The Pharma Innovation Journal 2022; SP-11(8): 770-774

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 770-774

www.thepharmajournal.com
Received: 28-06-2022
Accepted: 30-07-2022

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Economics of selected agroforestry systems in Kashmir valley

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Abstract
The study was carried on the project evaluation techniques on Agroforestry systems at District Bandipora and Ganderbal. From each district two Blocks were selected and out of these four blocks fifteen respondents/ households were selected taking the total number up to 240. Four agroforestry systems were prevalent in the study area i,e Horti-agricultural system, Agri-Horti-Silvicultural system, Silvi-pastoral system and Boundary plantation. Out of these Agroforestry systems boundary plantation was found most profitable with highest B.C ratio 2.11, NPV (Rs 414814), IRR (64-66%) and payback period of 2 years was calculated followed by Agri-horti-silvicultural system 1.98, NPV (Rs 48414), IRR (49-51%) and payback period of 2.5 years Horti-agricultural system 1.84 NPV (Rs 62302), IRR (39-41%) and payback period of 2.5 years and silvi pastoral system 1.45 NPV (Rs 5201), IRR (11-13%) and payback period of 5 years.

Keywords: Economics, agroforestry systems, agri-horti-silvicultural system

Introduction
Agroforestry (AF) can be defined as "a collective name for land-use systems having woody perennials grown along with herbaceous plants or livestock for ecological and economic interactions between the trees and other components of the system" (Lundgren, 1982; Young, 2002) [1, 9]. The scope of AF systems is now being recognised to minimise vulnerability and adjust to the conditions of a warmer, drier, more volatile environment (McCabe, 2013; Pala *et al*., 2020) [2]. AF systems are also increasingly known as an instrument to take advantage of the economically weaker sectors of emerging carbon markets. Improvement of soil quality parameters to conserve water supplies has also been recognised as an effective method of land management (Kumar, 2006; Murthy *et al*., 2013; Nair, 2004) [3, 4, 5]. Apart from combating species loss outside formal conservation zones (WAC, 2006; Nath *et al.*, 2015; Dawson *et al* 2013) [6, 7, 8], the economic contribution of agroforestry can be witnessed in terms of profitability by growing fodder for profitable milk production in developed countries. Tagasaste (*Chamaecytisus proliferus*) planted in alley farming and plantation systems in the northern agricultural area of western Australia has increased returns to diversifolia hedges grown along field boundaries, together with small amounts of phosphorus fertiliser, doubled their returns to labour (Place *et al.*, 2002) [10]; production of timber and fuelwood by intercropping trees and crops is practised on 3 million hectares in China (Sen, 1991) [11]. Thirty years after the implementation of agroforestry, two-thirds of the 46 000 ha of farmland in Minquan County (Henan Province) has been intercropped with trees of this genus Paulownia spp. in one commune. 37 percent of farm production was accounted for (Wu and Zhu, 1997) [12]. The timbers from these species provide outstanding fuelwood, fodder and compost fertiliser leaves, and wind erosion and evapo-transpiration protection (Wu and Zhu, 1997) [12]. A study by Current and Scherr (1995) found that 75 percent of agroforestry practices in Central America and the Caribbean had positive net present values.

Data and Methodology
The study is based on secondary as well as primary data. The secondary data on area, production and yield of Agroforestry systems were collected from diverse sources like Published sources, statistical Digests Periodicals, Books and Journals. The primary data on different aspects of Agroforestry system were obtained from the selected farmers. For data collection, in stage 1 Selection of district: Two districts, from Jammu Kashmir I, e. Bandipora

& Ganderbal were selected purposively owing to the fact that the researcher had more access to these districts being nearer to his residence. In IInd Stage Selection of block: The blocks of the two districts were listed & arranged as per the area under A.F two blocks from each district namely Aloosa, Arin from district Bandipora and Kangan, Gund form district Ganderbal were selected on the basis of max. area covered under A.F. In IIIrd Stage Selection of village: The villages of each block were listed and 4 villages from each blocks were drawn randomly through lottery method and in IVth Stage: Selection of household total number of 60HH from each block were selected randomly for detailed analysis taking total sample size to 240 households.

Analytical Tools

Benefit Cost Ratio (BCR)

Function of the following exponential form will be employed to identify the relationship between the cost and benefits of a proposed project.

BC ratio is calculated as:

$$BCR = \frac{\sum_{t=0}^{T} \frac{R_t}{(1+i)^t}}{\sum_{t=0}^{T} \frac{C_t}{(1+i)^t}}$$

Where,

Rt = Return in the period 't',

Ct = Cost in the period 't',

i = Discount rate, and

T = Project time.

The BCR should be greater than 1 for any working system, and then only it can be considered worthy.

Net Present Value (NPV)

The difference between the present value of cash inflows and the present value of cash outflows is the net present value (NPV). NPV has been used to assess the feasibility of a planned expenditure or project in capital budgeting;

The following is the formula for calculating NPV:

$$NPV = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+i)^T}$$

Where;

R = benefits in the year t,

C = costs in the year t,

i = selected discount rate, and

t = number of time periods

Payback period (PBP)

The amount of time required in terms of benefit or savings for an investment to recover its initial outlay. The function of the following structural type was used to calculate the length of time needed to recover an investment expense.

$$\text{Payback Period} = \frac{cost\ of\ the\ investment}{Annual\ net\ cash\ flow}$$

Internal rate of return (IRR)

The Internal Return Rate (IRR) is the interest rate at which the net present value of all cash flows (both positive and negative) of a project or expenditure is equal to zero.

IRR is calculated as:

$$IRR = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+i)^T} = 0$$

Where;

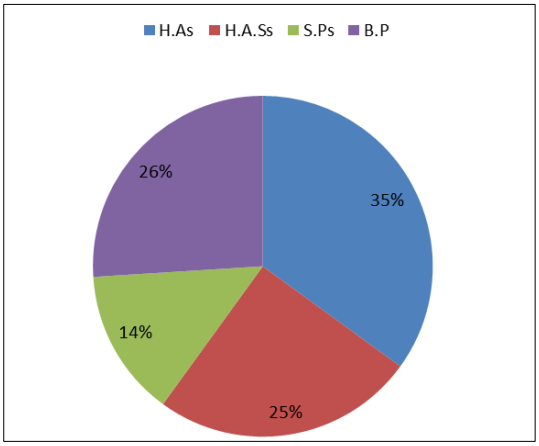
R = benefits in the year t,

C = costs in the year t,

i = selected discount rate, and

t = number of time periods

Result and Discussion



Graph 1: System-wise distribution of sample house holds.

In the study area the Agri-horticulture contributes to 35% followed by Boundary plantation 26%, Agri-horti-silvicultural 25% and Silvipastoral system 14%. Agri-horticulture contributes highest in the study area. The current area under agroforestry in India is estimated as 25.32 mha, or 8.2 per cent of the total geographical area of the country (Dhyani *et al.*, 2013) [14]. This includes 20.0 mha in cultivated lands and 5.32 mha in other areas.

Table 2: Avg. Land Holdings in percentage.

Area	H.A.S	H.A.S.S	S.PS	B.P
Residence	7.12	10.41	7.14	7.50
Lawn	7.57	13.75	9.52	7.50
Horticulture+Agriculture	82.42	0	0	0
Horticulture+Agriculture+silviculture	0	70.41	4.76	0
Silviculture+Pasture	0	0	75.95	0
Boundary-plantation	0	0	0	80.71
Waste land	3.63	5.00	1.66	4.64
Area in hectare	100.00	100.00	100.00	100.00

All of the farmers in the study area have their own land. At present, an average of 10.41% in Horti-agri-silvicultural system followed by Boundary-plantation 7.50, Silvi-pastoral system 7.14 and Horti-agriculture system 7.12 is residential area of households in the study area. Similarly Lawn with highest area of 13.75 in Horti-agri-silvicultural system, among four systems Horticulture+Agriculture with highest area of 82.42%, Horticulture+Agriculture+Silviculture with highest area of 70.41% in H.A.Ss, Silviculture+pasture with highest area of 75.95%, Boundary-Plantation with highest area of 80.71% and waste-land with highest area of 5% respectively. Among these systems, agrisilviculture followed by agrihorticulture, are the most prominent being practiced and advocated by the research institutions in the maximum agro-climatic zones. Home gardens, block plantation, energy plantation, shelterbelts and improvement or alternative to shifting cultivation are some of the specialized agroforestry systems developed. Dhyani *et al*. (2009) [15] listed twenty common agroforestry systems being practiced in different agro-ecological regions of India, these are, 1. Agrisilviculture; 2. Boundary plantation; 3. Block plantation; 4. Energy plantation (trees + crops during initial years); 5. Alley cropping (hedges + crops); 6. Agrihorticulture (fruit trees + crops); 7. Agri-silvi-horticulture (trees + fruit trees + crops); 8. Agri-silvi-pasture (trees+ crops + pasture or animals); 9. Silvi-olericulture (tree+ vegetables); 10. Horti-pasture (fruit trees + pasture or animals); 11. Horti-olericulture (fruit tree + vegetables); 12. Silvi-pasture (trees + pasture/ animals); 13. Forage forestry (forage trees + pasture); 14. Shelter-belts (trees + crops); 15. Wind-breaks (trees + crops); 16. Live fence (shrubs and under- trees on boundary); 17. Silvi or Horti-sericulture (trees or fruit trees + sericulture); 18. Horti-apiculture (fruit trees + honeybee); 19. Aqua-forestry (trees + fishes); and 20. Homestead (multiple combinations of trees, fruit trees, vegetable etc).

Table 3: Percentage cropping pattern.

Crop type	H.A.s	A.H.Ss	S.Ps	B.P
Rice	3.80	0	4.87	41.56
Maize	15.20	28.10	1.70	0
Wheat	12.76	0	0	4.94
Vegetables	3.79	8.71	0	6.68
Fruits	45.58	31.60	4.87	0
Oilseeds	0	0	0	0
Populus	0	10.53	36.55	40.12
Oats	0.53	0	42.25	0
Total area/hac	100.00	100.00	100.00	100.00

The respondents in study area have diverse cropping pattern. In case of Horti-agriculture system horticulture crop contributes to 45.58% and agriculture crop contributes to 54.42%. Likewise in case of Agri-horti-silviculture system agriculture components contributes 36.81%, followed by 31.60% in horticulture and 10.53% in silviculture. Similarly in case of silvipastoral system silviculture component consists of 36.55% and pastoral component I.e, Oats consists of 42.25% followed by agriculture 6.57%, fruit 4.87% and Boundary plantation consists of 53.18% agriculture system, silviculture component of 40.12% respectively. In the north-eastern hill region, combining grasses and legumes, such as *Stylosanthes guianensis*, *Panicum maximum*, *Setaria* etc. and fodder trees, such as alder (*Alnus nepalensis*) in a silvipastoral system stabilizes terrace risers and provides multiple outputs. Silvipastoral system comprising *Alnus nepalensis*, pineapple and forage crops like *Panicum maximum* or *Setaria sphacelata* coupled with *S. guyanensis* in 1:1 ratio was found to be a sustainable agroforestry practice in soils having 30-60% slope. This system also restored the fertility of soils (Chauhan *et al.*, 1993) [16].

Table 4: Economics of Agroforestry Systems (Avg.)

	H.As	H.A.Ss	S.Ps	B.P
Establishment cost				
Site preparation	5316 (1.82)	3729 (2.32)	2245 (3.15)	3019 (2.82)
Fencing	10127 (3.47)	5932 (3.69)	7143 (10.03)	7170 (6.71)
plant material	25316 (8.68)	21186 (13.17)	18367 (25.81)	18868 (17.65)
Pit digging	7595 (2.60)	5932 (3.69)	6531(9.18)	3019 (2.82)
Manure/fertilizer	66299 (22.73)	25424 (15.80)	17347 (24.38)	16981(15.88)
Maintenance cost (Variable costs)				
Pruning, weeding, hoeing etc	15822 (5.42)	9322(5.79)	2449 (3.44)	13208 (12.36)
Consulting company/ Extension etc	6329 (2.17)	3390 (2.11)	1020 (1.43)	1887 (1.77)
Watch and ward	5063 (1.74)	5085 (3.16)	2041(2.87)	943 (0.88)
Plant protectors	113924 (39.05)	59322 (36.86)	0	15849 (14.83)
Interest on variable costs (4%)	5646 (1.94)	3085 (1.92)	220 (0.31)	1429 (1.34)
Fixed costs				
Depreciation on implements	3797 (1.30)	1695 (1.05)	1020 (1.43)	2830 (2.65)
land rental	25316 (8.68)	16102 (10.00)	12245 (17.21)	20755 (19.42)
Interest on fixed costs (4%)	1165 (0.40)	712 (0.44)	531 (0.75)	943 (0.88)
Total costs	291715 (100.00)	160916 (100.00)	71159 (100.00)	106901 (100.00)
Returns				
Main product	449843 (89.25)	306780 (92.82)	91836 (81.82)	207547 (90.54)
Bi-product	54210 (10.75)	23729 (7.18)	20408 (18.18)	21698 (9.46)
Total Returns	504053 (100.00)	330509 (100.00)	112245 (100.00)	229245 (100)

Economics of Agroforestry system Table 4 predicts that three types of costs, establishment costs, maintenance costs and fixed costs are used to determine the total costs. Same in case of returns main product and bi-product are used to determine the total returns. In H.A.s the total costs of Rs 291715 are involved and gives total returns of Rs 504053. Followed by H.A.Ss total costs of Rs 160916 and gives total returns of Rs 330509, Silvipastoral system total costs of Rs 71159 and with total return of Rs 112245 and in case Boundary plantation total costs of Rs 106901 and total return of Rs 229245

respectively. To analyze economics in agroforestry, Jain and Singh (2000) used conventional cost and income measures to examine financial viability at three discount rates viz 10, 12 and 15 percent and reported that Poplar-based agroforestry is more economically feasible and productive than many of the area's crop rotations.

Table 5: Project feasibility tests of A.F systems in district Bandipora and Ganderbal of Kashmir valley.

System	H.A.S	A.H.SS	S.PS	B.P
BC ratio	1.72	2.05	1.57	2.14
NPV	62302	48414	5201	414814
Pay back period per year	2.5	2.5	5	2
IRR	39-41%	40-51%	11-13%	64-66%

Economic feasibility analysis, also known as cost analysis, involves, estimation of payback period (PBP), net present value (NPV), internal rate of return (IRR), benefit cost ratio (BCR) and Annual amortization cost is the most commonly followed procedure for determining the efficiency of any new project. It helps in identifying the profit against investment expected from a project. Cost and time are the most essential factors involved in the study. Poplar based agroforestry models adopted by the farmers in Haryana, Punjab and Western Uttar Pradesh are highly lucrative, therefore, attracting farmers in a big way (Singh and Sharma, 2007; Sidhu and Dhillon, 2007; Dhillon *et al*., 2009; Gill *et al*., 2009). Recognizing agroforestry as a viable venture, many business corporations, limited companies such as ITC, WIMCO, West Coast Paper Mills Ltd., Hindustan paper Mills Ltd., financial institutes such as IFFCO have entered into the business and initiated agroforestry activities in collaboration with farmers on a large scale (AICRPAF, 2008).

Benefit cost ratio (BCR) identifies the relationship between the cost and benefits and the ratios are oftenly used in corporate finance to detail the relationship between possible benefits and costs, of a proposed project. The figure registered in the Table… records the ratio of BCR>1, indicating that agroforestry systems are economically viable. Further among all the four systems practised in the study area Boundary plantation turned most profitable recording highest BCR of 2.14

Internal rate of return (IRR) is the discount rate at which the net present value (NPV) equals zero. Table… registers value of (IRR) from identified agroforestry systems. The highest IRR (64-66%) was recorded in Boundary plantation followed by 40-51% Agri-horti-silvicultural system, Horti agricultural system and Silvopastoral system, recorded 39-41%, and 11-13% respectively. Therefore, among all the systems Boundary plantation with highest internal rate of return turned economically among all the systems.

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. Function of this economic feasibility indicator is to find the profitability of a projected investment or project. Table registers the positive value of NPV in all six agroforestry systems, revealing thereby the profitability of this agroforestry system.

Payback period (PBP) determines the length of time period required for an investment to recover its initial outlay in terms of profits or savings. The figure (Table…) present the value of payback period from identified agroforestry system. The lowest pay back of 2 years was recorded in Boundary plantation, followed by 2.5 year each in Agri horti silvicultural system, Horti agriculture system, and 5 years in case of Silvopastoral system respectively to recover the costs of initial investment incurred in agroforestry project.

Conclusions and Policy Implications

Agroforestry is bound to play a major role in near future, not only for its importance in food and livelihood security but also for its role in combating the environmental challenges. Agroforestry and trees outside forest will be a key issue in providing a solution to global warming, climate change and enhancing the per unit productivity of the land and converting degraded and marginal lands into productive areas. The National Agroforestry Policy made several recommendations which will go a long way in stimulating large-scale adoption of the agroforestry by the farmers and will provide the required raw material to wood based industries on one hand and play its role in energy and environmental security on the other. The major focus of research in the coming years will be on developing agroforestry technologies for critical areas like arid and semi arid zones and other fragile ecosystems such as Himalayan region and Coastal eco-system to sustain these areas for higher productivity and natural resource management.

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