Off-season short-duration leafy coriander (*Coriandrum sativum*) with peri-urban market linkage model for small holders in drylands

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Traditionally farmers cultivate conventional crops like sorghum, bajra, castor, paddy, red gram, etc. in the drylands depending on their resources which are vulnerable to vagaries of monsoon, pests and diseases leading to crop failure. The problem is further aggravated with fluctuating market price of their produce for various reasons like drought, government policies, transient waterlogging, interference by middlemen, etc. Although the productivity of these crops has improved significantly with the advent of new technologies (variety, agronomic practices, etc), improved income to the farmers in the same tune is missing. In the last ten years, area under green chilly and green leafy vegetables (coriander, mint, fenugreek) cultivation has increased almost 10% over 2010, which indicates the increasing preference of farmers towards them[1] (Figure 1). Though the Government of India (GoI) is encouraging doubling the income of farmers, the risk-taking capacity of marginal farmers with marginal soil type is poor. Hence, an enterprise with low investment for a portable piece of land with tremendous income opportunities is highly profitable.

Coriander (*Coriandrum sativum*) is an annual herb plant used as a spice in the kitchen. It is mostly grown for its fruit and green leaves to provide flavour in various dishes. Coriander is gaining popularity in the recent past owing to short duration, high demand, being nutritionally rich (vitamin C)[2], low investment, suitability to grow on small pieces of land (backyard), easily managed by women and children (sowing to harvest), and needing only small quantity of water with meagre investment. In drylands, with limited water resources, the crop can be grown during off-season with high remunerative value and can be added to the existing cropping system to improve farmers' income and livelihoods[3]. Other leafy vegetables which are in demand throughout the year, are amaranthus, palak, etc. which are required on a weekly basis compared to coriander which is a common ingredient for most of the food preparations. Coriander can also be grown without any specialized skills of farming.

In the drylands the prime factor may be limited water resources. However, the judicious utilization of water for leafy vegetables, especially coriander, has fetched higher returns for the farmers than cereal/pulse crops grown during monsoon (*kharif*)[4], which fetch about Rs 10,000–20,000 per acre. The Indian crop growing period is divided into monsoon, winter and summer seasons. Monsoon crops grow with the support of rainfall besides irrigation, while winter crops grow with the help of the Northeast monsoon rainfall in some areas, in addition to irrigation[5]. But summer crops are grown with the irrigation water and during this period, the consumers feel the pinch of exorbitant prices of vegetables and fruits[6]. At times, the availability of green leafy vegetables is scarce, adding to the price.

Considering the benefits of this leafy vegetable, a dynamic market-linked harvest (DMLH) model was developed in Gadda Malaiah Guda village (17.094°N, 78.687°E), Yacharam Mandal, Ranga Reddy district, Telangana, India, to improve the income of farmers from small pieces of land (Figure 2). Coriander as a leafy vegetable was the model crop chosen for this study owing to its wide acceptance, low investment and portability for the marginal farmers in peri-urban location. The demand for coriander as leafy vegetable usually remains medium all round the year. However, it is in high demand during weekends, festivals, auspicious months (family and local functions). Due to weather extremes like rainy days and harsh summer, the demand is slightly hampered due to losses and quick decomposition. This demand cycle is the nodal point for the development of DMLH model, as enhanced demand has to be supplied by the farmer through regulated picking of coriander leaves. Usually farmers under this model will adopt staggered sowing and picking for fetching the higher rate of their produce, which will enable them to have a window of 10 days to meet the short, high demand of the commodity. This demand and supply model is regulated in a participatory mode, where the agro-met and agronomic advisories are given by the scientists and local dynamic market intelligence is taken care by the progressive coriander leaf-growers. DMLH has been developed in a participatory mode with the farmers, marketing agents and researchers using local market intelligence because the demand for coriander is constant; but being a short shelf-life crop, it can fetch price only when it is fresh. This model is working in peri-urban area and performing well due to the timely and regular availability of cheap public transport from 4:30 a.m. to

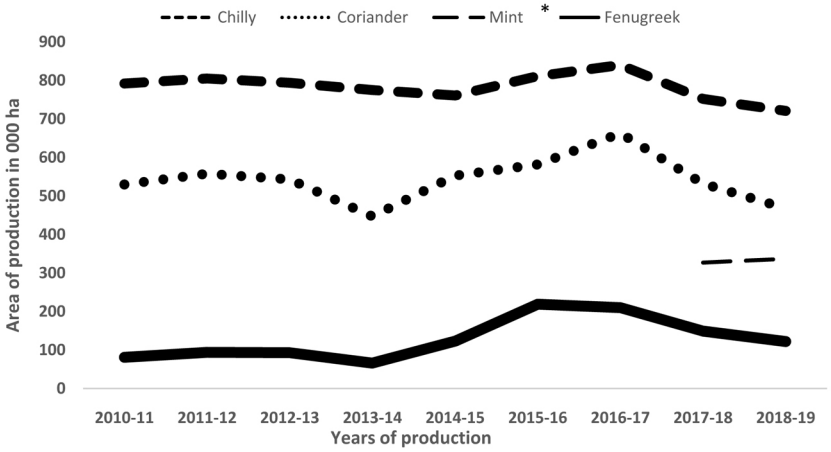

Figure 1. Area under major green leafy vegetable production during this decade[1]. *Data are available only for 2017–18.

Table 1. Irrigation and management schedule of leafy coriander crop under field conditions

Round-the-year production	Irrigation schedule	Preferred plant height (cm)	Yield (tonnes/acre)	Market rate
January–March (OS*)	Once in three days	12–15	1.2	Low
April–June (OS)	Once in two days	12–15	2.03	Very high
July–September	Depending on rainfall	15–20	1.53	High
October–December	Once in six days	15–20	1.1	Moderate

*OS, Off-season (March–June).

Table 2. Profitability of growing coriander under different farming conditions

	Coriander farming under different conditions			
	Off-season crop		Round-the-year production	
Particulars	Field conditions	Protected conditions	Field conditions	Protected conditions
Sowing window	March–June	March–June	January–December	January–December
Yield (tonnes/acre)	2.03	3.47	5.56	9.23
Seed rate (kg/acre)	15	12	15	12
Seed cost (Rs)	1500	1200	4500	3600
Irrigation cost (Rs)	2500	2000	5000	4000
Infrastructure cost (Rs)[#]	3000	50,000	3000	50,000
Labour cost on different operations (Rs)	5000	5000	10,000	10,000
Cost of cultivation/acre (Rs)	12,000	58,200	22,500	67,600
Gross income (Rs)	101,500*	173,500*	166,800**	276,900**
Net income (Rs)	89,500	115,300	144,300	209,300
B : C ratio	7.46	1.98	6.41	3.09

*Sale price Rs 50,000/tonne, **Sale price Rs 30,000/tonne.
[#]Total expenditure on protected structure, including micro-sprinklers is Rs 200,000; life of the structure is four years.

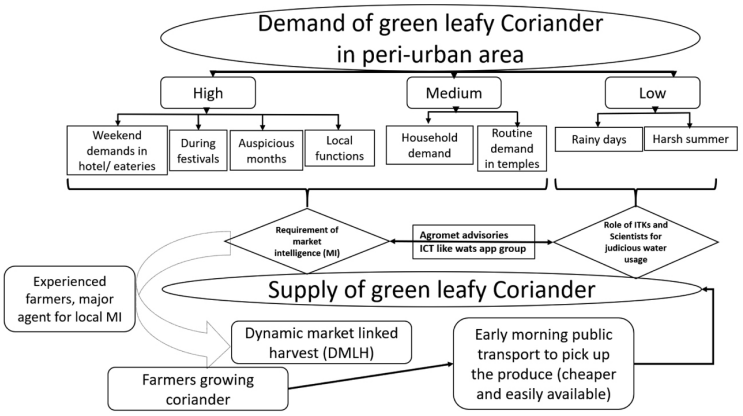

Figure 2. Dynamic market-linked harvest (DMHL) model operating in Gadda Malaiah Guda village, Telangana, India.

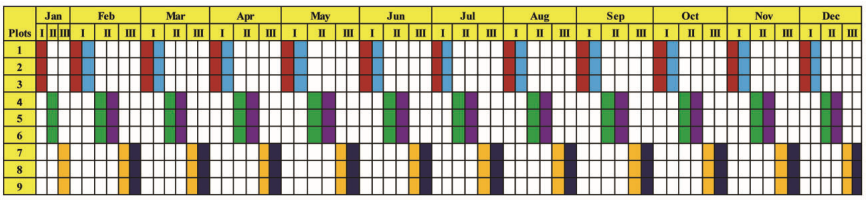

Figure 3. Staggered chart for coriander production. The same colour in a group of plots (1–3, 4–6 and 7–8) shows sowing in the first month and harvesting during the next month. When two different colours are together, the former is harvesting of the previous crop and latter is sowing of new crop. I, 1st to 10th day of the month; II, 11th to 20th day of the month; III, 21st to 30th/31st day of the month.

go to the Rythu market in the urban area. If DMLH is adopted, there is tremendous scope for enhancing farmers income by 20–25%. During the current COVID-19 situation also, marketing of the produce is done by farmers.

All the management factors like skilled labour availability, market demand and its dynamics, processing, and marketing are to be addressed.

The success of the DMLH model lies in the staggered sowing and harvesting of coriander leaves. In this system, the farmers divide their field into smaller plots for easy handling and to meet the high demand even at a short call. Figure 3 is a depiction of this system, exhibiting the division of land into nine smaller plots (1–9). For the convenience of growing the crop, sowing of coriander seeds in first set of plots (1–3) is done in the first 10 days of the month, however, the second set of plots (4–6) is sown during 10th–20th day of the month and third set (7–9) during 20th–30th day of the month. Seed rate of coriander to be used as leafy vegetable varies from 12 to 15 kg per acre. Irrigation of the crop is done using micro-sprinkler with an irrigation schedule of once in three days

during January to March, once in two days during April to June, usually rainfed with few sprinkles during July to September, and once in six days during October to December (Table 1). Since, the consumers pay more for the fresh leaves, staggered harvest is followed according to the DMLH model. The farmer will have a window of ten days for each type of plot in the month, which will enable him/her to supply fresh coriander leaves (growing period of the crop is less (25–40 days)). Every time the farmer harvests a crop and sows for the next crop cycle in the same plot, there is continuous crop growth in the meagre piece of land.

Figure 4. Standing crop of leafy coriander under micro-irrigation system in farmer's field.

With the DMLH model and staggered system of growing coriander, off-season crops can fetch a better price of their produce. The field study carried out in 2019–20 revealed that four types of coriander-farming situations prevail in Ranga Reddy district, namely off-season crop with or without protection and round-the-year crop with or without protection (Table 2). As the off-season crop is remunerative (Rs 89,500/acre in a season) with least investment (Rs 12,000) and B : C ratio of 7.46, majority of farmers have adopted this technology. In the region, the acceptance of the model can be visualized with its expansion to 50 acres of area in the Gadda Mallaiah Guda village, in 2 years (Figure 4). However, maximum profitability with minimum investment of time is possible with protected cultivation of leafy coriander as an off-season crop (Rs 115,300 acre in a season). Simultaneously, the farmers can obtain other benefits from different crops during the crop season, apart from this additional benefit. If the farmers cultivate leafy coriander for the whole year, they can reap the benefits of an average Rs 209,300/acre under protected conditions and Rs 144,300/acre under open-field conditions.

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A tale of two biologies: distinctions in philosophy and practice between organismal and sub-organismal science

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While the 21st century has been proclaimed as the age of biology, the disciplines of sub-organismal biology have received greater attention, often at a cost to organismal biology. However, the fields of organismal biology – ecology and evolution – are not only fundamental to biology, but are of societal importance in terms of their application in environmental conservation, sustainability and public health. We argue here that organismal and sub-organismal biology differ substantially in their philosophy and practice: while organismal biology focuses on systems and collectives, sub-organismal biology rests on reductionism. Further, we emphasize that these distinctions must be recognized in institutional and funding structures for organismal biology to fully realize its potential.

'Biology', a term coined by Lamarck in the early 1800s, is considered by many to be the science of the 21st century with its range of modern methods and applications. From molecular biology to microbiology, and cell and developmental biology, to genomics and proteomics, this range of disciplines receives both substantial attention and funding. Needless to say, with applications ranging from health (cancer biology, infectious diseases) to food security (transgenic crops to sustainable farming) to human well-being (biodiversity and ecosystems), the field appears to have as much to offer for the future of mankind as any other, if not more. The recent COVID-19 pandemic, which has brought the world to a grinding halt, more than even the World Wars of the last century, serves to hammer home this point, if somewhat painfully.

While this is without doubt an exciting time for biology, the bright facade hides