

Economics of value addition in Oleoresin: Implications for Access and Benefit Sharing of Byadagi Chilli in Karnataka

Report submitted to

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Preamble

The Ministry of Law and Justice (Government of India), promulgated the Biological Diversity Act, 2002 in order “to provide for conservation of biological diversity, sustainable use of the components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidence thereto”. According to the Chapter 1, Section 2(f) of The Biological Diversity Act, 2002; The Biological Diversity Rules, 2004 and The Karnataka Biological Diversity Rules, 2005 (with effect from 29th June 2006)¹, “commercial utilization” (of biological resources) means end uses of biological resources for commercial utilization such as drugs, industrial enzymes, food flavours, fragrance, cosmetics, emulsifiers, **oleoresins**, colours, extracts and genes used for improving crops and livestock through genetic intervention, but does not include conventional breeding or traditional practices in use in any agriculture, horticulture, poultry, dairy farming, animal husbandry or bee keeping;”. And therefore, the firms / industries involved in “commercial utilization” of biological resources need to share a certain percentage of their annual turnover as Access and Benefit Sharing (ABS) with the generators (or gatherers) of biological resources respecting the information, sustenance and sustainability of flow of biological resources. In order to appreciate ABS, it is crucial to estimate the returns obtainable from commercial utilization of biological resource towards commercial utilization. Origin of Chilli

Chilli originated as a wild crop in New Mexico and Guatemala around 7500 BC, and was domesticated in 5000 BC. In 1493 AD, the chilli seeds were carried by Columbus to Spain. Hence, cultivation of chilli spread rapidly in Spain and Europe. During 1584 AD, Portuguese carried capsicum from Brazil to India and the crop became popular in Asia as the south Asia climate was appropriately suited to Chilli. Currently in India, Chilli is the cheapest spice and popularly growth in Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu, which account for 75 per cent of the total area. AP produces the maximum chilli output followed by Tamil Nadu, Maharashtra, Orissa and Karnataka. Guntur in AP and Byadagi in Karnataka are the two large markets in the descending order of magnitude of arrivals and transactions of chilli.

India leads in Chilli exports

India is the world’s leader in the export of chillies with 25% share followed by China with 24% share in global export. Indonesia and US are the major markets. The exports *inter alia* are influenced by production in competing countries, domestic production, influence of monsoon determining the productivity, demand for value added products and the market forces. India exported 16.4% of its total chilli production in 2007-08. Out of the total export of spices, chilli accounts for 48% in quantity and 28% in value. India is the main source of red chilli in the international market traded as chilli powder, dried chilli, pickled chillies and chilli oleoresins. Malaysia is the largest buyer of Indian chilli with a share of 29%, followed by Bangladesh (19%), Sri Lanka (15%), the US (9%), the UAE (8%) and others (19%). Aflatoxin content in chilli has to be necessarily below 10 PPB for exports. Several consignments of Indian chillies have been rejected recently as Aflatoxin content exceeded the

¹ Karnataka Biodiversity Board, Vanavikas, Malleshwaram, Bangalore, <http://www.kbb.kar.nic.in/>

permissible limits and this highlights how vital is the level of Aflatoxins in chillies as well as other quality parameters in international trade. Countries such as US, UK, Germany and Sweden use chilli for oleoresins and extracts on a large scale.

Study objective

This study is a modest attempt to estimate the costs and returns involved in chilli oleoresin considering Byadagi chilli in Karnataka. The study highlights the issues involved in value addition in chilli oleoresins in view of the ABS evolved by the Karnataka Biodiversity Authority. The Pictures 1 to 50 in Appendix *inter alia* capture the shift in crop pattern from Byadagi chilli, problem of Murda leaf curl disease, facilities in Byadagi APMC market yard, Grinding units for chilli, cold storage units, and oleoresin units captured through a reconnaissance survey (during Aug 2015).

Oleoresin

The oil-soluble extract from the fruits of *Capsicum annum* / *Capsicum frutescens* is called paprika oleoresin or paprika extract. This is used for colouring, flavouring as it has capsaicin, the flavoring compound with pungency in different concentrations, and capsanthin and capsorubin responsible for the red color along with carotenoids. Oleoresin, the viscous liquid, with aroma and flavor, is also extracted from finely ground chilli powder. Oleoresin is used in medicine internally as a stimulant and carminative and externally as a counter irritant in rheumatism. The extraction of oleoresin is usually by percolation using solvent such as hexane. Paprika oleoresin is commonly used as coloring agent in orange juice, spice mixtures, sweets, sauces. It is also used in poultry feed in order to intensify the colour of egg yolk. According to FAO², 1 kg of paprika extract can substitute 12-15 kgs of paprika powder with regard to intensity of color. However, there has not been an established relationship between the intensity of color and pungency³. The oleoresins from red pepper are used as spice as they have pungency ranging from 80000 to 500,000 scoville units. The paprika extracts are viscous, homogenous red liquids which can be used to colour foods, while oleoresin is a flavoring agent with low capsaicin with little pungency. Chillies in food processing are used both for colour and pungency.

Trends in Area and productivity of Chilli in Karnataka

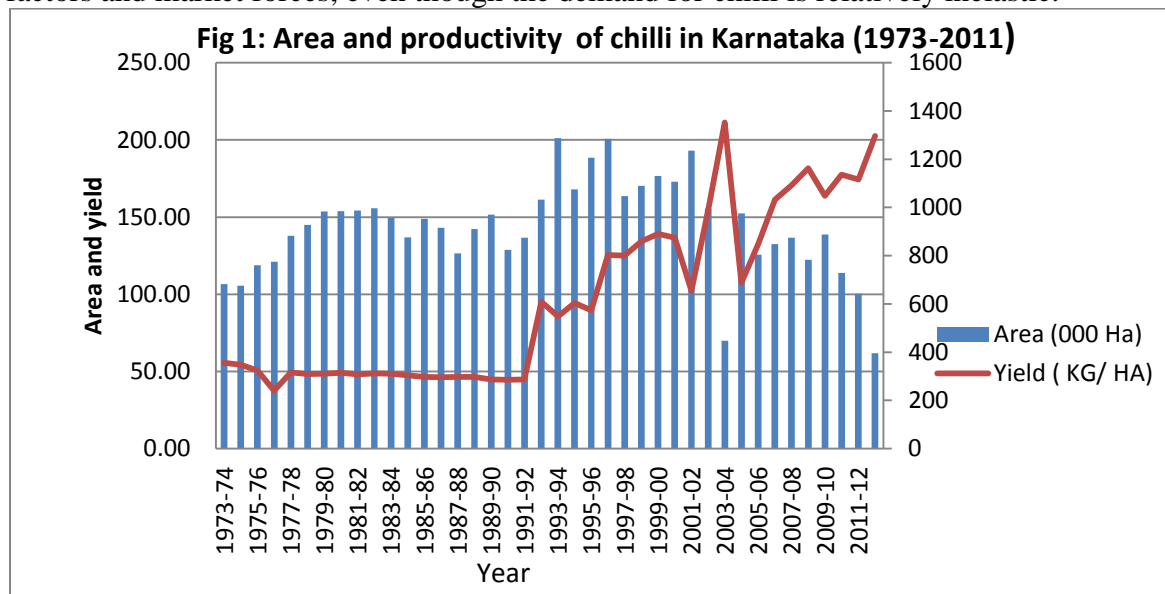
The area and productivity of chilli in Karnataka (Fig 1) indicate highly fluctuating area and production since 1973. The area under chillies was around one lakh ha in 1973, increased to 1.5 lakh ha in 1983, and fluctuated between 1.25 lakh ha and 1.5 lakh upto 1992. Area rose to an all time high of around 2 lakh ha in 1993 and 1996 and then fell to around 1.6 lakh ha in 2000, reaching a considerable low of 0.65 lakh ha in 2003. Though the area picked up since 2004, again surpassing 1 lakh ha upto 2009, the area reduced to below 1 lakh ha since 2010 reaching the all time low of around 0.6 lakh ha in 2011.

The productivity of chilli began from around 0.3 quintal per ha in 1973 sustaining upto 1991, with a spurt in 1992 to 0.6 quintal per ha. The productivity surpassed 1 quintal per ha in 1996, reaching an all time high of around 1.3 quintal per ha in 2003 and has sustained at this level till 2011. Thus, a comparison of Area and productivity of Chilli in Karnataka since 1973, indicates that the productivity

² http://www.fao.org/fileadmin/templates/agns/pdf/jecfa/cta/69/Paprika_extract.pdf

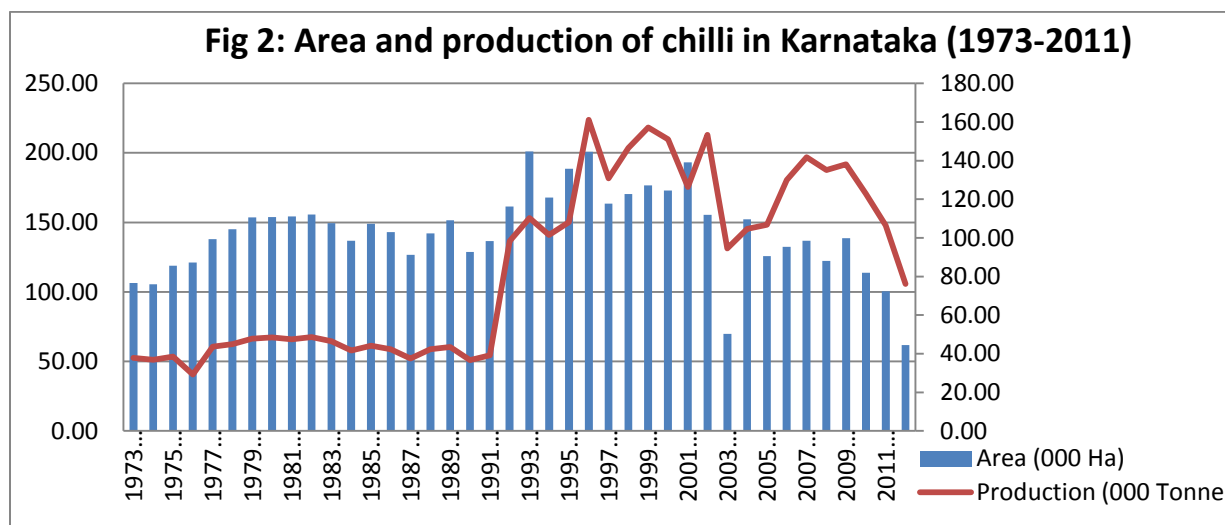
³ http://www.fao.org/fileadmin/templates/agns/pdf/jecfa/cta/69/Paprika_extract.pdf

is rising over the period, the area is falling, both with substantial fluctuations due to both agroclimatic factors and market forces, even though the demand for chilli is relatively inelastic.

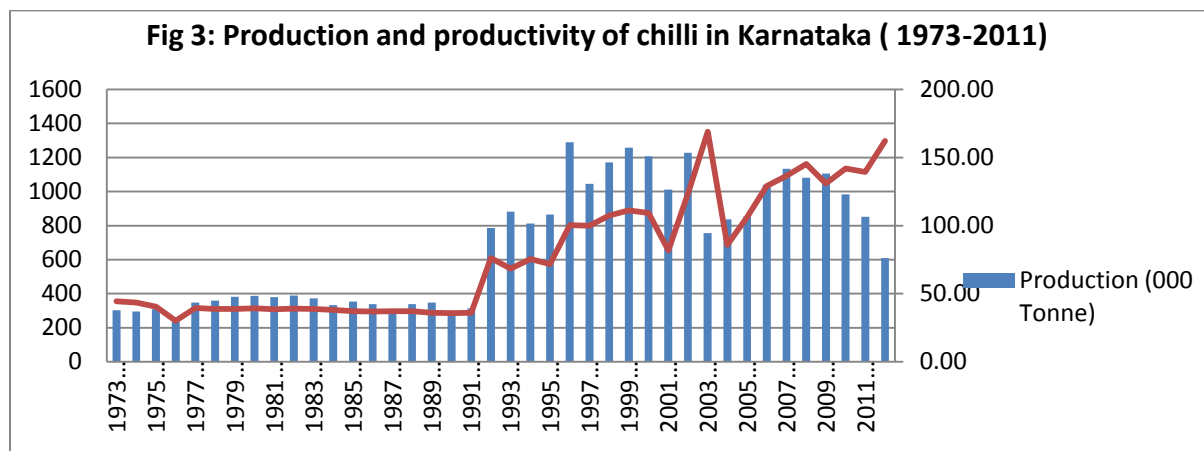


Spurt in production of chilli due to demand for Oleoresins since 1991

The production of chilli, rose with the area at a slow pace from 1973 to 1991, with a steep increase (in production) from 1991. The production remained around 1.40 lakh tonnes from 1995 and it fell to around 0.8 lakh tonnes in 2011, and the area also fell, despite increase in productivity (Fig 1). Therefore, the productivity growth in Chilli has not been impressive enough to increase production or reduce the area. The area however reduced due to the relative profitability of competing crops such as cotton and maize. Nevertheless, the overall compound growth rate of production of 4.7 % between 1973 and 2011 is different from the growth rate of production of 7.7 percent between 1991 and 2011. Thus the overall growth rate (of 4.7%) in production hides the spurt in the growth rate from 1991 being (7.7%). The spurt in the production since 1991, can be attributed to spurt in the increase in demand for Oleoresins since then.



Despite increase in productivity, the production fell as area reduced and hence productivity gain has not been substantial in Chilli (Fig 3). Accordingly farmers are suggesting to develop improved varieties / hybrids in Chilli with low Aflataxin and especially tolerant / resistant to the Murda leaf curl virus and at the same time meeting the pungency and color requirements, due to raise in demand for oleoresins all over the world. The productivity of chilli is increasing from 1973 from a bear 40 kgs per ha in 1973 to 140 kgs per ha in 2011, registering a simple growth rate of 5.82 percent. However this growth rate is not economically substantial to sustain growth in area and production.



Major chilli producing districts of Karnataka

The major chilli producing districts in Karnataka are Bellary, Dharwad, Haveri, Raichur and Gadag (Table 1). The districts of Bellary, Dharwad and Haveri contribute to 46% of the State's area and 38% of the State's production. Raichur and Gadag are the districts which are focusing on Chilli. With the availability of improved Chilli varieties and hybrids, and increased tolerance / resistance to Chilli leaf curl Murda disease, other areas in Northern Karnataka have the potential to grow chilli.

Table 1. Area (ha) and Production (tonnes) of Dry Chillies in major five districts of Karnataka

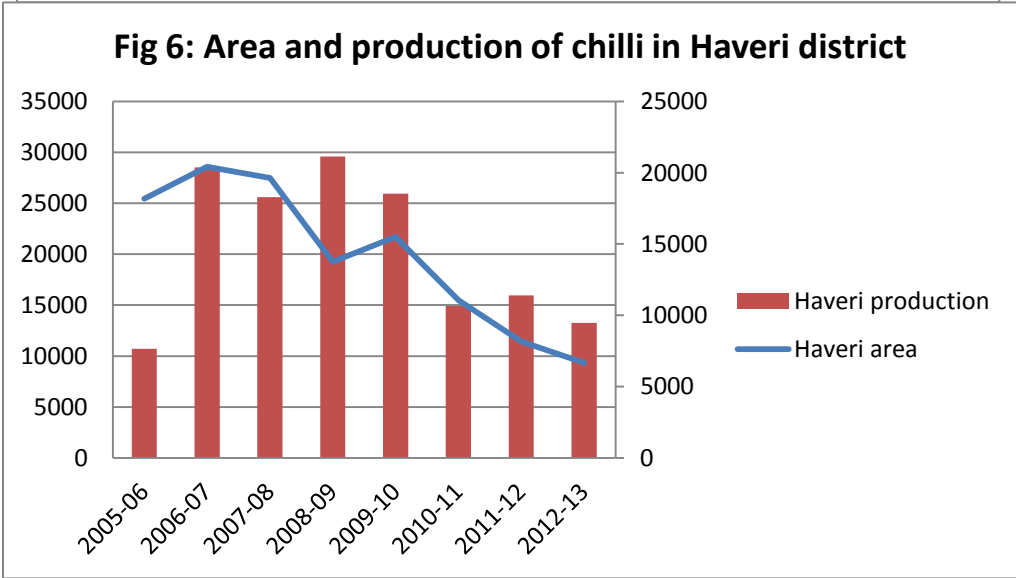
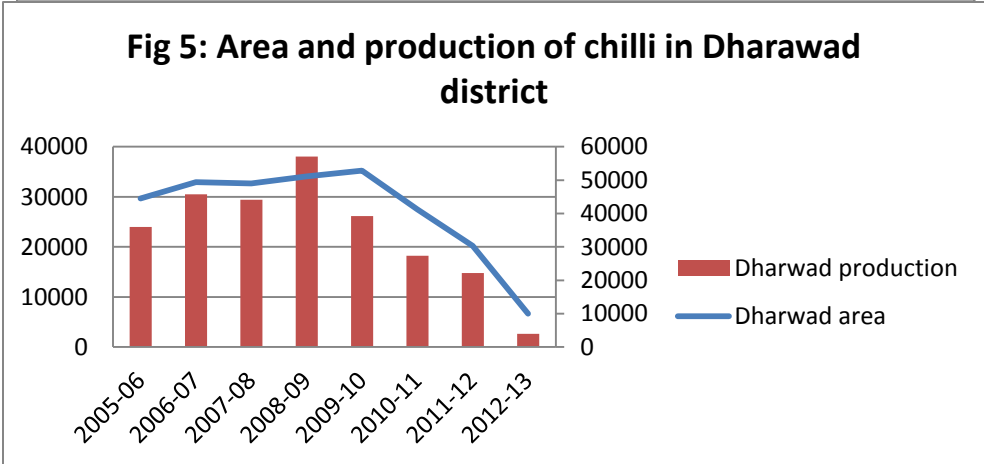
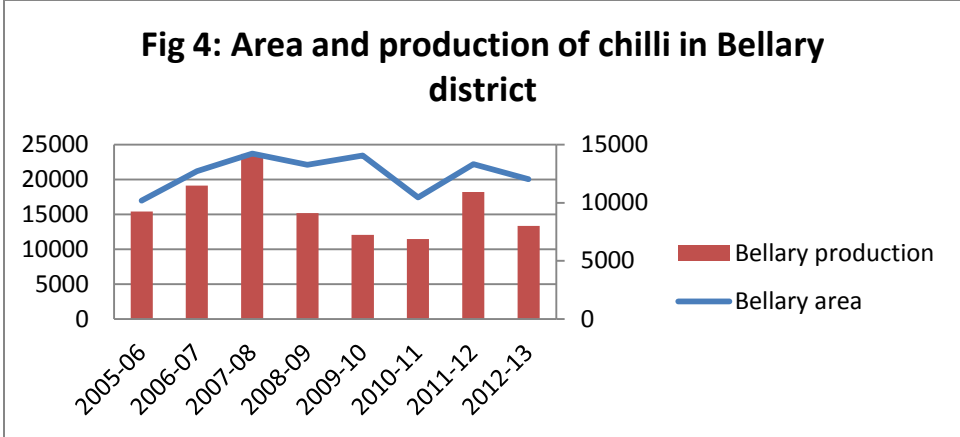
year	Bellary		Dharwad		Haveri		Raichur		Gadag	
	area	production	area	production	area	production	area	production	area	production
2005-06	10196	15394	44513	23973	18180	10722	1116	955	16624	11326
2006-07	12714	19139	49399	30513	20421	28525	1799	1788	18798	5526
2007-08	14226	23690	49032	29393	19638	25588	3336	1821	18132	11399
2008-09	13274	15189	51070	38030	13763	29606	3300	2523	8610	4987
2009-10	14072	12040	52855	26153	15512	25938	2184	2230	21213	10480
2010-11	10451	11450	41230	18205	11053	14932	2124	3064	17240	15348
2011-12	13320	18236	30347	14759	8161	15951	3483	3703	15010	6939
2012-13	12042	13347	9979	2629	6653	13268	4440	5108	3660	2556

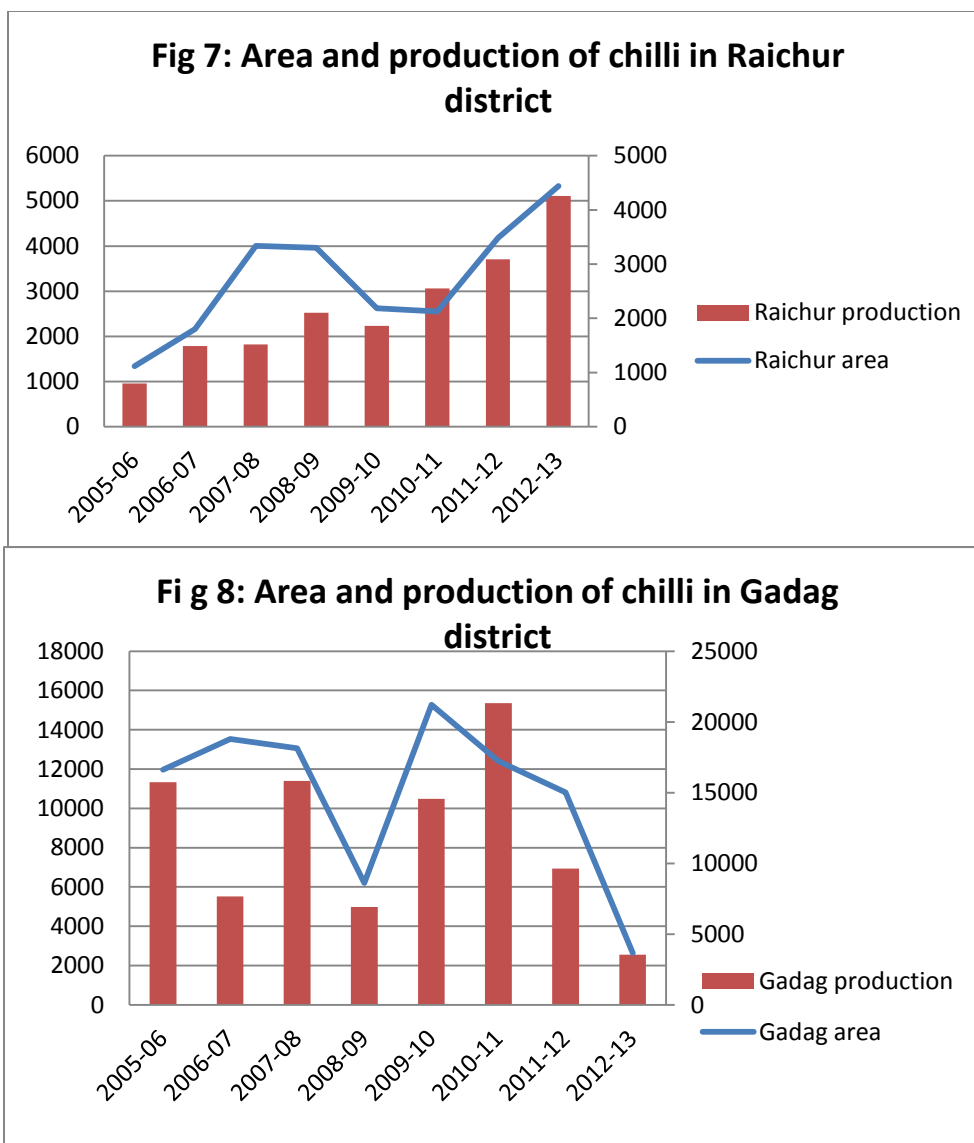
Area and production in Bellary

Area and production of Chilli in Bellary (Fig 4), Dharwad (Fig 5), Haveri (Fig 6), Raichur (Fig7) and Gadag (Fig 8) indicate different trends. Bellary district has been a leader in maintaining at least 10000 ha under chillies fluctuating between 10000 and

14000 ha. The production has been widely fluctuating from around 11,450 tonnes to 23,690 tonnes, Dharwar district which was the leader in Chili with around 50000 ha has seen a consistent fall in area since 2009. The major reason is the murda leaf curl disease attack on chillie. Haveri district too exhibits fall in area. Except Raichur district, which is showing an increasing trend in both area and production, there is a threat to Chilli cultivation in Karnataka due to Murda leaf curl disease which has virtually reduced the area and production by fifty percent compared with the situation in mid nineties.

The Chilli *murda* complex disease is due to thrips, mites and a virus, the most serious disease of chilli. Due to the disease, there will be severe leaf curling in upward and downward directions leading to wrinkling elongated petiole and finally sterility. The leaves exhibit dark green mottling with vein banding symptoms.





Economics of chilli cultivation under rainfed conditions

Among the different items of expenditure in the cultivation of dry land chilli (Table 2), the labor cost including the payment to bullock labor forms around 40 percent of the total cost of cultivation of Rs. 40134 per acre followed by capital required spent on fertilizers, FYM, seeds, plant protection chemicals. The rental value of land is around 13 percent. With the realization of 5.5 quintals per acre, the gross returns at the price of Rs. 9182 per quintal works to Rs. 50,500, yielding a net return of Rs. 10366 per acre. This works to the cost of production of Rs. 7297 per quintal of chilli. Thus, with the realization of the market price of Rs. 9182 per quintal, deducting the cost of production of Rs. 7297 per quintal of chilli, the net return of chilli under rainfed condition works to Rs. 1885 per quintal.

Table 2. Cost of cultivation for dry land chilli in Byadagi area Rs. Per acre (2015)

Sl. No	Particulars	Quantity	Average cost	% of total cost
1	FYM	2 tractor loads @Rs. 2000 per load	4000	9.97
2	Seed quantity	90 grams @ Rs. 27.7 per gram	2500	6.23
3	Chemical fertilizer	2 bags of DAP + 1 bags of urea = 150 kgs	3000	7.48
4	Plant protection chemicals		2000	4.98
5	Tractor ploughing	2 hours per acre @ Rs. 750 per hour	1500	3.74
6	Bullock Ploughing	one bullock pair day @ Rs. 1000 per day	1000	2.49
7	Harrowing	one bullock pair day @ Rs. 1000 per day	1000	2.49
8	Inter cultivation	one bullock pair day @ Rs. 1000 per day for 3.5 days	3500	8.72
9	Transportation of FYM	1.5 tractor loads @ Rs. 500 per load	750	1.87
10	Labor for Spreading of FYM	3 mandays of labor @ Rs. 233 per man day	700	1.74
11	Labor for Seed bed preparation	1 man days @ Rs. 250 per man day	250	0.62
12	Labor for Transplanting of seedlings	Piece work	950	2.37
13	Labor for Fertilizer application	3 man days @ Rs. 233 per man day	700	1.74
14	Labor for Weeding	Piece work (say 10 women days @ Rs. 150 per women day)	1500	3.74
15	Labor for PPC spraying	6 man days	1350	3.36
16	Labor for Harvesting	21 man days	4200	10.47
17	Labor for Drying	3 man days	600	1.50
Working capital			29500	73.50
1	Rental value of land		5250	13.08
2	Interest on working capital at 12.5 % for 6 months		1843.75	4.59
3	Risk premium @ 2 % of working capital		590	1.47
4	Managerial cost @ 10% of working capital		2950	7.35
Total cost			40133.75	100
Gross returns		5.5 quintals @ Rs. 9182 per quintal	50500	
Cost for production of 1 qtl chilli			7297.04	
Net returns			10366.25	

Economics of chilli cultivation under irrigated conditions

Byadagi chilli is also cultivated under irrigated conditions. Considering the different items of the cost of cultivation (Table 2), it works to Rs. 75441 inclusive of interest on working capital,

Table. 2 Cost of cultivation of borewell irrigated chilli in Byadagi area Rs. Per acre 2015

No	Particulars	Quantity	Total cost	%of total cost
1	FYM	2 tractor loads @Rs. 2500 per load	5000	6.63
2	Seed quantity	100 grams @ Rs. 31.5 per gram	3150	4.18
3	DAP (Rs.1250 per bag), Urea (Rs.350 per bag) and Complex fertilizers (Rs. 950 per bag)	4 bags of DAP + 2 bags of urea + 3 bags of complex = 450 kgs	8750	11.60
4	Plant protection chemicals		7500	9.94
5	Tractor ploughing – land preparation	4 hours per acre @ Rs. 750 per hour	3000	3.98
6	Bullock Ploughing - land preparation	one bullock pair day @ Rs. 1000 per day	1000	1.33
7	Harrowing – land preparation	one bullock pair day @ Rs. 1000 per day	1000	1.33
8	Inter cultivation	one bullock pair day @ Rs. 1000 per day for 4.5 days	4500	5.96
9	Transportation cost FYM (from source to destination)	2 tractor loads @ Rs. 550 per load	1100	1.46
10	Labor for Spreading of FYM	5 mandays of labor @ Rs. 260 per man day	1300	1.72
11	Labor for Seed bed preparation	2 man days @ Rs. 200 per man day	400	0.53
12	Labor for Transplanting seedlings	Piece work	1100	1.46
13	Labor for Fertilizer application	4 man days @ Rs. 225 per man day	900	1.19
14	Irrigation charges	5 irrigations @ Rs. 550 per irrigation	2750	3.65
15	Labor for Weeding	Piece work (say 21 women days @ Rs. 150 per women day)	3250	4.31
16	Labor for PPC spraying	6 man days	1350	1.79
17	Labor for Harvesting	32 man days	6500	8.62
18	Labor for Drying	7 man days	1100	1.46
Working capital			53650	71.12
1	Rental value of land		12000	15.91
2	Interest on working capital at 12.5 % for 6 months		3353.12	4.44
3	Risk premium At 2 % of working capital		1073	1.42
4	Managerial cost at 10 % of working capital		5365	7.11
Total cost			75441.12	100
Gross returns		11.5 quintals @ Rs. 9270 per quintal	106600	
Cost for production of 1 qtl chilli			6560.10	
Net returns			31158.88	

managerial cost, risk premium as well as rental value of land. Considering the proportion of total cost, labor component forms around 30 percent of the cost of cultivation followed by fertilizers (11.6%) and plant protection chemicals (10%). In the irrigated conditions, chemical fertilizers, FYM, PPC and seeds account around 30 percent of the cost of cultivation. The rental value of land forms around 16 percent of the cost. Byadagi Chilli comes to flowering 40 days after transplantation although the majority of flowers bloom 60 to 80 days after transplanting. In chilli, around 65 to 75% by weight is pericarp (skin), 30% is seeds by weight. After deseeding, the pericarp is powdered, pelletized before extraction for oleoresin content of around 6%.

With the realization of an average yield of 11.5 quintals per acre as output under irrigated condition, at the average price of Rs. 9270 per quintal, the net return works to Rs. 31159 per acre. This amounts to the cost of production of Rs. 6560 per quintal of chilli and net return of Rs. 2710 per quintal. In comparison of the net return per quintal under rainfed conditions being Rs. 1885 per quintal of chilli, the irrigated chilli offers 44% higher net return. The irrigated chilli is picking up in Raichur district distinctly. It is also being cultivated under irrigated conditions using canal water in Bellary district, as also in other districts.

Reservation price for Chilli

Considering the total cost of cultivation of Rs. 40,000 per acre under dry land cultivation to around Rs. 75,000 per acre under irrigated condition, farmer has to realize atleast Rs. 7300 per quintal in the case of rainfed chilli and at least Rs. 6600 per quintal in the case of irrigated chilli, to be economically worthwhile. Thus, Rs. 7300 per quintal can be designated as reservation price of rainfed chilli and Rs. 6600 per quintal can be considered as reservation price of irrigated chilli, below which the supply of chilli is not worthwhile, as the price below the reservation price will not be able to recover the total cost of cultivation. However, if the working capital alone is considered, then the cost of production of rainfed chilli works to Rs. 5364 per quintal and that of irrigated chilli works to Rs. 4665 per quintal, in which case the reservation price would be lower than that by considering the total cost of cultivation.

Byadagi APMC

Byadagi chilli is well known for color richness and modest pungency. The Agriculture Produce Market Committee commenced in Byadagi in 1948, rendering it as one of the oldest markets in the State. It is also the second largest market for chillies in India. The marketing activities gain momentum from December to April. Here, chilli is transacted Monday through Thursday in the market. A majority of the farmers who bring their produce to the market belong to small and marginal category who bring around 20 bags (of 30 kgs) weighing around 6 quintals. In the marketing season, thus, there will be around 10,000 farmers who bring their produce to the Byadagi market, served by around 200 to 300 middlemen who facilitate the transactions. The market is highly competitive and has electronic facilities bringing transparency in bidding and other functions. This is the very reason as to why farmers, traders, middlemen want to buy and sell the Chilli in Byadagi market, due to high degree of market regulation. The price of chilli also depends upon the proportion of chilli used for oleoresin and that used directly for spice. At present about 70% of the chilli is coming from irrigated chilli from Bellary, Raichur, Sindhanur and 30% is the rainfed chilli from Gadag, Lakshmeshwar, Kundagol.

For each lot, there may be around 30 to 40 bidders and the highest bidder will get to purchase the produce. As soon as farmer brings produce to APMC (Agriculture Produce Market Committee), he is

issued an entry pass and an unique lot number. His product is weighed and put on a platform, ready for sale. This is followed by bidding across the lots available. After finalization of bids, SMS is sent to the concerned farmer indicating the highest bidder. Later on issue of sale bill is made with payment the same day, delivery of the lot, and e-permitting. Thus, farmer after displaying his produce by 2 pm on trading day can find details about the price in an hour.

In addition to market being competitive, the farmers as well as functionaries have fairly good information about the quality of chilli demanded / supplied. For instance, price of chilli sold / bought depends upon the color with ASTA rating (say 2000) and pungency 30,000 units. This chilli is called high color high capcaicin chilli. High capcaicin is colloquially referred to by merchants as Highcap chilli, which has high pungency. There is a variety Theja from Andhra Pradesh which is a high cap chilli and fetches Rs. 85 to Rs. 100 per kg. Namdhari variety has ASTA of 100 with 16000 pungency which fetches Rs. 65 to Rs. 80 per kg of chilli. During 2014-15, the annual turnover of Byadagi market surpassed Rs. 700 crores.

There are different estimates regarding the proportion of chilli which goes towards different types of oleoresin. According to RG Patil traders in Byadagi, 75% of the chilli is processed for pungency and 25% of the chilli is processed for oleoresins. According to a cold storage worker in Byadagi, about 60% of the storage space is being utilized by the processors of chilli oleoresin and 40% of the space is being utilized by chilli for spices. Those who use the cold storage space *inter alia* are largely for oleoresins such as Synthite Harihar, Kancor Ingredients, Motebennur, AK Flour, Thadsa, Plant lipids, Dodda ballapur, Kolancheri, Kerala, Eastren company, AV Thomas, Cochin. Synthite⁴ the world's largest producer of value added spices has patented the process to make oleoresins has Commission Agents who buy Byadagi chilli for the company, which has processing units in Harihar, Doddaballapur.

The Chilli is stored in cold storage before processing. There are differing estimates regarding what proportion of chilli marketed is stored in cold storage. The opinion survey indicated that the volume stored is increasing over time along with arrivals in APMC. The awareness among traders, buyers including industries which are involved in value addition such as oleoresin are aware of the ASTA color units, that Byadagi Chilli with 200 ASTA⁵ is of fine quality and that with 100 ASTA is of low quality. The moisture content in chilli has to be 10 to 12 percent, but sometimes farmers sprinkle water bringing the moisture to the level of 16 to 18 percent. This has become a major problem for traders, who cannot reject the lot easily once it is accepted.

The buyers such as McCormick⁶, MTR⁷ are the world leaders in preparation of ingredients for food preparation as also the buyers of chilli insisting on ASTA color standards. Hence it is crucial for even farmers to be aware of international standards in Chilli and incorporate the steps and strategies in cultivation of chilli in order that they can cater to International standards as India exports around 15 to 20 percent of its domestic production. Since quality chilli requires that the source needs to be identified, it is to the advantage of farmers cultivating Byadagi Chilli to adopt the package of practices for cultivating quality chilli.

⁴ <http://www.synthite.com/synthite.html>

⁵ <http://measuretruecolor.hunterlab.com/2014/06/04/asta-color-and-ic-color-of-paprika-and-oleoresin-spices/>

⁶ <http://www.mccormick.com/Food-Coloring-and-Extracts/Food-Coloring-Guide>

⁷ <http://www.mtrfoods.com/products/masala-powders>

Quality of Byadagi chilli

The name Byadagi is associated with Byadagi Chilli with its deep red color with (American Spice Trade Association or ASTA) color unit values of 160 to 300 and thus has higher color compared to any other type of chilli in India. The chilli is also wrinkled and the quality also depends upon the wrinkled chillies. The higher the wrinkle, higher is the quality. The pungency value of Byadagi chilli is low ranging from 9000 to 15000 SHU (Scoville Heat Units). Thus, the price offered for red chilli is associated with ASTA color units, and higher the ASTA color units, higher is the price. Compared with other chilli varieties, the use of plant protection chemicals for Byadagi chilli is low. With the modest content of capsaicin, its relatively low pungency, unique flavor, as also having the GI tag (144), the Byadagi chilli, has high demand for both as spice and as oleoresin. The oleoresin (oil) from Byadagi chili is popular and used in cosmetics, food preparations, in pharmaceuticals.

Why Oleoresin demand is responsible for economic expansion of Byadagi chilli market

Theoretically the demand for chilli for culinary purpose (for use as spice in sambar making for instance) has to be perfectly inelastic, since, similar to salt, the quantity of use as spice cannot depend upon the price. Thus, irrespective of the price, the consumption of chilli as spice (chilli powder put in sambar powder) may vary around 3 to 5 grams per day (a relatively constant quantity) (Fig 1).

Heuristic Inelastic demand for Chilli used for culinary purposes

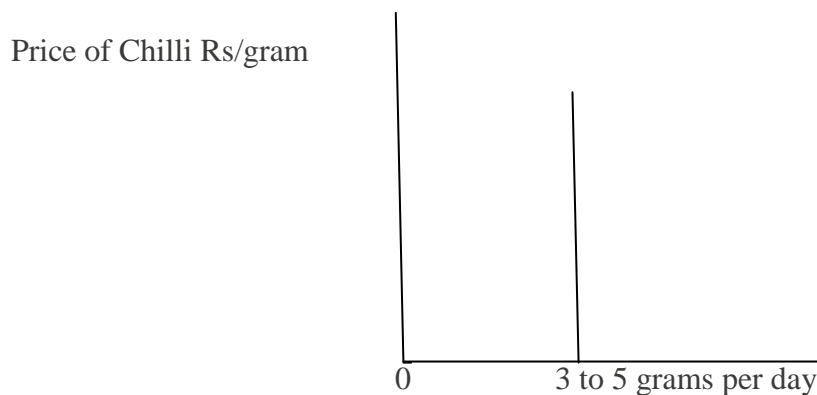


Fig 1: Quantity demanded of Chilli for culinary purpose

Therefore, the demand for Byadagi chilli for the purpose of use as spice (chilli powder or sambar powder) has to be theoretically perfectly inelastic (with an elasticity value of zero). However in reality even if this is assumed to be a small figure of -0.05 , which means, for a one percent increase in price there is 0.05 percent fall in quantity demanded, it is relatively inelastic demand for chillies used in culinary purposes.

Heuristic elastic demand for Chilli used for oleoresin

The demand for chilli used for Oleoresin purposes, theoretically has to be relatively elastic, since oleoresin can be made from different sources (and hence has substitutes) on the one hand and on the other, is used for cosmetic preparations, pharmaceuticals, coloring which may have different

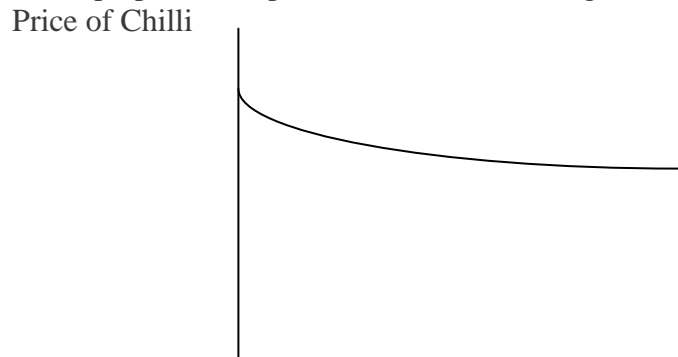
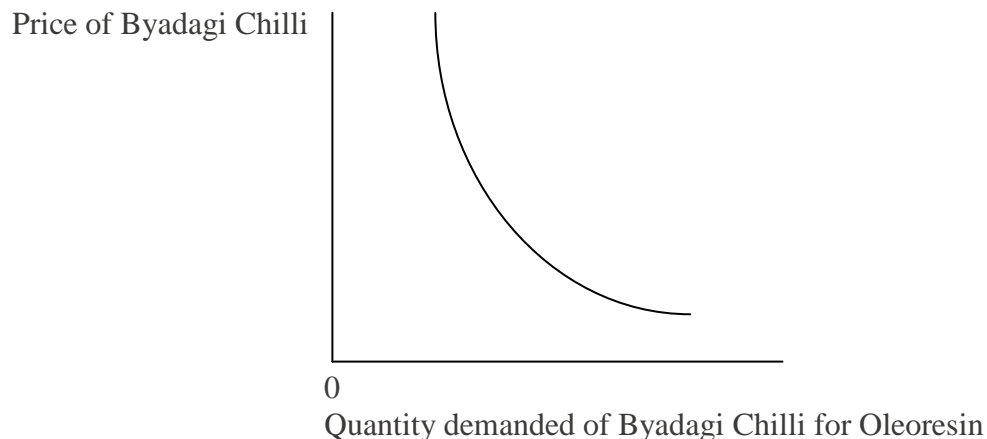


Fig 2: Quantity demanded of Chilli for non-culinary purposes substitutes for chilli. Thus, the demand for chilli for non-culinary purposes must be highly price sensitive or price elastic and accordingly the quantity of chilli which is consumed or used for oleoresin making may fluctuate relatively widely, when compared with that used for spice purposes.

Heuristic inelastic demand for Byadagi Chilli for Oleoresin

While demand for chilli for use as oleoresin is heuristically relatively elastic, Byadagi chilli has a special place in the oleoresin economy, due to its special characteristics such as a high ASTA value of 150 to 200, low pungency, high color intensity with the GI granted. Thus, the demand for Byadagi chilli used for Oleoresin making theoretically has to be relatively inelastic.



The prima facie evidences for relatively inelastic demand for Byadagi are as under:

1. Byadagi in Haveri district houses the APMC with the second largest trading market turnover of around Rs. 700 crores (2014-15) compared with other varieties of chillies due to its demand both as a spice and for oleoresin. In addition the turnover of Byadagi APMC is increasing over time.
2. In Byadagi, there are currently 17 cold storages, all in private sector (largely by chilli traders) each with a capacity to store 1 lakh bags of 30 to 35 kgs each, implying storage capacity of

35000 quintals (or 3500 tonnes) of Byadagi chilli per year. In addition the number of cold storages to store Byadagi chilli is increasing year by year, due to increase in demand for cold storage. Also at least 50% of the storage space in cold storages, is used by Oleoresin processors.

3. The number of cold storages being built to store chilli are increasing over time in Byadagi and Bellary.
4. In addition to cold storages in Byadagi, there are 15 cold storages in Bellary for dry chillies⁸ for transporting chilli to the Byadagi market, depending upon the market price fluctuations, a function of the relative proportion of chilli used for culinary and oleoresin purposes.
5. The cold storage capacity is almost fully utilized due to relatively inelastic demand for Byadagi chilli for both culinary and oleoresin purposes.
6. According to a cold storage operator, there is virtually no space to store extra chilli in Byadagi. This impressive performance, in itself is a *prima facie* indicator of the potential for Byadagi chilli cultivation, production, cold storage and processing. Byadagi chilli received Geographical indication (tag 144) in Feb 2011. The quality of chilli is measured by the extractable red color pigment which is measured in ASTA (American Spice Trade Association) color units. Kaddi (for oleoresin) and Dabbi (for spice) are the popular Byadagi varieties of chilli. Currently Namdhari and Teja varieties are also ruling the market.

Since 1990s, due to spurt in the demand for oleoresin both in domestic market and in international market, Byadagi Chilli is also being cultivated / processed for oleoresin extraction used in the preparation of nail polish and lipsticks, cosmetics, medicinal purposes⁹. The demand for chilli for extraction of oleoresin has also attracted the private sector (traders of chillies) to establish cold storage units with 24 hour power supply generators, since chilli is usually stored for 6 months to one year before sale for any purpose. In cold storage units in Byadagi chilli pods are maintained at a low temperature of 4 to 6-degree Celsius to maintain the colour and purity. According to a trader, storing in cold storage units also increases the amount of oleoresin extracted from chilli by about 30–40%. However according to another trader, there will be a loss upto 10% due to cold storage. Hence, this aspect needs further study. According to an estimate, about 50 litres of oleoresin can be extracted from about 1 tonne of Byadagi chillies. Companies have been set up in and around Byadagi that are involved in the extraction of oleoresin. Chilli cultivation is also popular in Madhya Pradesh in the areas of Dhamnod, Kukshi. In Karnataka the cultivation of byadagi chilli has reached Hubli, Ron, Gadag, Samshi, Raichur, Sindhanoor.

Byadagi market attracts traders from all over Karnataka and from neighboring Andhra Pradesh because of favorable conditions for business like fair price, immediate payment and accurate measurement of the chillies. The recent uprise of sales of low-priced, more-pungent chilli varieties into the market have cause a dent in the price of Byadagi chillies as well. Byadagi chilli with its GI (Geographical Indication) is known as one of the best varieties of chilli and is also known as Kashmiri Chilli in other states and as paprika in other parts of the world. The unique characteristics of Byadgi chilli is its low pungency with high color value which is widely used for extraction of

⁸ [http://www.horticulture.kar.nic.in/Design final/Horticulture%20Services/LIST OF COLD STORAGES NAMES 11-12.pdf](http://www.horticulture.kar.nic.in/Design_final/Horticulture%20Services/LIST_OF_COLD_STORAGES_NAMES_11-12.pdf) for list of cold storages in Karnataka

⁹ <http://www.thehindubusinessline.com/economy/agri-business/karnataka-leads-drive-for-online-integration-of-farm-markets/article7146929.ece>

oleoresin, in manufacturing of spice blends and seasonings in cuisines. It is also used as a lead ingredient to manufacture poultry food products in foreign countries and also in food industry. It is named after the town of Byadgi which is located in the Haveri district of Karnataka. The business involving Byadgi chilli has the second largest turnover among all chilli varieties of India. Byadgi chilli is also known for its deep red colour, less spicy, with aromatic flavor and is used in many food preparations of India.

Oleoresin extracted from these chillies is used in the preparation of poultry feeds. It is widely used in food industry in foreign countries as food ingredient. Some part is used to manufacture cosmetics like nail polish and lipsticks. Due to this there is great demand for Byadgi Chilli in international market. The special character of this chilli is its unique flavor. This has its own perception in the mind of Indians. This flavor is different from any other chilli available in India which has the taste of pungent, sweet, and even has the Indian traditional taste.

Economics of Cold storages for storing High volume High value Bydadagi chillies

Chillies need to be stored as the crop is seasonal and the major production is from the rainy or kharif season and comes to market from December onwards. Obviously Chillies have to be stored for catering to its different needs throughout the year. Storing chilli in dry weather leads to loss of color, flavor and pungency. All the cold storages in Byadagi are constructed under private sector. The cost of storage is Rs. 100 per month per bag of chilli and will be charged for at least 6 months, even if the chilli is removed earlier. Cold storages are called A/C colloquially by the local traders in Byadagi. There are 18 cold storages in byadagi and each cold storage has capacity to store 1 lakh to 1.5 lakh bags = 35000 quintals (or 3500 tonnes). This year (2015) the Chilli crop in MP failed and hence the chilli prices increased in Byaadagi. There are cold storages in Bellary and other parts also. Chillies can be stored upto a maximum of one year in order to maintain the pungency and color.

In order to process Byadagi chilli for use as spice as ingredient in sambar powder, there are 30 grinding units and 17 cold storages all in private sector. The charges of cold storage vary with the user. Oleoresin companies keep 40000 to 50000 bags (1400 tonnes to 1750 tonnes) and are charged Rs. 20 per bag per month and are charged according to actual period of storage (since they store in bulk, and hence are offered discount). For all others, the charge is Rs. 80 to Rs. 100 per bag for six months and are charged for a minimum of 6 months, even if stored for a day or month. The peak season of storage is Dec to May (chilli season) and June to Nov is lean season. According to a cold storage operator, 60% of cold storage space has been used by oleoresin companies; 20% by farmers, 20% by merchants. For instance AV Thomas is oleoresin maker keeps 50000 bags for one year contract. The seeds left over after extraction of oleoresin are used for pain killer balms amrithanjan, vicks, also for pickels. Oleoresin makers pay Rs. 70 to Rs. 100 per kg of chilli and not beyond. In cold storage, 60% is the cost of expenditure involved in cold storage, 40% is the profit. The demand for cold storage in byadagi is ever increasing the 17 cold storage space does not suffice.

Economics of processing chilli to Oleoresin

In the survey, attempts were made to obtain the actual costs and returns from processing chilli to oleoresins. However, as this involves the physical and chemical processes, which may have been patented, it was difficult to assess the profitability. Following the aphorism “it is better to be roughly right than exactly wrong” of British Philosopher Carveth Read, the cost and return involved

is presented¹⁰. Considering 100 kgs of Byadagi chilli worth Rs. 8,000 (or Rs. 80 per kg), the oleoresin content ranges from 6% to 8%. Considering the conservative basis of 6% of chilli to be oleoresin, 6 kgs of oleoresin is extractable from 100 kgs of chilli. Oleoresin is priced at around (30 USD or) Rs. 1800 per kg. Thus, from 100 kgs of chilli, 6 kgs of oleoresin valued @Rs. 1800 per kg = Rs. 10,800 worth of oleoresin is extracted. In the process of making oleoresin, 40 kgs of seeds are obtained and are valued at Rs. 50 to Rs. 70 per kg. These seeds are used in manufacture of Namkeens, lipstick, chemical industries, medicinal pharmacies.

At a conservative price of Rs. 60 per kilo for seeds, the value of 40 kgs of seeds extracted is Rs. 2400. In addition to chilli, in the process of making oleoresin, 30 kgs of BOC are realized. Each kg of BOC is worth Rs. 15 per kg and is valued Rs. 450 per quintal of chilli. Thus, from each quintal of chilli worth Rs. 8000, 6 kgs of oleoresin worth (6 kgs X Rs. 1800 =) Rs. 10,800 + 40 kgs of chilli seeds valued at Rs. 60 per kg worth Rs. 2400 + 30 kgs of BOC valued at Rs. 15 per kg, worth Rs 450, totaling Rs. 13650 are obtained. Thus, in all from 100 kgs of dry chilli worth Rs. 8000, Rs. 10800 (of oleoresin) + Rs. 2400 (of seeds) + Rs. 450 (of BOC) = Rs. 13650 imply the value addition of (Rs. 13650 minus Rs. 8000) = Rs. 5650 or around 70 percent. The cost involved in these processes is around Rs. 2500 plus the raw material cost of Rs. 8000 per 100 kgs of chilli totaling Rs. 10500. Therefore the cost of processing 100 kgs of chilli to oleoresins is Rs. 10500, and the return is Rs. 13650. The profit from processing chilli to oleoresin value addition (oleoresin plus seeds plus BOC) is Rs. 3150 per quintal of chilli. Since 6 kgs of oleoresin are extracted from 100 kgs of chilli, the profit is Rs. 525 per kg of oleoresin.

ABS from Oleoresin

According to the Biological Diversity Act, 2002, a modest percentage of 0.1% to 0.5% of (the annual gross exfactory) sale of product is recommended as ABS. This works to ten to fifty paise out of Rs. 100. Considering the annual gross exfactory sale value of Rs. 13650 (from processing 100 kgs of chilli to 6 kgs of oleoresin), the ABS works to Rs. 13.65 which needs to be shared with the farmers by oleoresin processors by processing every quintal of Byadagi chilli. The actual gross return is a function of the percentage of oleoresin which varies from 6 to 10 percent. The demand for oleoresin is increasing domestically. For instance, Delhi metropolitan alone demands around 100 tonnes of oleoresin per month, which translates to 1666 tonnes of chillies creating a substantive demand.

Six challenges for Byadagi chilli and oleoresin processing

Challenge 1: Monoculture of chilli

Due to relatively high profitability of chilli, farmers resort to continuous cropping avoiding crop rotation. This leads to susceptibility to attack by Murda leaf curl disease, termed as Murda complex due to combination of action by Thrips, Mites and Viruses. Extension efforts are required to educate farmers regarding monocropping of chilli, crop rotation and organic farming methods, including biological control of the virus as reported by Pandey, Mathur and Srivastava¹¹ (Table 1)

¹⁰ We are thankful to Sri Mallikarjun Kenvi, Chilli trader, grinder and owner of cold storage in Byadgi for this estimate.

¹¹ SK Pandey, AC Mathur and M Srivastava, Management of leaf curl disease of chilli (*Capsicum annum* L), 2010, International Journal of Virology, Vol 6, No.4, pp. 246-250.

Table 1: Effect of plant seed extracts on the incidence of chilli leaf curl disease

Name of plant seed extracts	Conc. (%)	Percent mean	
		Disease incidence	Reduction in disease incidence in comparison to untreated check*
Neem seed kernel extract	5	27.78 (31.81)	60.00 (50.77)
Tumba seed extract	5	33.33 (35.26)	52.00 (46.15)
Karanj seed extract	5	36.11 (36.94)	48.00 (43.85)
Untreated check	--	69.44 (56.44)	0.00 (0.00)
SEm±		1.18	0.91
CD at 5%		3.76	2.91

*Average of four replications. Values in parentheses are angular transformed values

Challenge 2: Increasing incidence of Murda Leaf Curl Disease thereby depleting area under chilli in traditional areas of Haveri, Dharwar districts

The Murda leaf curl disease has intensified in conventional areas of Byadagi chilli thereby reducing the area under chilli substantially in Karnataka (Figs 4,5,6 above). The chili leaf curl complex (Murda complex) is caused by leaf curl gemini virus (CLCV) transmitted by chilli mite (*Polyphagotarsonemus latus*), whitefly (*Bemisia tabaci*) and thrips (*Scirtothrips dorsalis*) and the control measures are complicated as more than one agent is involved in causing and spreading the disease. The following pictures¹² indicate the different aspects of Murda leaf curl virus.

¹² K Madhavi Reddy, Strategy to breed hot pepper for Chilli leaf curl and tospovirus resistance, Indian Institute of Horticultural Research Bangalore-560089. Pictures are from the power point presentation of K Madhavi Reddy.



The area under chilli and the associated production are under threat in Karnataka, due to lack of suitable varieties which are tolerant / resistant to Murda leaf curl disease. A survey of Haveri, Dharwad, Belgaum and Gadag districts indicated¹³ that Haveri district has the maximum average disease incidence (of 45.86%) followed by Dharwad (39.36%), Belgaum (31.68%) and Gadag (30.81%). Obviously the area under chilli in Haveri and Dharwad districts has been considerably affected. Unless

Challenge 3: Climate change is exacerbating population of insect vectors and their distribution

Challenge 4: Pesticide resistance

Challenge 5: Absence of varieties tolerant / resistant to Murda Leaf Curl Disease of Chilli

Improved varieties are the need of the hour which are tolerant / resistant to Murda leaf curl disease and resistant to leaf sucking pests such as thrips and mites are the need of the hour. Byadagi area is

¹³ Manyam Pradeep, AS Byadgi, Status of Chilli *Murda* Disease in Northern Karnataka and Its Management, Trends in Biosciences, Vol 6, No. 6, 2013.

<http://www.indianjournals.com/ijor.aspx?target=ijor:tbs&volume=6&issue=6&article=020>

already devoid of chilli due to Murda leaf curl disease incidence which reduced the profitability of chilli cultivation. It is desirable to develop varieties with thick and long fruit size.

Challenge 6: Mechanization for harvesting chilli

Since labor for cultivation of chilli is prohibitive, mechanical harvesting is the need of the hour and vastly reduces the labor cost of harvesting since picking is frequent. Thus, harvesting machinery needs to be developed to reduce the cost of harvesting chilli. China is a competitor for India in exports as well as in oleoresin processing. The prima facie indicator of China's competition is that Synthite, the major oleoresin producer of India has already opened its factory in China¹⁴ to process chilli to oleoresin, since the chilli is available at a lower cost than in India.

Challenge 7: Maintenance of proper level of Aflatoxin in Chilli

Aflatoxin content in chilli has to be below 10 PPB for exports. Any consignment with aflatoxin more than 10 PPB, will be rejected by the importing countries.

Phenomenal rise in the price of Byadagi chilli

During the survey, while discussing with aged farmers, it was reported that in 1963 price of Byadagi chilli was Rs. 150 per quintal. And in 2015 price is Rs. 10000 per quintal. Therefore the growth in the price works to 8.41 percent, a phenomenal rise in the price. With the peduncle removed, the price of Byadagi chili is Rs. 12500 per quintal. There are three major areas of chilli cultivated in India, namely Madhya Pradesh, Guntur and Byadagi.

Efforts towards contract farming

In order that farmers get an assured price and that the contracting company gets quality produce, the Synthite company did contract farming experiment in 1980s. However farmers did not cooperate and due to moral hazard, the company halted its contract farming operations.

End use pricing

Often price is being dictated by the end use. Chilli can be put largely to spice and oleoresin. Oleoresin manufactures usually buy chilli at Rs. 9000 per quintal, but will not buy at Rs. 12000 to 13000 per quintal. The higher price is offered by those who choose to convert chilli to spice. The major buyers are MDH, MTR, Mayya, Everest, who buy for 12000 to 13000 per quintal for spice purpose. It was reported that Ralleigh variety, Theja¹⁵ variety from Khammam, Andhra Pradesh with high pungency command high prices. Other varieties are Kaddi, Dabbi, Guntur, Local (or byadagi), DB, Namdhari traded in Byadagi market. After 1990, oleoresin industry picked up the market and increased the economic and export potential of farmers cultivating Chilli. .

Pepper Spray and Chinese venture

The Pepper Spray the essential component of which is the Oleoresin is extracted from Teja variety of chilli grown in Khammam extensively. Considering the popularity of Teja variety for its by-products , a Chinese company has set up unit in Mudigonda mandal for extraction of Oleoresin and

¹⁴ <http://www.synthite.com/synthite/our-people/synthite-speak>

¹⁵ <http://www.thehindu.com/todays-paper/tp-national/tp-andhrapradesh/teja-selling-like-hot-flakes/article6184138.ece>

export. Khammam with black soil and fertile lands is the leading producer of chilli followed by Warangal. Teja variety with striking red colour and pungency, is widely grown here

Summary and conclusion

The Karnataka Biodiversity Act stipulates that commercial utilization of biological resources which leads to incomes by processors, need to be shared with those who are responsible for generation of the resource. Else the processors would not be assured of appropriate supplies and this mutually affects production and processing. In this study, the economics of processing Byadagi chilli into oleoresins has been considered, since Oleoresins are characterized as commercial utilization of Byadagi chilli.

The Biological Diversity Act, 2002, prescribes a modest percentage of 0.1% to 0.5% of (the annual gross exfactory) sale of product as access and benefit sharing. The annual gross exfactory sale value obtained by processing 100 kgs of chilli to 6 kgs of oleoresin is Rs. 13650. Accordingly the ABS works to 0.1% of Rs. 13650, equal to Rs. 13.65. This needs to be shared with the farmers by oleoresin processors.

The study highlights the challenges in maintaining a sustainable supply of Byadagi chilli in Karnataka such as evolving a tolerant / resistant variety for Murda leaf curl virus disease. The challenges of avoiding monocropping, pesticide resistance, adopting organic control methods are also discussed.

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Pic : 1 and 2: Byadagi area with cotton and maize as dominant cropping pattern, replacing Chilli



Pic : 3 and 4: Income inequality despite Byadagi market influence handling high value chilli crop



Pic: 5 and 6: Byadagi with ideal banking and marketing infrastructure for chilli trade



Pic : 6 and 7: Chilli for drying in Byadagi market area with tarpaulin facility in the wake of rain



Pic: 7 and 8: Coding / Numbering of chilli in storage, transportation in Byadagi market



Pic: 9 and 10: Largely women labor involved by traders in removing peduncle from Byadagi chilli



Pic: 11 and 12: Modest facility for women labor removing peduncle in Byadagi market yard



Pic: 13 and 14: Removal of peduncle from chilli meticulously by women labor in Byadagi



Pic : 15 and 16: Removed peduncle of chilli to be used for cattle feed in Byadagi



Pic: 17 and 18: Drying yard facilities for drying of purchased chilli in Byadagi



Pic: 19 and 20: Transport facility for Byadagi chilli in market yard and discussion with traders



Pic: 21 and 22: In the home of an honest Village panchayath chairman in Byadagi



Pic: 23 and 24: Supply of potable water in Byadagi Chilli market area



Pic: 25 and 26: Byadagi APMC since 1948, one of the oldest, largest APMCs in terms of value traded



Pic: 27 and 28: Shift to vegetable seed production Byadagi due to Chilli Murda leaf curl menace



Pic 29 and 30: Chilli crop affected by Murda Leaf Curl Disease in Byadagi area



Pic 30 and 31: Farmer showing the Murda leaf curl disease affected plant and the crop



Pic 31 and 32: APMC Byadagi with well laid out market yard for Byadagi chilli



Pic 33 and 34: Byadagi chilli market yard with facilities to bag, store and sell



Pic 34 and 35: Byadagi cold storage demonstrating quality infrastructure



Pic 36 and 37: Discussion with chilli trader in Byadagi, Detailed itemized receipt in trading



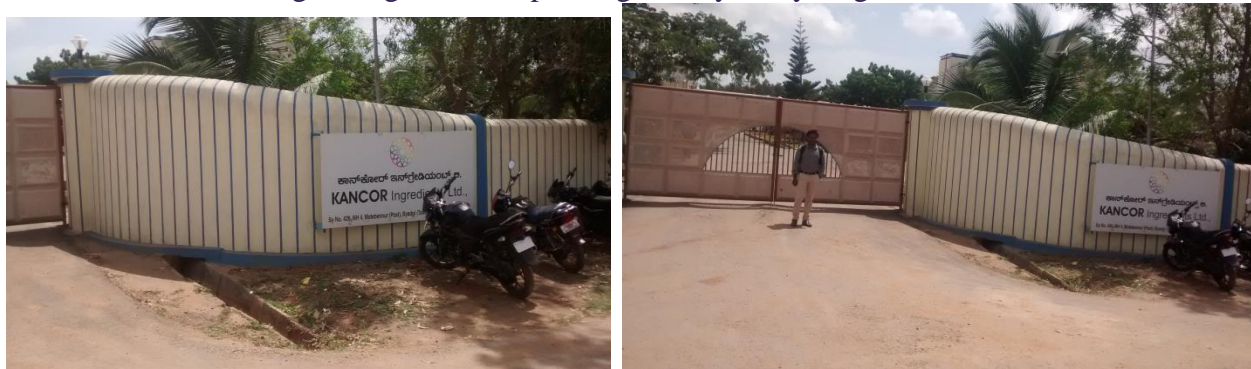
Pic: 38: Mammoth grinding unit for chilli in Byadagi



Pic 39 and 40: Chilli grinding unit in Byadagi with workers processing chilli for use as spice



Pic: 41 and 42; Chilli grinding unit with packing facility in Byadagi



Pic: 43 and 44: Chilli oleoresin processing unit in Byadagi



Pic 45 and 46: Cold storage in Byadagi for storing Chilli, chilli seeds, chilli powder



Pic 47 and 48: Cold storage in Byadagi with efficient space utilization



Pic 49 and 50: Inner view of Byadagi cold storage, with poor facilities

Year	Area (000 Ha)	Productivity (KG/ HA)	Production (000 Tonnes)
1973-74	106.50	356	37.90
1974-75	105.60	348	36.80
1975-76	118.90	324	38.50
1976-77	121.20	241	29.20
1977-78	138.00	316	43.60
1978-79	145.00	310	45.00
1979-80	153.60	311	47.80
1980-81	153.80	315	48.50
1981-82	154.30	308	47.40
1982-83	155.70	312	48.60
1983-84	149.50	311	46.50
1984-85	136.80	304	41.60
1985-86	148.90	297	44.20
1986-87	143.10	296	42.40
1987-88	126.60	297	37.60
1988-89	142.20	298	42.30
1989-90	151.60	287	43.50
1990-91	128.70	285	36.70
1991-92	136.60	287	39.20
1992-93	161.40	609	98.30
1993-94	201.10	548	110.30
1994-95	167.90	604	101.50
1995-96	188.50	574	108.10
1996-97	200.80	803	161.20
1997-98	163.60	800	130.80
1998-99	170.30	860	146.50
1999-00	176.70	890	157.20
2000-01	172.90	874	151.00
2001-02	193.10	655	126.40
2002-03	155.50	987	153.40
2003-04	69.88	1352	94.50
2004-05	152.32	687	104.58
2005-06	125.67	850	106.81
2006-07	132.52	1032	129.95
2007-08	136.70	1092	141.79
2008-09	122.31	1162	135.04

2009-10	138.71	1048	138.15
2010-11	113.87	1136	122.87
2011-12	100.42	1116	106.50
2012-13	61.77	1297	76.14