Comparative study of black pepper (*Piper nigrum* L.) nursery raising in Karnataka: traditional variety Sigandhini versus popular variety Panniyur-I

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Black pepper is the world's most traded spice, mainly cultivated in Karnataka and Kerala, India. The extensively planted pepper hybrid, Panniyur-1 has resulted in a drastic fall in yield due to foot rot disease. An ancient indigenous variety, 'Sigandhini' has recently obtained Intellectual Property Rights under PPVFRA-2001. In the present study, we estimated the area under pepper and its seedlings demand in Karnataka, and also analysed the comparative economics of Sigandhini and Panniyur-1 nurseries. Data were collected from primary and secondary sources and the compound annual growth rate and financial feasibility of black pepper nursery raising were analysed. Karnataka's area grew at an annual rate of 18.63% and revealed that an additional area of 27,048 ha would require 300.50 lakh seedlings in 2020–21. Sigandhini earns higher net revenue to farmers compared to Panniyur-1 seedlings.

Keywords: Black pepper, comparative economics, nursery raising, traditional and popular varieties.

BLACK pepper (*Piper nigrum* L.) is a climbing, perennial, woody vine native to southern India's hot, humid climate, and is popularly known as the 'king of spices'[1]. It is one of the most ancient and traditional spice crops of India which has been cultivated and traded worldwide[2,3]. Black pepper has a long history of use as a digestive aid, indigenous treatment for gastrointestinal ailments and also as a preservative[4]. It was used in traditional Chinese medicine to settle rebellious *qi* and as a therapy for epilepsy. It has also been utilized in several therapies and for a variety of reasons for centuries. According to Ayurveda, the pungency and heating properties of black pepper help in the metabolization of food as it goes through our digestive system. Its heat functions as a stimulant in the same way as fire. This stimulating nature is also used to treat pulmonary congestion[5]. Black pepper is often propagated commercially by vegetative propagation, i.e. stem cuttings. It can also be reproduced through seeds, but this takes a longer time and produces lower yields. Thus stem cutting is used to generate higher yields in a faster mode. Growing pepper seedlings in nurseries requires specialized knowledge and it is a source of income for many farmers.

India is a major producer, consumer and exporter of black pepper in the world, even though it is predominantly grown for export. In addition to traditional areas of Kerala, Karnataka and Tamil Nadu, black pepper is extensively grown in Maharashtra, the North East regions, and Andaman and Nicobar Islands. Kerala and Karnataka generate majority of the black pepper production in the country. In recent years, the range of black pepper has expanded into previously uncharted territory. During 2019–20, India produced 1,040,710 tonnes of black pepper in a total area of 2,591,480 ha. Karnataka is leading the way with 630,280 tonnes produced in a total area of 1,607,740 ha. During 2019–20, India exported 17,000 tonnes of black pepper with a net revenue of Rs 57,371 lakhs[6].

Panniyur-1 is the leading pepper variety commercially cultivated in Karnataka and Kerala since many decades. Majority of the farmers have adopted this high yielding and remunerative income variety, which was released in 1966–67. This is a hybrid of Uthirankotta and Cheriyakaniakkadan developed by the Kerala Agricultural University at Panniyur. The wider adoption of this variety led to the loss of highly diverse traditional and local cultivars from major growing areas in the Western Ghats of Karnataka. The widespread use of a single variety has increased the likelihood of epidemics, unprecedented risks associated with pest-disease outbreaks and crop loss due to a range

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of factors including drought, flood and heavy rainfall. Many farmers have documented the value of indigenous medical knowledge in terms of local people's health, resource conservation and economic benefits[7]. Several cultivars have been preserved because certain black pepper producers were more concerned with maintaining and promoting regional, indigenous and traditional landraces. Ademane, Keregadde Mallisara, Kurimale, Boppanalli Chomala, Basari Balli, Somali are some examples; the cultivar Sigandhini is also one of them.

Ramakanth Hegde, an innovative farmer from Hunsekoppaa, a small village in Uttara Kannada district of Karnataka has conserved the unique traditional and indigenous landrace of Sigandhini[8]. About 25 years ago, he observed a vine that appeared similar to Panniyur-1 but with a purple tip on the runner, while undertaking cultural operations in the field. Later, he reproduced this landrace and planted it on his farm. He observed that these plants had lower incidence of foot rot caused by *Phytophthora capsici* and other diseases compared to Panniyur-1. This variety is now popular among the farmer, with several requests for planting material from across the country where black pepper is being grown. When compared to the leading hybrid Panniyur-1, Sigandhini matures one month earlier (it can be harvested in the December–January), giving the plant additional rest time and resulting in more regular and consistent bearing. In Hegde's nursery, plants propagated from single node cuttings make great nursery plants and the root system is robust. This is also suitable for growing in areca nut-based multistoreyed cropping systems, just like other pepper varieties.

The Indian Parliament passed PPVFRA-2001 to build an effective framework for preserving plant landraces/varieties, farmers' and plant breeders' rights, and encouraging the development and cultivation of novel plant varieties. Plant breeders, researchers and farmers who discover new or existing plant varieties are granted intellectual property rights (IPR) under PPVFRA-2001. Only the registration of a plant variety confers the rights given under this Act, which are heritable and assignable. This Act also allows for the registration of essentially derived varieties (EDVs), which can be new or existing. Farmers have the right to save, use, sow, re-sow, exchange or sell their farm produce in an unbranded way, including seed of a registered variety[9]. Farmers' varieties are eligible for registration, and they are not required to pay any fees in connection with any proceedings brought under this Act. The farmer who registers the variety with PPVFRA is entitled monetary benefits because of the monopoly pricing strategy till 18 years.

In this connection, the aim of the present study includes area estimation, seedling demand forecasting, investment patterns, comparative economics and financial viability of the Sigandhini and Panniyur-1 black pepper nurseries in Uttara Kannada district of Karnataka.

Methodology

This study is based on a combination of primary and secondary data acquired from a variety of sources. During 2021, primary data were collected from black pepper nurserymen using a pre-designed interview schedule that covers investment, returns and other information. From 2010–11 to 2019–20, secondary data on the area were gathered from various Karnataka's horticulture crop statistics and other official sources[6].

Uttara Kannada district was chosen for the study because it is one of the major producers of both black pepper varieties in Karnataka's Western Ghats, and IPR (PPVFRA) of the Sigandhini variety is held by this district's farmer. The compound annual growth rate (CAGR) in area under black pepper and the per hectare seedlings requirement as indicated in the package of practices were used to evaluate the demand for pepper seedlings in the major districts of Karnataka and the state as a whole. Based on crop occupancy, 10 pepper nurseries from 3 taluks of Sirsi, Yallapura and Siddapura in Uttara Kannada district were chosen for primary data collection, and hence a total of 30 nursery entrepreneurs were selected for the study.

Compound annual growth rate

CAGR was calculated using the exponential approach[10].

$$Y_t = \beta_0 \beta_1^t U_t,$$

where Y_t is the area under pepper during time period t in the major districts of Karnataka and the state as a whole, β_0 the intercept, β_1 the slope coefficient, t the time (2010–11 to 2019–20) and U_t is the stochastic term.

Natural logarithmic transformation was used to obtain estimable form of the model. The model's parameters were calculated using simple least squares.

$$\ln Y_t = \ln \beta_0 + t \ln \beta_1 + U_t.$$

The growth rate of area was calculated using the formula CAGR = [antilog($\ln \beta_1$) – 1] × 100. The expansion in area for the next year, 2020–21 was calculated by multiplying the actual area of 2019–20 by CAGR, i.e. incremental area in 2020–21 equals area in 2019–20 multiplied by CAGR[11]. For example, CAGR in area was 30.65% each year, and the area in Uttara Kannada district in 2019–20 was 5215 ha. In 2020–21, the incremental area expansion will be 30.65% of 5215 ha = 1598 ha. As a result, the total area predicted for the coming year is 5215 + 1598 = 6813 ha. The need for seedlings was predicted based on the expected incremental area for 2020–21 and the per hectare seedling requirement indicated in the package of practices. The seedling demand projection for

an expected area of 1598 ha was calculated using seedling requirement of 550 per ha (ref. 12).

Nurserymen must use advanced seedling raising procedures to cater to the demand for seedlings. Financial analysis was done to determine whether investing in nurseries was economically feasible. As a result, primary data were collected using simple random sampling technique from 30 nurseries in Uttara Kannada district, i.e. 10 each from major growing taluks of Sirsi, Siddapura and Yellapura using a pre-tested questionnaire. The information was collected on investment patterns as well as the cost and return structures in raising pepper seedlings under protected conditions.

Financial feasibility of black pepper nurseries in Karnataka using project evaluation techniques

Net present worth: This is the discounted value of a project's net cash inflows. The net cash inflows representing the opportunity cost of capital were discounted using a discount rate of 11% in this study. If the net present worth (NPW) is positive, the project is considered viable. It can be represented as

$$\text{NPW} = \sum_{i=1}^{n} Y_i \ (1+r)^{-i} - I,$$

where Y_i is the net cash at the end of the year i, r the discount rate, i the time period (i = 1, 2, 3, …, n years) and I is the initial investment.

Benefit–cost ratio: This is the ratio of discounted cash inflows to discounted cash outflows. For an investment to be considered worthwhile, the benefit–cost ratio (BCR) must be at least one. BCR was calculated as

$$\text{BCR} = \sum_{i=1}^{n} \frac{Y_i (1+r)^{-i}}{I},$$

where Y_i is the net cash at the end of the year i, r the discount rate, i the time period (i = 1, 2, 3, …, n years) and I is the initial investment.

Internal rate of return: This is the rate at which a project's NPW equals zero. The present value was calculated by discounting the net cash inflows using the interpolation technique described below.

$$\text{IRR} = \text{LDR} + (\text{HDR} - \text{LDR}) \times \frac{\text{NPW at LDR}}{\text{Absolute difference between NPW at LDR and NPW at HDR}},$$

where IRR is the internal rate of return, LDR the lower discount rate and HDR is the higher discount rate.

Undiscounted cash flow measures

Payback period: This is the time (years) taken to liquidate the investment. The payback period (PBP) was estimated by summing up all the undiscounted net benefits over the years to make up the initial investment incurred for establishment.

$$\text{PBP} = \frac{\text{Initial investment}}{\text{Annual net cash revenue}}.$$

Results and discussion

Area estimation and seedlings demand forecast of black pepper in Karnataka

CAGR of area under black pepper in Karnataka was 18.63%/year during the study period (Table 1). Due to government initiatives on the area expansion programme and farmers generating remunerative earnings, Hassana, Uttara Kannada, Shivamogga, Chikkamagaluru and Dakshina Kannada districts had considerable increase of 32.46%, 30.65%, 25.28%, 20.22% and 12.22% each year indicating that the farming community is more open to adopting and accepting the crop. The area under other minor districts grew at a CAGR of 16.57%/year, indicating that the crop is becoming more extensively accepted by the farmers. Despite the fact that Kodagu is the largest producer of black pepper in Karnataka, there was only a small increase in the area (5.67%/year) because there was no room for expansion when compared to other districts. In case of chilli, the inverse trend was observed in Karnataka[13].

The incremental (increase/decline) area for the following year was calculated using CAGR. In Karnataka, there was expansion to the tune of 27,048 ha for the following year, i.e. 2020–21. Hassana district had the maximum area of 14,170 ha, followed by Chikkamagaluru (7966 ha), Uttara Kannada (1598 ha), Shivamogga (1301 ha) and Kodagu (930 ha) districts. The demand for seedlings was assessed based on incremental area as stated in the package of practices. If necessary, the seedlings requirement for an increased area of 27,048 ha in 2020–21 will be around 300.50 lakhs. Similar outcome was observed in the case of chilli[13].

According to CAGR, the largest expected demand for seedlings was found in Hassana (157.43 lakhs), followed by Chikkamagaluru (88.50 lakhs), Uttara Kannada (17.76 lakhs), Shivamogga (14.45 lakhs) and Dakshina Kannada (8 lakhs). Nonetheless, according to peripheral CAGR, the traditional centre point of Kodagu would only require 10.33 lakh seedlings. As a result, it is critical to devote resources to nursery exercises in order to meet the increasing demand for seedlings. During the study period, other non-traditional districts also showed an outstanding

Table 1. Area estimation and demand forecast of pepper seedlings in Karnataka, India

Major districts	Area under black pepper in 2019–20 (ha)	Compound annual growth rate (%) in area from 2010–11 to 2019–20	Increase/decrease in area during 2020–21 (ha)	Estimated total area in 2020–21 (ha)	Estimated demand for black pepper seedlings during 2020–21 (lakhs)
Uttara Kannada	5216	30.65	1598	6814	17.76
Shivamogga	5146	25.28	1301	6447	14.45
Dakshina Kannada	5892	12.22	720	6612	8.00
Chikkamagaluru	39,388	20.22	7966	47,354	88.50
Hassana	43,658	32.46	14,170	57,828	157.43
Kodagu	16,384	5.67	930	17,314	10.33
Other districts	2,193	16.57	363	2556	4.04
Total	117,877	18.63	27,048	1,44,925	300.50

Table 2. Initial investment on black pepper nursery under protected structure (500 sq. m)

Particulars	Quantity (no.)	Price (Rs/unit)	Total cost (Rs)	Share (%)
Open well	1	55,000	55,000	11.00
Irrigation pumpset and connection	1	50,150	50,150	10.03
Protected structure, humid chamber and construction	1	361,520	361,520	72.30
Rose can/hose pipe	2	396	792	0.16
Knapsack sprayer	1	4982	4982	1.00
Plastic crates	50	350	17,500	3.50
Baskets	5	152	760	0.15
Spade	2	642	1284	0.26
Pickaxe	2	654	1308	0.26
Secateur	4	413	1652	0.33
Miscellaneous		5102	5102	1.02
Total investment			500,050	
Subsidized amount			250,025	
Net investment			250,025	

CAGR (16.57%/year), demonstrating the crop's tolerance to a variety of climatic conditions. This can be attributed to the active promotion of black pepper by the Department of Horticulture and Spice Board through the area expansion programme. In these districts, the incremental area would be around 363 ha and the seedlings needed for new plantation would be around 4.04 lakhs.

Initial investment of black pepper nurseries under protected structure

Table 2 shows the initial investment for a black pepper seedling nursery in a protected structure. This structure includes a polyhouse, an open well, an irrigation pump set and motor, construction fees, plastic crates and other small equipment. A 500 sq. m commercial pepper nursery capable of growing 100,000 seedlings requires a total net investment of Rs 500,050. The protected structure accounted for 72.30% (Rs 361,520), with the drilling open well accounting for 11% (Rs 55,000) and irrigation facilities accounting for 10.03% (Rs 50,150) of the overall investment. A total of Rs 33,380 was spent on other minor expenses (6.67%). As a result, the total cost of setting up a pepper nursery in a covered structure is Rs 500,050. The Department of Horticulture, Government of Karnataka provides 50% subsidy on the total investment, i.e. Rs 250,025. As a result, nurserymen spend Rs 250,025 on establishing a pepper nursery.

Comparative cost and returns of black pepper nursery under protected structure

Table 3 shows the cost of raising a pepper (Signdhini and Panniyur-1) nursery in a protected environment. The protected structure, which was constructed on a 500 sq. m plot, has the capacity to accommodate 100,000 seedlings. The total cost of growing seedlings on 500 sq. m for Sigandhini pepper seedlings was Rs 520,958. The variable cost accounted for 93.96% of the total cost, whereas the fixed cost accounted for 6.04%. Cuttings were the largest variable expenses (Rs 200,000), followed by polybags (Rs 75,000), men labour (Rs 60,000), organic manure (Rs 44,000), working capital interest (Rs 36,258) and women labour (Rs 30,000). Fixed costs included amortized costs of Rs 25,003, and interest on fixed capital was computed at a rate of 12% on the entrepreneur's investment in the pepper nursery, which amounted to Rs 3372. The yearly rental value of land of Rs 3000/year was considered for pepper nursery production in an area of 500 sq. m.

The overall cost of propagating one lakh Panniyur-1 seedlings was Rs 379,048, with polybags accounting for

Table 3. Comparative cost of black pepper nursery under protected structure

Particulars	Sigandhini				Panniyur-1			
	Quantity (no.)	Price (Rs/unit)	Total cost (Rs)	Share (%)	Quantity (no.)	Price (Rs/unit)	Total cost (Rs)	Share (%)
A. Variable cost								
Pepper cuttings (no.)	100,000	2	200,000	38.39	100,000	0.75	75,000	19.79
Red soil (tonnes)	50	350	17,500	3.36	50	325	16,250	4.29
Polybags (no.)	100,000	0.75	75,000	14.40	100,000	0.78	78,000	20.58
Fertilizer (kg)	100	24	2400	0.46	147	24	3528	0.93
Organic manures (tonnes)	22	2000	44,000	8.45	15	2,214	33,210	8.76
Bio-agents	50	150	7500	1.44	24	150	3600	0.95
Plant protection chemicals (kg)	5	1120	5600	1.07	8.5	720	6120	1.61
Men labour (mandays)	240	250	60,000	11.52	280	250	70,000	18.47
Women labour (mandays)	150	200	30,000	5.76	110	200	22,000	5.80
Humic acid (kg)	10	685	6850	1.31	12.5	705	8813	2.32
IBA (rooting hormone)	25	175	4375	0.84	27	185	4995	1.32
Interest on working capital @ 8% per annum			36,258	6.96			25,721	6.79
Total variable cost (A)			489,483				347,237	
B. Fixed cost								
Rental value of land (Rs)			3000	0.58			3250	0.86
Land revenue (Rs)			100	0.02			150	0.04
Miscellaneous			0	0.00			0	0.00
Amortized cost			25,003	4.80			25,003	6.60
Interest on fixed cost (12%)			3372	0.65			3408	0.90
Total fixed cost (B)			31,475				31,811	
Total cost (A + B)			520,958				379,048	

Table 4. Returns from black pepper nursery raising under protected structure

Particulars	Sigandhini	Panniyur-1
Black pepper seedlings after mortality (no.)	90,000	90,000
Price of seedlings (Rs/unit)	20	10
Gross income (Rs)	1,800,000	900,000
Total cost (Rs)	520,958	379,048
Net income (Rs)	1,279,042	520,952
Cost of seedling (Rs/unit)	5.79	4.21
Profit per seedling (Rs/unit)	14.21	5.79
Input–output ratio	3.46	2.37

the largest proportion of the total cost at Rs 78,000 (20.58%), followed by the cost of propagation cuttings at Rs 75,000 (19.79%) and men labour accounting for Rs 70,000 (18.47%). Majority of the fixed costs was accounted towards interest on fixed capital, rental value of land and amortized cost, which totalled to Rs 3408, Rs 3250 and Rs 25,003 respectively. At a price of Rs 20/seedling, the total profit from the sale of 90,000 seedlings was Rs 1,800,000 (Table 4). After subtracting total expenditure, the net return was estimated to be Rs 1,279,042. The average cost of raising one seedling was Rs 5.79, with a net profit of Rs 14.21/plant. Similar findings were reported in the case of tomato[14]. The pepper seedlings can be raised in a nursery based on demand from the farming community.

Due to the high cost of cuttings, the total production cost of Sigandhini was higher than that of Panniyur-1. This is also related to the scarcity of Sigandhini cuttings and the monopoly pricing strategy of the farmer's varieties (due to PPVFRA). The total income from pepper nurseries was estimated by considering the seedling mortality rate of 10%. The market price of seedlings was Rs 20 and Rs 10 respectively for Sigandhini and Panniyur-1. The gross profit from the sale of 90,000 Sigandhini and Panniyur-1 seedlings was Rs 1,800,000 and Rs 900,000 respectively. As a result, Sigandhini and Panniyur-1 earned a total net income of Rs 1,279,042 and Rs 520,952 respectively. Despite the fact that Sigandhini seedlings have a higher production cost, the higher net income is due to a monopoly pricing strategy that results in a higher selling price than Panniyur-1. Sigandhini has a higher cost per plant (Rs 5.79) due to the higher cost of cuttings used in propagation, whereas Panniyur-1 has a lower cost (Rs 4.21) due to lesser cost of cuttings. Farmers owing a Sigandhini nursery make a profit of Rs 14.21/sapling compared to Panniyur-1 (Rs 5.79), due to the higher selling price. Sigandhini has a higher input–output ratio of 3.46 than Panniyur-1 (2.37), indicating that it is highly profitable per rupee invested.

Economic feasibility of investment in pepper nursery enterprise

Table 5 shows the findings of economic feasibility of investment in a pepper nursery enterprise using parameters such as NPW, BCR, PBP and IRR. The cultivation of pepper seedlings necessitates a substantial investment of Rs 250,025. It was evaluated whether the investment in a commercial nursery was remunerative or not using

Table 5. Comparative financial feasibility of pepper nurseries in Karnataka

Project-evaluation technique	Sigandhini	Panniyur-1
Net present worth	38,50,297	11,18,451
Benefit-cost ratio	7.39	2.95
Internal rate of return	144.85	59.12
Pay-back period	0.20	0.52

Table 6. Problems faced by pepper nursery entrepreneurs (n = 30)

Particulars	No. of nursery entrepreneurs	Percentage
Water scarcity	1	3.33
Labour availability	14	46.67
Success rate of seedlings	3	10.00
Sale of seedlings	3	10.00
Lack of technical guidance	2	6.67
Lack of credit facility	1	3.33
Competition among nurseries	3	10.00
Pest and disease incidence	3	10.00

discounted and undiscounted cash-flow techniques. For Sigandhini and Panniyur-1 seedlings, NPW, an investment under protected conditions generated wealth of Rs 3,850,297 and Rs 1,118,451 respectively, over the course of its life (inflation was taken into account for its estimation). The economic viability of investing in a Sigandhini pepper nursery was long lasting, as indicated by the highest positive NPW as compared to Panniyur-1. Another metric used to assess the project's feasibility was BCR, which was 7.39 for Sigandhini and 2.95 for Panniyur-1, suggesting that the project delivers a return of Rs 7.39 for every rupee invested, which was very high for Sigandhini. Similar results were obtained when investing in a jasmine garden[15,16].

The magnitude of returns realized in each year across the economic life span, and especially in the early years of the pepper nursery, determines the IRR value. It should be emphasized that when compared to the opportunity cost of capital or the rate of interest paid on borrowed capital, IRR was found to be high, i.e. 144.85 (Sigandhini) and 59.12 (Panniyur-1). As a result, the Sigandhini nursery business was found to be profitable, economically viable and financially sound as it indicated higher average earning power of the investment. PBP is the time taken to recover the initial investment made in establishing the nursery. It was determined to be 0.2 year for Sigandhini and 0.52 year for Panniyur-1, indicating quick recovery of money invested in the Sigandhini nursery.

Problems in raising pepper seedlings

Despite the fact that the nursery is a profitable business, it is subject to similar constraints as in other businesses. A survey of the nurserymen's opinion on the production limits of pepper seedlings was done (Table 6). From the study, it can be seen that 46.67% of entrepreneurs consider labour shortage during peak operations to be a major issue with more labour wages needed to be paid. Tough competition from other nurseries, pests and diseases, success rate and seedling marketing were identified as other key issues, as mentioned by the entrepreneurs (10% each). The absence of technical guidance in pests and diseases control (6.67%), credit facility (3.33%) and water scarcity were the other issues (3.33%). Similar results were reported for orchids[17].

Conclusion

The black pepper area has expanded dramatically in the study area, as a result of government involvement and farmer awareness about black pepper as an intercrop. About 300.50 lakh additional seedlings are required to plant an estimated additional area of 27,048 ha in 2020–21. The protected structure accounted for majority of the initial and net investments to the tune of Rs 361,520 and Rs 250,025 respectively. Whereas the cost of generating one lakh Sigandhini and Panniyur-1 seedlings was calculated to be Rs 520,958 and Rs 379,048 respectively. For Sigandhini, the most significant expense was the cost of cuttings, which is a result of monopoly opportunity cost. Higher market price for Sigandhini seedlings results into larger net revenue of Rs 1,279,042 compared to Panniyur-1 (Rs 520,952). The cost of producing one Sigandhini seedling was estimated to be Rs 5.79 and for Panniyur-1, it was Rs 4.21. The current profit per seedling for Sigandhini and Panniyur-1 was Rs 14.21 and Rs 5.79 respectively. Project evaluation techniques revealed that the investment in Sigandhini nursery was highly economical and financially viable compared to a Panniyur-1 nursery.

Conflict of interest: The authors declare no conflict of interest.

1. Hembade, V. L., Alex, S., Soni, K. B., Sreekantan, L., Nair, S. D. and Raghunath, B. R., Presence of integrase core domain in mutanat type black pepper *Piper nigrum* L. 'Thekkan' with altered inflorescence architecture. *Indian J. Exp. Biol*., 2019, **57**, 770–773.
2. Vidyaasgar, G. M. and Murthy, S. S. M., Medicinal plants used in the treatment of diabetes mellitus in Bellary district, Karnataka. *Indian J. Tradit. Knowl*., 2013, **12**, 747–751.
3. Achar, S. K. G., Boosanur, V. and Shivanna, M. B., Ethnomedico-botanical knowledge of Tiptur taluk in Tumkur district of Karnataka, India. *Indian J. Tradit. Knowl*., 2015, **1**, 147–154.
4. Semwal, D. P., Saradhi, P. P, Kala, C. P. and Sajwan, B. S., Medicinal plants used by local *vaidyas* in Ukhimath block, Uttarkhand, *Indian J. Tradit. Knowl*., 2010, **9**, 480–485.
5. Reddy, K. N., Thrimurthulu, G. and Reddy, S., Medicinal plants used by ethnic people of Medak district, Andhra Pradesh. *Indian J. Tradit. Knowl*., 2010, **9**, 184–190.
6. Anon., Black pepper: area, production and productivity in India. Directorate of Arecanut and Spice Development, Calicut, India, 2021; https://www.dasd.gov.in/adminimage/Pepper_area_and_production.pdf.
7. Samal, K. P., Shah, A., Tiwari, C. S. and Agarwal, K. D., Indigenous healthcare practices and their linkages with bioresource conservation and socio-economic development in Central Himalayan region of India. *Indian J. Tradit. Knowl*., 2004, **3**, 12–26.
8. Shankarprasad, K. S., Kulkarni, N. S., Hegde, L. and Harisha, C. B., Sigandhini: a black pepper variety from Uttara Kannada, *Spice India*, 2021, **34**, 17–19.
9. Gautam, U. S., Sing, A., Dubey, S. K., Srivastava, A. K. and Singh, A. K., Step up farmer's right with PPV and FRA and ICAR-ATARI, Kanpur, 2016, p. 41.
10. Ashoka, N., Ravi, Y., Raveesha, S. and Yeledhalli, R. A., Economic analysis of brinjal seedling nursery enterprise in Karnataka. *Indian J. Agric. Econ*., 2020, **75**, 337–346.
11. Ashoka, N., Ravi, Y., Lingamurthy, K. R., Ravikuamr, B. and Anupama, G., Area and seedlings demand forecast of cabbage and economics of nurseries in Karnataka. *Econ. Aff*., 2019, **64**, 495–501.
12. Anon., Package of practices for horticulture crops, University of Horticultural Sciences, Bagalakote, 2014, pp. 159–165.
13. Ashoka, N., Ravi, Y., Lingamurthy, K. R., Ravikuamr, B. and Anupama, G., A study on seedling demand and economic analysis of chilli nurseries in Karnataka. *J. Crop Weed*, 2019, **15**, 120–125.
14. Ashoka, N., Lingamurthy, K. R., Dhanraj, P., Ravikuamr, B., Kustagi, G. and Anupama, G., Area and seedlings forecast of tomato and economic analysis of nursery in Karnataka. *J. Pharmacogn. Phytochem*., 2019, **8**, 1709–1713.
15. Ashoka, N., Shrinivasulu, G. B., Anupama, G., Harshavardhan, M. and Kattimani, K. N., Economic analysis of production and marketing of jasmine in Hyderabad–Karnataka region: a case in Koppal District, India. *Int. J. Curr. Microbiol. Appl. Sci*., 2017, **6**, 1702–1711.
16. Kumar, S., Mandanna, P. K. and Naik, T. S., Investment feasibility and marketing of jasmine in Chitradurga district. *Int. J. Commer. Bus. Manag.*, 2013, **6**, 9–13.
17. Shreedevi, B. C. and Sonnad, J. S., Production and marketing constrains of orchids in Karnataka. *Kar. J. Agric. Sci.*, 2014, **27**, 363–364.

ACKNOWLEDGEMENT. We thank the farmers in the study area for sharing their wisdom on raising Sigandhini and Panniyur-1 seedlings of black pepper.

Received 14 September 2021; accepted 22 September 2021

doi: 10.18520/cs/v121/i9/1201-1207