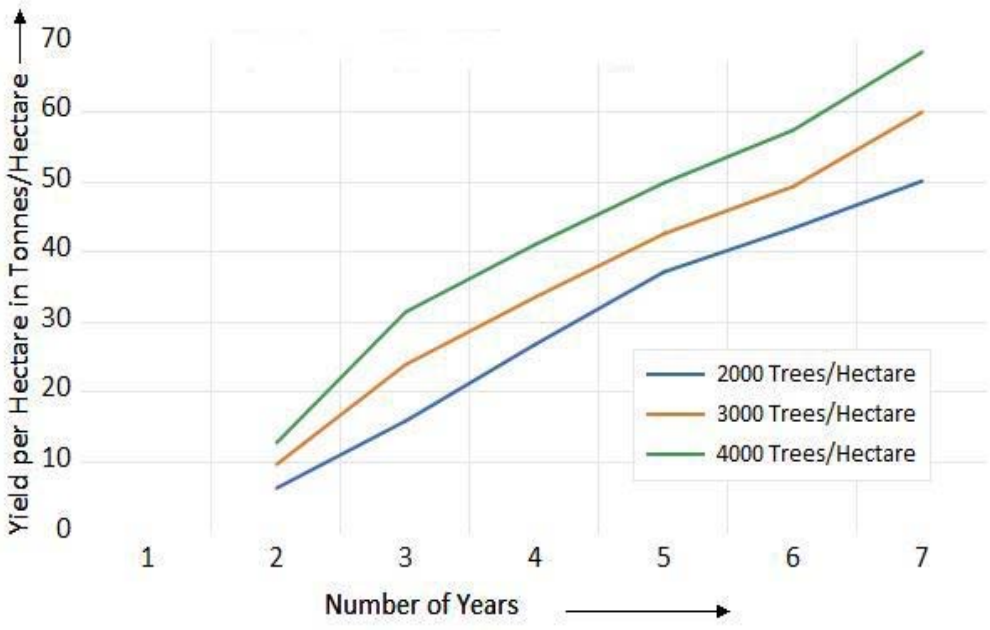

Figure 1: Yield per Hectare through the Years

Figure 2, shows the cost of the trees per hectare which includes the establishment cost of the trees. The establishment cost mainly includes, plant-material cost, drip-irrigation set-up cost, trellis system development cost, fencing, fertlizers and pesticides cost, tree-training cost and supervision cost. The graph shows linear relationship between the tree density/hectare and the cost of trees, as the equation we concluded was Y= 4681+ 4.14X, (P<0.01), where Y is the total cost per hectare and X is the tree density per hectare (see, Figure 2). There is slight dip with the increase in density of the trees which means that the costs lower when the densities increase. The lowering of the costs is partly attributed to the discount offers and the economies of scale. McKenzie et al., (1976) had discussed the relative cost of high-density apple vis-à-vis the traditional farming of New Zealand and found a similar linear increase with a slight fall in the highest bracket.

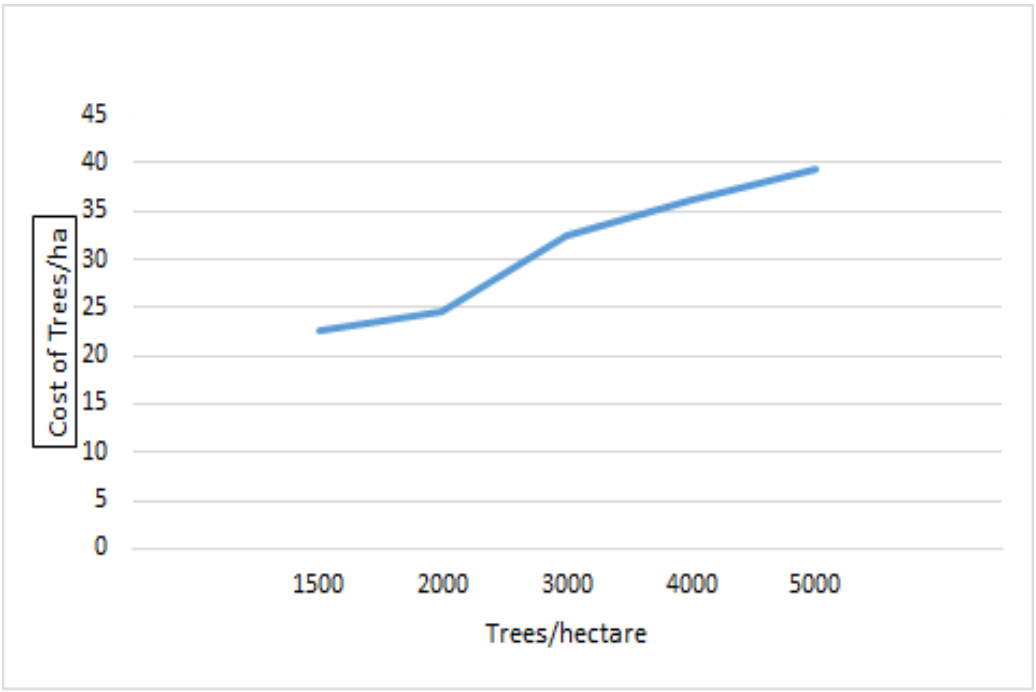

Figure 2: Cost of Trees/ha with respect to Tree Density

According to Table 2, the establishment costs in the first year (Year 1) ranges from 22.7 thousand euros for 1500 Trees/Hectare to 38.4 Thousand Euros for 4000Trees/Hectare. In the lower-density orchards, the upfront cost per tree is high when compared with the higher-density orchards in proportion. The supreme quality of the high-density apple trees enables them to bear fruit in the second year only. Although the yield is low and doesn't amount to any substantial returns in that year, thus we have a net additional accumulated amount in the second year on account of the maintenance and production cost like fertilizer, pesticide and tree-training raising the overall investment (see, Table 2)

Table 2: Payback period in terms of accumulated amount.

Amount = Euro (000/ha)

Trees/Ha	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
1500	(-22.7)	(-24.4)	(-22.2)	(-12.5)	(-1.4)	20.5	41.5
2000	(-24.2)	(-31.2)	(-27.1)	(-14.5)	3.5	24.6	50.1
2500	(-28.8)	(-34.2)	(-29.3)	(-16.2)	4.9	30.7	55.5
3000	(-32.4)	(-37.4)	(-31.4)	(-15.9)	6.3	38.5	61.9
3500	(-33.5)	(-40.4)	(-34.5)	(-16.1)	8.5	43.8	68.5
4000	(-36.2)	(-42.4)	(-35.2)	(-17.6)	11.5	48.2	71.52

Source: MONIQA Italy, OECD.

The farmer starts earning profit in the fifth year. The lower -density orchards have higher productivity from the start and as such the respective farmers start receiving profits sooner than the other farmers. However, with increase in the tree density, we see a large jump in the profitability from the fifth year which increases significantly with each passing year. The less dense orchards therefore show a short-term gain at a rapid pace, while it steadies its profiteering from Year 6 onwards. The trend runs opposite in higher density orchard combinations, where the yield per hectare increases steadily over a longer time-period, making it a better investment venture for the farmers. The result is consistent with the findings of Ivey (1990), who studied the impact of high-density orchards on the farm-returns. Cahn (1992), had made similar conclusions when studying the farms of Netherlands.

b) *Part II- Case of High-Density Apple Cultivation Scheme- Jammu and Kashmir. India*

In the introduction we have attempted to analyse the importance of Horticulture in the state economy. And it needs no emphasis that the acreage under horticulture as well as the production has increased manifold during the last few decades. Hanan (2015). Primarily, the value of output per hectare has pushed for the diversification in agriculture, particularly towards apple cultivation in the erstwhile state. On the other hand, the cost of production of the apple crop is consistently on the rise whereas the marketing potential is not increasing at the same rate. Moreover, the productivity of apple in the Union Territory has plateaued at 11.43 tonnes/ hectare, and from past few years it has remained nearly stagnant (Directorate of Horticulture, Jammu and Kashmir, 2019). This has resulted in lesser net return than the potential of the crop in the region. The stagnancy in productivity is due to application of traditional methods of cultivation, harvesting and post-harvesting.

Acknowledging the significance of the crop, the Government of Jammu and Kashmir brought in a 100% State Sponsored High-Density Apple Plantation Scheme (Department of Horticulture, Jammu and Kashmir, 2015). The Government has laid down the standards of procedure in planting different tree densities in the orchards. According to the government, the scheme provides two major tree-densities per hectare which the farmer can opt. However, the farmer in consonance with the agricultural scientists can also improvise according to their own interests and needs.

The orchardist witnessed production from the onset of the second year only (Year 2). The productivity per hectare increases year on year from the second year, increasing from 1.9 tonnes/hectare to 9.1 tonnes/ hectare in the lowest density orchards (1000 trees/ hectare) (see Figure 3). In orchards with tree density of 1500 trees/hectare and 2000 trees/hectare, the productivity or the yield per hectare has increased from 3 tonnes/hectare and 4 tonnes/hectare to 14 tonnes/ hectare and 17 tonnes/hectare respectively. Similarly, in orchards with density of 3000 trees/hectare the yield has increased from 5 tonnes/hectare in the second year to 20 tonnes/hectare in the fifth year. Therefore, the yield per hectare has substantially increased in all the orchard combinations. Although, the trees are yet to reach their maturity, their yield per hectare has surpassed the yield of the mature traditional apple orchards. The yield per hectare is likely to reach 50-70 tonnes/hectare in the higher densities (Clements, 2011). Therefore, making it

one of the most profitable horticultural investment for the farmers.

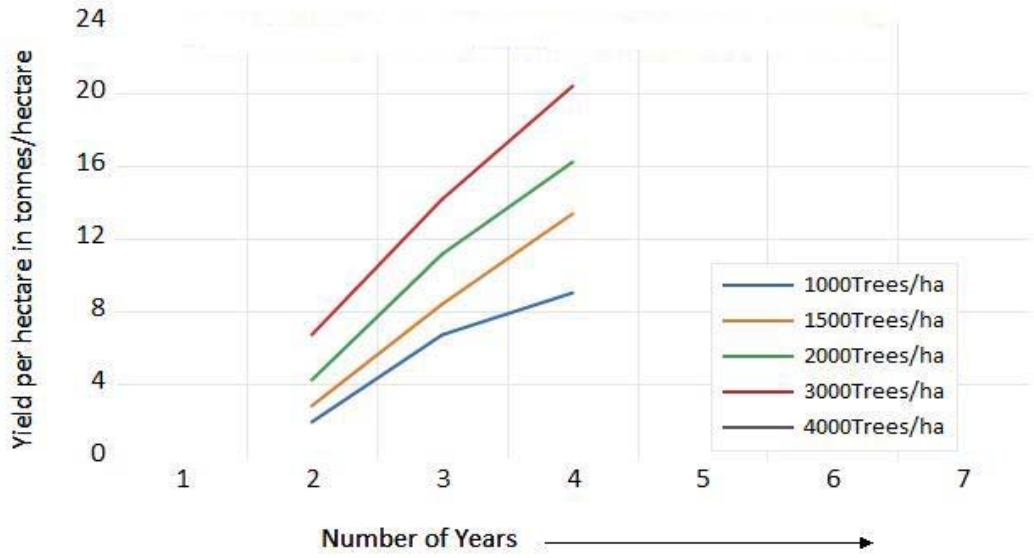

Figure 3: Yield per hectare with respect to Orchard Density

Another important point to be noted here is that there is fall in productivity in the lower-density orchards while in the higher categories the increase in productivity is linearly proportional to the number of years (see, Figure 3). This fall is higher as compared to the Italian orchards and may be attributed to poor-rootstocks supplied, improper or inadequate management of the crops by these farmers or even to some agri-climatic differences. In the higher category, the productivity increases linearly which is consistent with Cahn and Goedegebure (1992) analysis of the crops in Netherland.

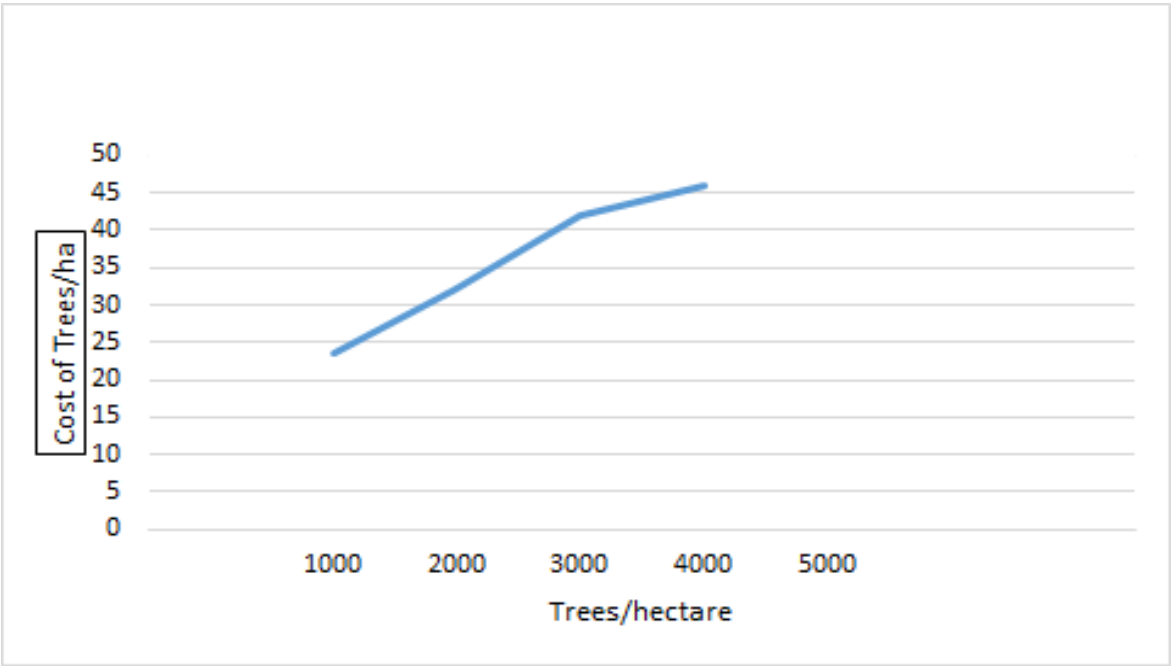

Figure 4: Cost of Trees/ha with respect to Tree Density in Lakh INR

The initial investment of establishing the high-density apple orchard is very high as compared to the traditional apple orchard. First, the density of trees planted is very high and the cost of each tree is appreciably higher due to their superior quality. Second, the trellis system and the deployment of micro and drip irrigation for each tree elevates the investment cost further. On our sample survey, we understood that for each Kanal there is an average cost of 1.6 lakh INR. The annual expenditure of these orchards is substantially higher than the traditional orchards as the maintenance cost per tree increases in higher-density orchards. The establishment cost of the orchards is seen linearly proportional in the high-density apple orchards playing similar to what the Italian orchard system does. The cost increases linearly with the increase in the tree density of the orchards, however at higher densities, above 3000 trees/hectare there is slight lowering of the production cost (see, Figure 4). This is due to the discount offers and the economies of scale. Similar trend was noticed in the analysis of the Italian counterparts.

Table 3: Regression Analysis

	1000 trees/hectare		1500 trees/hectare		2000 trees/hectare		3000 trees/hectare	
Independent Variables	Estimates	p-Value	Estimates	p-Value	Estimates	p-Value	Estimates	p-Value
Plant-Material Cost	0.11	0.0165*	0.15	0.0172*	0.21	0.013*	0.19	0.0165*
Trellis and Irrigation Cost	0.14	0.031*	0.156	0.042*	0.11	0.025*	0.129	0.025*
Land Development and Fencing	-0.05	0.035*	-0.1	0.0923*	-0.09	0.059*	-0.013	0.0679*
Fertlizers and Pesticides cost	0.1	0.0258*	0.121	0.0112*	0.14	0.011*	0.163	0.0238*
Harvesting, Transportation and Supervision Cost	0.052	0.241*	0.041	0.231**	0.049	0.124**	0.0485	0.314**
Tree-Training Cost	0.06	0.2312**	0.023	0.533**	0.0192	0.0843**	0.0212	0.0813**
R-Squared	0.9145		0.9235		0.9158		0.9442	

*p<0.1, **p<0.05. ***p<0.01

The results of the regression analysis of the establishment and the maintenance cost are nearly consistent with the analysis done in Italian Orchards (see Appendix A). Plant material and the development of the trellis system is positive and significant. Even fertilizers and pesticides cost per annum is relatively significant in terms of the maintenance cost and point out to judicious use for increasing the production (see Table 3). Land Development and Fencing is negative and significant which means that it negatively impacts the revenue of the orchards. The analysis brings attention to important parameters and inputs required for the effective development of orchards.

Table 4: Payback period with respect to accumulated amount (in Rupees lakh/hectare)

Trees/Ha	Year 1(lakh/ha)	Year 2	Year 3	Year 4	Year 5
1000	(-23.6)	(-19.7)	(-13)	(0.2)	14.5
1500	(-26)	(-27.5)	(-18)	(-4)	13.8
2000	(-31)	(-32.7)	(-25)	(-7)	16.6
3000	(-42)	(-44.8)	(-29)	(-10)	22.5
4200	NA	NA	NA	NA	NA

*₹ 700/box – Price of one apple box, 18 kgs- weight of each apple box. (Total revenue= No. of boxes*price of one box)*

Table 4, presents the total accumulated investment and the annual production and maintenance costs incurred by the farmers on their respective farms per hectare basis. The Horticulture Department, Jammu and Kashmir has laid down rates for the investment of the orchard based on different densities. For an orchard with tree-density of 2000 trees/hectare, there is an upfront cost of 31 lakh INR and similarly for the tree-density of 3000 trees/hectare the cost escalates to 42 lakh INR. In addition to this, there is an annual

accumulated cost on each orchard based on their density for maintenance like fertilizers, pesticides, tilling, grass-management and pruning. For instance, for the 2000 trees/density orchard the maintenance cost in the second year reaches to 1.7 lakh INR. The cost of the higher-density orchards per hectare is very high as compared to the traditional apple orchards, therefore the farmers (20 percent) chose densities below 1500 trees/hectare. Their analysis is crucial to understand their profitability as well their sustainability related to the yield per hectare.

The payback period for the orchards under study came out to be the fifth year, which is similar to that found in Italian orchards (see Table 4). This means that the farmers start earning net profits from the investment from the fifth year, earning all the investments and cost incurred on their respective farms till that year. However, for the lowest-density, the net profit for the farmers starts early from the fourth year (Year 3), which is crucial for their sustainability too. With nearly 20 percent of the farmers falling in the category of 1000-1500 trees/hectare (see Table 1), this is relevant for them as their interest cost lowers due to early repayment of their loans and the famers get the options to even enhance their investment for the betterment of the crop as well for their economic fortunes.

Moreover, when the payback periods of these orchard combinations are compared with the existing traditional apple orchard, it is concluded that high-density orchards are way ahead than the traditional apple orchards. The payback period of the traditional apple orchards is 11-12 years which lowers down to just 5 years in the high-density orchards. Malik (2013). For the payback period, the high-density orchard combinations are comparable with the high-density orchards of Italy. The net-revenue earned in these orchards in the fifth year is mentioned in Table 4. This net revenue is the total profit earned in the fifth-year factoring in all the costs and investments incurred till then (Net Revenue= Total Cost- Total Revenue). In orchards with densities 1000 trees/hectare, the net revenue of the farmers is 13.5 lakh INR, similarly for the orchards with densities 1500trees/hectare and 2000trees/hectare, the net revenue is 13.8 lakh and 16.6 lakh INR respectively. In the higher-density orchard (3000 trees/hectare), the net-revenue is 22.5 lakh INR which is substantially high. The payback period and the net-revenue albeit lower than the Italian counterparts, is significant and fairly consistent with the overall performance in the initial years of the Italian high-density orchards (Part I).

Cahn and Goedegebure (1992) had observed that the high-density orchards reach 60% of their full potential by the fifth year. Thus, the productivity or the yield per hectare will further increase in these orchards, even taking them closer to the yield per hectare of Italian orchards. Therefore, the production as well the net-revenue per annum is set to increase in all these orchards in the coming years which is beneficial for the development of the crop in Jammu and Kashmir.

IV. Conclusion

Trentino-Alto-Adige, Italy has shown considerable increase in its productivity as well as total production from past few decades on account of high-density apple orcharding. The early gestation period and the substantially higher productivity per tree favours the concept, leading to an early gestation period of just 5 years as compared to 8-9 years in traditional orcharding in Italy. Italy, therefore has been one of the important countries producing high-quality apples with substantially higher productivity. FAO (2013). In Jammu and Kashmir, the novelty of the concept has been received positively so far by the farmers. The productivity of the farmers has substantially improved from 11.43 tonnes/hectare to 23 tonnes/hectare in the fifth year of the scheme. Even in the lowest-density orchard, this productivity has risen to 1.5 times than the normal productivity over the years. Post 7th Year, the productivity is anticipated to reach to 50-60 tonnes/hectare. Even the payback period has been reduced to just five years from 11-12 years in the traditional years. Choure (2014). The low gestation period and therefore the early returns is beneficial for the small and marginal farmers, as it helps them mitigate the interest cost of their credits. The farmers claimed that the quality has improved which helps in better marketing of their product and fetches better price too. However, while comparing with the Italian counterparts the productivity is lower in all the densities. The reason for this might be the agro-climatic conditions, soil-health, quality of the rootstock and the scientific management of the crops overall. The upfront cost of the highest-density orchard is substantially high which forces the majority of the farmers (90 percent) to choose density between 1500-2000 trees/hectare.

The yield per hectare curve flattens out a bit in the lower-density orchards thus, these orchards may reach stagnation in ninth to eleventh (9-11) years which may stagnate the profits as well. However, this yield is steadily increasing in the higher-density orchards, therefore making them the best long-term choices for the farmers. Thus, higher-density orchards are better compared to the lower-density orchards. The orchards with density 4000trees/hectare in Italy infact have the highest yield per hectare and the returns are nearly twice than 1000trees/hectare in the seventh year. But unfortunately, not a single farmer has opted for this density as the cost-upfront is unaffordable.

The government needs to bring in concrete steps to address these concerns. First, there should be easy access to credit facilities for the farmers at affordable rates. Even a government subsidy upfront is

feasible for the development of these high-density orchards, especially above 3000 trees/hectare. Second, nearly 80 percent of the farmers are in the small and marginal category, therefore Farmer Producer Organisations- FPOs will prove effective. These FPOs will help in development of clusters amongst farmers, pooling in their farms for better resource efficiency. Cooperative societies can also be brought in to club these small and marginal farmers and establish high-density orchards with proper standard of procedures. Overall, this will bring in resource-efficiency and help in improving the sector. Third, the agricultural extension services need to be very effective in disseminating scientific knowledge and information to the farmers for scientific management of these orchards. The high-density apple plantation scheme has started on a positive note and is treading on an upward trajectory with good growth projections which would enable to make Jammu and Kashmir as the horticultural hotspot of the country.

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Appendix A

Regression Analysis of the Orchard Combinations						
	2000 trees/hectare		3000 trees/hectare		4000 trees/hectare	
Independent Variables	Estimated Coefficients	p-Value	Estimated Coefficients	p-Value	Estimated Coefficients	p-Value
Plant-Material Cost	0.24	0.015*	0.31	0.0172*	0.29	0.0115*
Trellis and Irrigation Cost	0.21	0.052*	0.19	0.042*	0.11	0.045*
Land Development and Fencing	0.09	0.049*	0.11	0.0923*	0.1	0.079*
Fertlizers and Pesticides cost	0.12	0.018*	0.18	0.0112*	0.142	0.028*
Harvesting, Transportation and Supervision Cost	0.082	0.572**	0.11	0.231**	0.11	0.324**
Tree-Training Cost	0.045	0.7823**	0.05	0.533**	0.032	0.0223**
R-squared	0.9423		0.9139		0.9104	
*p<0.1, **p<0.05. ***p<0.01						