Market awareness and profitability: case study of Mango production in Karnataka, India

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Abstract: *This article presents a case study of mango farmers in the Kolar district of Karnataka to understand the determinants of profitability and constraints faced by the horticulture industry in India in general. The mango value chain is analysed in-depth to understand the market choices of farmers and the role of market intermediaries and is based on data collected from a primary survey of 131 farmers. The study uses an instrumental variable approach to model the profitability of farmers as a function of market awareness, distance from markets, farming practices, and control variables. It finds that in addition to age and education, distance to markets and farming practices are significant factors influencing the profitability of mango cultivators.*

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Agriculture is the predominant source of livelihood in South Asian countries, with the sectoral share of agriculture in the gross domestic product (GDP) ranging from 19% (India) to 39% (Nepal). These countries face numerous challenges in the form of small land size holdings, decreasing investment in agriculture, environmental degradation, and the increasing globalisation of agriculture, resulting in cheap imports which threaten the livelihoods of several farmers. As a result, there is an increasing trend towards crop diversification in South Asia in favour of high value-added horticultural commodities, livestock, and fish products. Horticulture not only has a high employment potential but can also contribute to the export revenues.[1]

In India, the annual rate of growth of net value added of agro-industries at constant prices increased from 5.15% during the pre-reform period (1985–1990) to 8.3% during the post-reform period (1991–96) (Gandhi et al 2001). With the launch of the National Horticulture Mission by the central government in 2005–06, there was a spurt in area and production of fruits and vegetables from 11.8 million hectares in 2004-05 to 16 million hectares in 2015-16 (Horticulture Statistics, Government of India, 2017) . However, despite these developments, the horticulture sector has not performed well in export markets and the share of fruits and vegetables in total exports has fallen steadily from 28 percent in 2009-10 to 14 percent in 2015-16 (APEDA, 2017).The reasons cited included lack of infrastructure and the presence of intermediaries among others. At the same time, the initial thrust on horticulture and the various subsidies to promote the industry, resulted in the excessive use of chemical fertilisers and pesticides and exploitation of water resources through indiscriminate digging of borewells, jeopardising the sustainability of the eco-system and farmer livelihoods in many regions.

There is lack of systematic evidence about the impact of government policies on different types of farmers engaged in horticulture. Case-based and anecdotal evidence is inconclusive with respect to the success or failure of these policies in regard to increasing the growth rate of exports or improving farmer livelihoods. This article presents a case study of mango farmers in the Kolar district of Karnataka to understand the determinants of profitability at the farm level and constraints faced by the horticulture

industry in India in general. The Kolar district has the highest share of mango production in Karnataka and has also faced a water crisis in recent years.

Section I gives a background of the study, followed by section II which describes the marketing channels available for mango. Section III presents the literature review on the determinants of profitability. Section IV discusses the data and methodology, followed by results and policy implications in section V. The findings are important from a policy perspective

I. The Background

It is a well-known fact that India is the largest producer of mango in the world (40%), followed by China and Thailand. In 2012–13, the area under mango cultivation accounted for 36% of the total area under fruit production, and the quantity produced was about 22.1% of the total fruit production of India. Although India is the top producer of mangoes in the world, its productivity is very low because of post-harvest losses, poor infrastructure, and size of orchards among other reasons (Banerjee 2011). Further, its share in the export of mangoes or processed mango products is comparatively low and it ranks fifth globally in the export of mangoes. The export of mango pulp on the other hand is almost three times that of export of fresh fruits from India. While the mango production has increased in absolute terms, the sector is facing constraints with respect to not only domestic production but exports as well since 2009–10. Table 1 indicates the falling area under mango cultivation as well as its falling share in the total fruit production (Table 1).

Table 1: Mango Production in India

Year	Area (1,000 Ha)	% of fruit total area	Production (1,000 MT)	% of total fruit production	Productivity (Production/Ha)
2002–03	1,623.4	42.9	12,733	28.2	7.8
2003–04	1,906.7	39.8	11,490	25.2	6.0
2004–05	1,970	39.7	11,830	24.0	6.0
2005–06	2,080.7	39.1	12,663	22.9	6.1

2006–07	2,153.7	39.1	13,734	23.1	6.4
2007–08	2,201.0	37.6	13,997	21.3	6.4
2008–09	2,309.0	37.8	12,750	18.6	5.5
2009–10	2,312.3	36.5	15,027	21.0	6.5
2010–11	2,297.0	36.0	15,188	20.3	6.6
2011–12	2,378.1	35.3	16,196	21.2	6.8
2012–13	2,500	35.8	18,002	22.1	7.2
2013–14	2,516	34.3	18,431	20.7	7.3
2014–15	2,163	34.7	18,527	20.7	8.5
2015-16	2209	35.1	18643	20.7	8.4
2016-17	2263	34.9	19687	21.2	8.7

Source: Indian Horticulture Database 2009, Handbook on Horticulture Statistics 2014, Horticulture Statistics at a Glance 2017, Government of India.

The lack of profitable marketing opportunities is one among the several constraints faced by farmers. Specifically, the marketing channels for small and medium farmers are circumscribed by credit relations, high transaction costs, and lack of transparency in price fixation. To support the cultivation of traditional crops and cash crops like soybean, technology has been introduced and information dissemination systems like e-choupals have been established. This has made the farmers more aware, resulting in competitive prices and profitable business opportunities (Goyal 2010). Despite these developments, the majority of small and medium farmers continue to be heavily dependent on wholesale agents and traders for market information and credit facilities, which binds them in an informal contractual relationship with the latter (Saripalle 2016).

The traditional agricultural wholesale markets in developing countries are dominated by wholesale agents/contractors who not only minimise marketing risks by aggregating the agro-products but also are the sole financiers for small farmers, helping them meet input and irrigation costs. Section 2 discusses in detail the marketing channels available for the mango farmers in Kolar district.

An important reason for the declining productivity (production per hectare) of the mango crop, (at least until 2011–12) has been the high cost of irrigation and declining water tables in many agricultural regions. As mango is grown during summer, farmers have to rely on good irrigation methods for

improving fruit yield despite the fact that it is not a water-intensive crop. This has increased the pressure on water resources, resulting in declining water tables. Hence, the role of declining water tables needs to be addressed with a sense of urgency by introducing water saving techniques. A randomised experiment (Spreer et al 2009) on the impact of water-saving techniques on mango yields in Thailand found that during the dry season the trees that were irrigated using water-saving techniques showed greater yield as compared to other trees.

India has also not been able to export mangoes successfully because of the lack of infrastructure for complying with food safety standards. Among the top export destinations, the United Arab Emirates (UAE) imports almost 69% to 70% of India's total fresh mango exports. However, exports have been falling since 2011–12 because of both political uncertainties in the UAE as well as compliance issues (Table 2).

Table 2: Export of Fresh Mangoes from India

	Quantity (MT)	Value (₹ Lakhs)
2010–11	58,863	16,484
2011–12	63,441	20,974
2012–13	55,585	26,472
2013–14	41,280	28,543
2014–15	42,998	30,254
2015–16	36,329	31,710
2016–17	53,177	44,555

Source: GOI 2014; GOI 2017

A major reason for the decline of mango exports since 2011–12 is the pesticide residue and presence of fruit fly infestation, which has resulted in the ban of Indian mangoes in the United States, European, and Japanese markets (Jha 2016; Goyal et al 2017). Japan had placed an embargo on the import of mangoes from India in 1986, and the ban was only lifted in 2003 once the Vapor Heat Treatment (VHT) facilities to sterilise the fruit were in place (*Business Standard* 2013). The related infrastructure pertaining to

washing, drying, pallet, pre-cooling and cold storage facilities are currently available only in Mumbai and have been sponsored by the Maharashtra State Agricultural Marketing Board.

Another reason behind the low demand for Alphonso mangoes is the colour and appearance which do not compare well with mangoes from Israel and Latin America (Hegde 2006). In India, the mango production is the highest in the state of Uttar Pradesh followed by Andhra Pradesh and Karnataka. This paper analyses the case of Karnataka's mango growers, specifically their profitability, the costs they incur, and their market choices. It tries to understand the role of market intermediaries and the credit relationship between the farmers and wholesale agents in the state.

The Kolar district of Karnataka has the highest share of mango production in the state (Table 3). Within the Kolar district, Srinivasapura taluk has the highest share of mango production (50%), and is known for its mangoes in the entire state. In terms of exports to countries such as the US and Europe, Uttar Pradesh, Maharashtra and Andhra Pradesh have a higher share in exports of mangoes as compared to Karnataka, where mangoes are mostly supplied to the fruit processing industry.

Kolar is a relatively dry area, categorised under the Agro climatic zone 10.[2] The increasing dependence on rainwater for irrigation and the government incentives for the horticulture sector encouraged farmers to switch to mango cultivation post 2004–05 (Mittal 2007; Kumar 2012). The subsidies for investment in irrigation also resulted in the construction of a number of borewells in the region. The district now has the highest concentration of deep borewells, resulting in over exploitation of water, with zero water available for groundwater irrigation (Nagaraj et al 2011). In addition, the water table has also declined because of eucalyptus plantations.[3] Hence, with a rapid decrease in the water table, the production per hectare of mango in the Kolar district has fallen drastically since 2011–12 (Table 3).

Table 3: Area and Production of Mango in Karnataka[4]

	Kolar district			Karnataka State		
Year	Area (hectares)	Production (tonnes)	Production per	Area (hectares)	Production (tonnes)	Production per hectare

			hectare			
2005–06	45,587	1,68,034	3.7	1,181,58	4,50,688	3.8
2006–07	41,868	1,68,519	4.0	1,16,780	6,09,383	5.2
2007–08	32,280	58,556	1.8	1,08,774	3,58,560	3.3
2008-09	32,831	1,09,360	3.3	1,14,972	4,85,384	4.2
2009–10	33,131	1,36,135	4.1	1,20,018	5,10,407	4.3
2010–11	40,769	1,81,218	4.4	1,37,197	6,65,012	4.8
2011–12	41,570	2,19,032	5.3	1,42,546	7,98,290	5.6
2012–13	42,170	1,71,927	4.1	1,44,753	7,61,893	5.3
2013–14	45,000	2,00,000	4.4	1,60,000	8,00,000	5.0

Source: Directorate of Economics and Statistics, Karnataka 2013

The harvesting of mangoes starts in the first week of May and lasts until the end of June or the first week of July. During the first week of May, Alphonso is harvested and mostly sold to juice and pulp manufacturing companies. From 25 May onwards, more popular varieties like Banganapalli come into the market and are exported to all states in the country. Mangoes are also sold to agents from other states in India or to agents from markets located in West Asia. In the first week of June, Totapuri and Neelam are harvested and together comprise around 70% of all mangoes produced in Karnataka. The green varieties are sold to pulp manufacturing units, while the more ripe varieties are sold across India. There are many local varieties which are sold in the domestic market within the state. The largest proportion of farmers was found to be growing Totapuri, followed by Neelam and Badami/Alphonso. In terms of price, Badami fetches the highest rate followed by Banganapalli and Mallika (Table 4). The next section describes the various marketing channels available to the farmers.

Table 4: Mango Varieties and Prices

Name of Mango Variety	Number of farmers growing these varieties	Price/quintal (INR Rupees)
Malika	27	2,500
Badami/Alphonso	76	3,000
Banisha	67	2,000
Totapuri	117	1,300
Nelam	92	1,300
Rasapuri	6	2,000
Rajgira	47	900
Khurdoos	5	900
Banganapalli	3	2,500
Mulgova	6	1,200
Sindoora	1	800
Kalapad	2	500
Laddu	1	500
Amleta	1	500

Source: Generated by the author using data collected from the field survey.

II. Marketing Channels

In Srinivasapura, within a radius of 200 kilometres, there are 18 retail marketing centers, bordering the states of Andhra Pradesh and Tamil Nadu. The farmers in the region sell their produce through three predominant marketing channels: they sell at the farmgate to the pre-harvest contractor; they sell at the village Agricultural Produce Marketing Commission (APMC) yard; or they sell directly in city retail markets or government authorised wholesale centers such as the Horticultural Producers' Co-operative Marketing and Processing Society (HOPCOMS)[5] and Safal. The value chain is illustrated in Figure 1, where the yellow arrows depict the credit relations circumscribing the value chain.

A majority of farmers (60%) sell their produce at the farm gate to the pre-harvest contractors, who in most cases are also the wholesale agents at the APMC yard, under a mutually agreed contract. The contract is verbal in a majority of cases. The contractors visit the farm during the post-flowering period and evaluate the farm. Based on their evaluation, an amount is decided and payment is made in full. The cost of transportation is borne by the farmers. From the primary data collected, it can be seen that the pre-harvest contractor is the most common market agent of the region (Table 5). The table also shows the average revenues and profits of farmers for each marketing channel.

Table 5: Distribution of Farmers by Marketing Channels

Market	Percent	Average Revenue per acre	Average profit per acre
Farm gate/Pre-harvest contractor	52	31,452	14,838
APMC	32	25,476	-790
Village market	12	30,585	9370
City Market	4	23,051	-17260
Total	100		

Source: Generated by the author using data collected from the field survey.

The second marketing channel is the nearest APMC yard, which is situated at Srinivasapura. Generally, mangoes are supposed to be sold on an auction basis here. But this kind of auction system rarely exists. The prices are fixed by wholesale agents operating in the yard, with farmers lacking any power to negotiate them. For small farmers, the volume produced usually is below the minimum quantity required by corporate buyers. Hence, they are forced to sell at the APMC yard at a fixed rate. The farmers from nearby villages travel to the market yard to sell their produce. In many cases, the farmer sells it to the wholesale agent or the pre-harvest contractor, who pays the farmer in advance after deducting a 10% commission. All the costs related to activities like grading, transportation, packing and storage are borne by the contractors. The wholesale commission agents have tie-ups with agro-processing units like Mother

India farms, Pepsi and Dabur, which are located in Andhra Pradesh. These agro-processing units are not located in Karnataka because of the wet and humid climate in April, which is not conducive for pulp production.

According to the Agricultural Produce Marketing Committee Act, 1960 (APMC Act), the entire state is divided into smaller geographical areas or markets that are managed by marketing committees constituted by the state government. Under the Act, farmers are prohibited from selling their produce directly to consumers and have to sell to authorised middlemen so that they can get a fair and consistent price for their produce. As per the APMC Act, agricultural produce has to be brought to the marketing yards set up by the government, and licensed wholesale marketing agents should auction the produce to the traders or retail agents from nearby regions or other states.

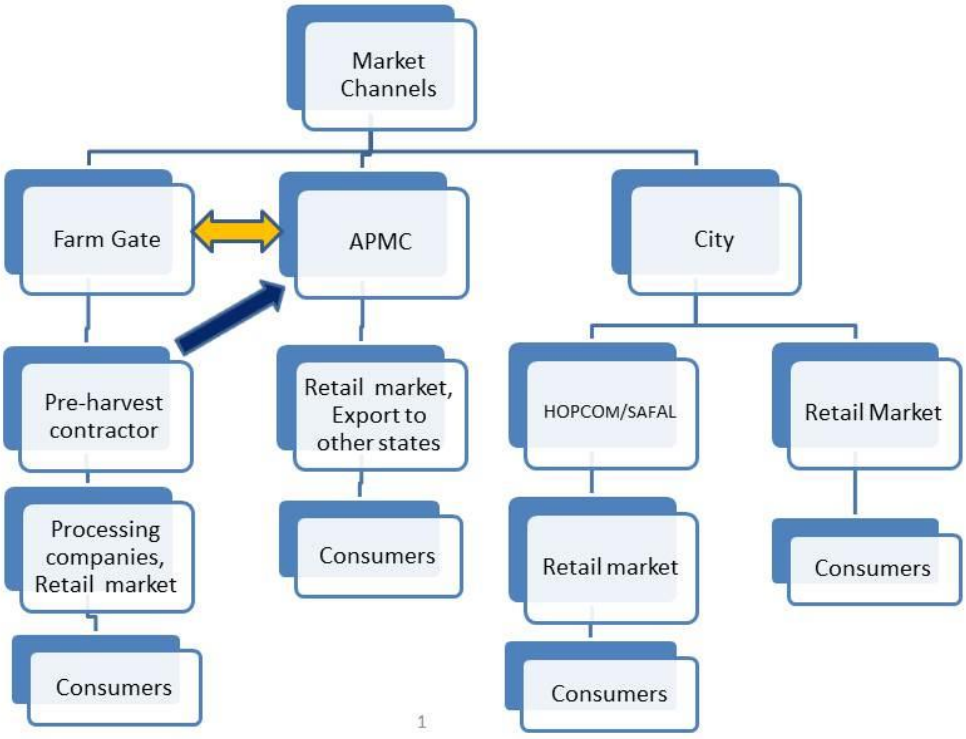
However, this system has been misused by the wholesale marketing agents who collude with the traders and fix prices overnight (*Deccan Herald* 2010). During the field survey interviews, many of the farmers reported that the pricing of mangoes was not transparent and there was collusion among the traders and wholesale agents and preharvest contractors. Most often, farmers were indebted to the village wholesale traders and pre-harvest contractors, who gave them money to buy seeds and fertilisers and then buy back their produce after deducting the market commission.

Further, s during the interviews it was reported by some farmers that that some big farmers also lent to the wholesale agents and indirectly got access to the APMC yard without having proper license, implying that there could also be informal credit linkages between the wholesale agents and a few big farmers. In Figure 1, the two-way arrow depicts the credit relationship that exists among the farmers and the APMC wholesale agents.

The third marketing channel used by farmers is the city market. In the city market, farmers can sell to retail agents or to government authorised wholesale markets—HOPCOMS and Safal. Mangoes are sold to processing units like Safal,[6] a government initiative to set up a terminal wholesale market, which works

on the principle of clock auction with backward and forward linkages in the supply chain. It buys fruits from the farm gate and brings it to its collection centre from where these are transported to the company. Since SAFAL procures only produce which complies with certain grade standards, the farmers are forced to partly depend on commission agents or village merchants to lift their remaining produce. Some farmers go to the city market directly and sell their mangoes to government approved markets known as HOPCOMS.

Figure 1: Mango Value Chain



Source: Generated by the author using data collected from the field survey.

The farmers who want to directly sell to exporters have to obtain a GlobalG.A.P certification.[7] The produced mangoes are graded, and only about 50% of Grade A is exported. The survey conducted in this study did not have any such farmers in the sample. In the survey, mangoes were mostly exported to other

cities and states such as Delhi and Rajasthan.. Having analysed the Mango value chain, the paper next discusses some of the important factors that influence farm profitability including socio-economic factors, the choice of market channels and dependence on pre-harvest contractor in the value chain.

III. Determinants of Profitability

Socio-economic characteristics such as education, land size, age, and membership in organisations are important determinants of farm profitability. A recent study in Meerut found that floriculture adoption (commercial tuberose cultivation) is highly correlated with education, mass media exposure, land holding, and social participation (Singh et al 2010). However, it has been found that in rural areas participation in social networks through non-governmental organisations (NGOs), farmers organisations or industry associations in the food sector is limited (Mahendra and Rao 2005). Infrastructural constraints, lack of storage and post-harvest facilities, and weak labour legislation laws are major impediments to improve crop yields and profitability. A study on grape farmers in Chile (Collins 1995) found that small farms in the Sao Francisco Valley could produce grapes at a much lesser cost than large farms because of the use of family labour. However, their market access was limited because of the lack of post-harvest facilities and marketing costs.

Access to high value markets (non-local and export markets) is an important determinant of higher returns. A study (Roy et al 2008) on Mahagrapes, a co-operative partnership firm, finds that farmers who exported their produce had higher returns compared to those did not. A combination of collective action and public private partnerships resulted in the cooperative (Mahagrapes) to export successfully. The study also finds that some of the important factors influencing the decision to become a member of the cooperative were farmers' education, age, distance from a city, and transaction costs of inputs not provided by the cooperative.

Rural peasants in developing economies are dependent on the wholesale agent for marketing and never go beyond the nearest market. Therefore, a prerequisite to market access is market awareness which is an important factor that can influence the participation in export markets. In the context of floriculture, it was found that the commercial success of floriculture depended on the entrepreneurial ability of the small farmers, that is the ability to identify and access distant but high value markets (Prakash and Bahadur 2005). This in turn depends on education, participation in cooperatives and other organisations, and availability of labour and irrigation facilities (Echeverría et al 2009). Education enhances agricultural production mainly by influencing farmers' decision-making ability and, less importantly, enhancing their technical capability in both traditional and modernised agriculture environments (Pudasini 1983).

In the present study, given the lack of a direct connection between farmers and markets, it was not possible to infer whether their produce was being exported or not. Farmers, as producers, are only interested in the cultivation of the crop and not interested in the final destination of their produce. A majority of mango farmers still rely on intermediary wholesale agents/contractors for marketing their produce. Market awareness was captured by asking the farmers if they were aware of the final destination and whether the mangoes they produce were sent to other states in India as well as exported to other countries. The mangoes are sent to other states in India, where these are further processed and then exported to countries in the Middle East.

IV. Data and Empirical Modeling

This section describes the data and empirical modeling strategy in detail. The study uses primary data from a survey of 131 farmers in Srinivasapura, Kolar district in Karnataka, conducted during 2014. The farmers were chosen from a random sample of 11 villages. A majority of farmers in the area were small and medium farmers who sold their produce locally or to the processing companies through agents. To obtain a list of farmers who sent their mangoes to other states in India or to other countries, information was collected from one of the biggest wholesale agent who could identify some of the big farmers who were following good farming practices. Table 6 shows that the average size of landholding was 12 acres

and production increased with the size of the landholding. However, sales do not show such a linear relationship with landholding.

It was found that 36% of the farmers were either illiterate or had just gone to primary school, 45% were educated up to the secondary level, and the remaining 19% had a college degree. The average family size was seven members, with most of the male members being involved in mango cultivation. Their years of experience in mango cultivation ranged from five to seventy, the latter indicating the involvement of previous generations of family members. The revenue from the crop depended on the type of mango varieties grown (ranging from three to nine varieties), dependence on other vegetables, and the choice of market and ranged from ₹2,00,000 to ₹40,00,000 per season (Table 7). Figure 2 shows the distribution of land holdings in the sample, where majority of farmers are small with less than five acres of land.

Table 6: Acreage and Production Details

Village	Average area (Acres)	Average income from sale of mangoes (₹)	Average production in quintals
Gathahalli	5	63,750	127
Hodali	6	1,59,333	139
Kallur	6	1,38,263	127
Chiruvarahalli	8	42,000	127
Dalasanuru	8	1,34,455	156
Chillapanahalli	9	1,24,900	107
Kiruvara	11	2,24,000	206
Hoovahalli	15	2,15,500	153
Palya	18	1,24,000	164
Settihalli	22	3,51,364	287
Arahalli	26	1,87,556	225

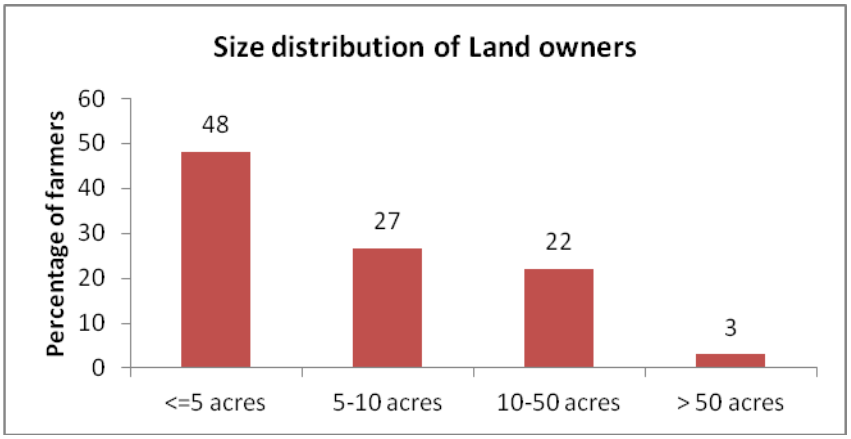
Source: Generated by the author using data collected from the field survey.

Table 7: Sample Characteristics

Variable	Obs	Mean	Standard Deviation	Min	Max
Age	131	50	14	24	86
Family members	131	7	5	2	42
Persons in farming	130	3	3	1	30
Years of Experience	130	22	13	5	70
Revenue from Mango (₹)	131	2,61,276	4,25,812	2,600	40,50,000
Illiterate (count)	131	20			
Primary education (count)	131	28			
SSLC (count)	131	59			
Grad (count)	131	24			
Total Area	131	11	16	1	110
Varieties	131	3	1	1	9
Production in quintals	131	163	202	1	1,400
Quantity sold	131	159	202	1	1,400

Source: Generated by the author using data collected from the field survey.

Figure 2: Size Distribution of Farmers Surveyed



Source: Generated by the author using data collected from the field survey.

The farmers were classified on the basis of their market awareness, defined as the knowledge of markets outside the state, including export markets. Interestingly, of the 130 odd farmers only 29 knew about the destination of their produce, while the rest of them were only interested in selling their produce to the contractor. The level of education, average size of land holding, costs and profits were all higher among

the more aware farmers (Table 8). The farmers with better awareness also followed better irrigation practices compared to the less aware farmers. However, the amount of money lent under contract by the agent was marginally higher for farmers who were less aware of other markets.

Table 8: Differences in Age, Education, Costs and Farming Practices Among Two Groups

	Aware of non-local and export markets	Not aware of other markets
Age (average)	46	51
Experience in years (average)	24	21
Illiterate %	3%	19%
Primary %	7%	25%
SSLC%	59%	41%
Grad%	31%	15%
Area (average acres)	18	10
Fixed cost per acre (₹)	3,526	5,127
Variable cost per acre (₹)	23,929	19,940
Profits per acre (₹)	10,443	7,220
Transport cost (₹)	1,800	891
Money Borrowed (₹)	80,138	82,748
Sell to Pre-harvest contractor	12	71
Sell to APMC	12	30
Sell directly in City market	2	3
Irrigation_per month	6	4
Manure	2	3
Pesticides	1	2
Varieties (average)	4	3

Source: Generated by the author using data collected from the field survey.

The study analyses the determinants of profitability per acre as a function of market awareness and farmer specific control variables. The differences between the two groups of farmers could either be because the farmers self-select themselves (assuming they are picked from a random sample with similar attributes) or because of some unobservable characteristics that are influencing their awareness about export markets. Market awareness is thus an endogenous variable, which is in turn is dependent upon factors such as distance from markets, education, and years of experience.

The standard OLS (ordinary least squares) estimation will not be able to capture the endogeneity of the export variable and this technique will result in omitted variable bias. To address the endogeneity of the explanatory variable, one can use selection models or instrumental variable model. Heckman type corrections are typically used when you have a truncated variable. Instrumental Variable Least Square regression (IVLS) is used in case of endogeneity, but only when you have observations for all variables and outcomes. Studies (Angrist and Krueger 1991; Kelejian 1971) have shown that one can use a dummy endogenous variable in an instrumental variable regression, and the linear regression for the first-stage estimates generates consistent second-stage estimates even with a dummy endogenous variable. It is assumed that instruments of the endogenous variable are not correlated with the stochastic error term of the profit equation.

The profitability of mango production is modelled as a function of market awareness, farming practices, and other socio-economic variables such as size of land ownership, age, fixed costs incurred, money borrowed from the wholesale contractor, and subsidy availed. Farming practices are considered as entrepreneurial qualities of farmer that influence profitability directly.

$\Pi_i = \alpha + \delta d_i + \beta X_i + \varepsilon_i$; where,

Π_i is calculated as profit per acre incurred during the season and defined as the total revenue per acre variable cost and per acre fixed costs, where fixed costs are apportioned over the age of the crop assuming a discount rate of 10%. Since it takes up to six months for a mango plant to yield fruits, the variable costs components were collected for the gestation period (up to six months) and after the gestation period separately. The fixed costs included seedling costs, field preparation, support material used, irrigation costs (investment in borewell), and any other costs. The fixed costs were apportioned over the age of the farm, using a discount rate of 10% to reflect the opportunity cost of capital. Table A1 shows the cost components across all age groups of the farms.

d_i is the dummy variable that takes the value 1 if farmer is aware that his mangoes are being exported and the value is 0 otherwise. The endogeneity of the market awareness is taken care by modelling it as a function of variables that are not directly correlated to the control variables from the profit regression.

$d_i = \alpha + \theta Z_i + u_i$; where, Z_i includes distance from market and education availed (a dummy variable, with the base variable being illiterate).

X_i is the set of control variables that include age and land size. Other dummy variables included: pre-harvest contractor, that is, whether the farmer borrowed money from a pre-harvest contractor; the number of times in a month the crop was irrigated during the gestation period; and the number of times in a month pesticides were applied during the gestation period.

Empirically the equation to be estimated is as follows:

Log Profitability = $\alpha + \beta_1$ log Size + β_2 log Age + β_3 log Age_farm + δ_1 market_awareness + δ_2 Contractor + δ_3 irrigation_frequency + δ_4 pesticide_frequency + δ_5 manure_frequency + δ_6 DAP_frequency +e, where profitability is defined as profit per acre. In some cases, calculated profits were negative, which were transformed to take care of extreme values;[8] size is the acreage of the farm; age is the farmer's age; age of farm is the farm's age, market awareness is whether the farmer is aware of the final destination of his produce; contractor is a dummy variable that refers to whether the farmer has borrowed money from the contractor; irrigation, pesticide, manure and Diammonium phosphate (DAP) frequency refer to the number of times per month they are applied on the field and "e" is the stochastic error term.

V Results

Table 9 shows the mean values of all the variables used in the model. As can be seen, there is a lot of variation in profitability, irrigation frequency, and distance to the market.

Table 9: Descriptive Statistics

Variable	Obs	Mean	Standard Deviation	Minimum	Maximum
log profit per acre	131	1.9	10.2	-11.5	11.7
log size	131	1.9	0.9	-0.3	4.7
log age	131	3.9	0.3	3.2	4.5
log age_farm	131	2.8	0.5	1.8	4.1
Contractor_dummy	131	0.6	0.5	0.0	1.0
Irrigation_frequency	131	2.2	4.8	0.0	40.0
Manure_frequency	131	3.0	2.5	0.0	20.0
Pesticide_frequency	131	1.9	2.6	0.0	15.0
DAP_Frequency	131	0.4	0.9	0.0	5.0
Graduate	131	0.2	0.4	0.0	1.0
SSLC	131	0.5	0.5	0.0	1.0
Primary	131	0.2	0.4	0.0	1.0
Distance	128	5.6	11.5	0.0	70.0

Source: Generated by the author using data collected from the field survey.

Table 10 shows the results from the estimation. Column 1 shows the instrumental variable regression while column 2 shows the OLS estimation. Market awareness does not have a significant impact on profitability. The coefficient signs are the same in both cases, but the magnitude of the market awareness is much higher when the endogeneity is taken care of under instrumental variable regression. Both the age of the farmer and the farm have a positive and significant impact on profitability because they indicate the experience of the farmer.

The contractor dummy variable also has a positive and significant impact on the profitability of the farmer. Farmers who had borrowed money from the contractor had higher profitability compared to those who did not. Among the two farming practices, the frequency of irrigation was found to have a negative though not a significant impact on profitability, while the frequency of pesticide application was found to have a negative impact. In terms of cost, irrigation is highly expensive because of the investment in borewells. As described earlier, groundwater capacity is severely depleted in Kolar and investment in irrigation is not cost-effective with the high fertilisers and pesticide use.

In the OLS regression, size, age of farmer, age of farm, and higher education (a college degree) are positive and significant. The number of times pesticide applied is negative and significant, implying that higher pesticide use may be detrimental to the quality of the crop and the yield. Table 10 shows the results from the probit equation that models the determinants of export awareness and finds education up to graduation and distance to the market have a positive and significant impact on the awareness about exports.

Table 10: Results from Instrumental Variable and OLS Estimation

Dep Variable =log profits	Coefficients IV (Column 1)	Coefficients OLS (Column 2)
Export Awareness	7.01 (7.7)	3.02 (1.9)
Distance (km)		-0.09 (0.06)
Primary		1.8 (2.8)
SSLC		0.57 (2.6)
Graduation		6.3 ** (2.8)
Log size	-0.58 (1.18)	-1.08 (1.06)
Log age	7.8*** (2.8)	7.7 *** (2.5)
Log age farm	4.5 ***(1.8)	4.6 ***(1.5)
Dummy _contractor	3.4 * (1.9)	1.6 (1.7)
Irrigation_no	-0.1 (0.12)	-0.1 (0.12)
Pesticide_no.	-0.71*(0.38)	-0.74 **(0.36)
Manure_no.	0.36 (0.41)	0.34 (0.36)
DAP	0.04 (0.75)	0.16 (0.7)
Cons	-42 (11.3)	-41*** (10.8)
R square	0.16	0.24
N	128	128

Figures in parenthesis represent standard errors. ***, **, * represent significance at 1%, 5% and 10% levels, respectively.

Source: Generated by the author using Stata

Table 11: Probit Regression

Y=Market Awareness	Coefficients
Distance	0.02* (0.01)
SSLC	0.9* (0.52)
Primary	0.11 (0.6)
Graduate	1.26** (0.55)
_constant	-1.6 ***(0.48)
Rsquare	0.12
N	128

Figures in parenthesis represent standard errors. ***, **, * represent significance at 1%, 5% and 10% levels.

Source: Generated by the author using Stata

Conclusions

While the paper reinforces the findings from earlier studies that suggest that the profitability of agriculture depends on a number of socio-economic factors such as the farmer's education and age, it also contributes to the existing literature in two distinct ways. The first important contribution of this paper is that it takes into account not only the marketing channels available to the farmers but also their awareness of high value markets. Further, the role of farming practices has been captured in the analysis of profitability, especially irrigation, manure and pesticide application. The findings are important from a policy perspective and reinforce the role of cost- effective methods of irrigation that will improve productivity of crops in the long run.

The analysis of the mango value chain in the Kolar region also suggests that farmers seem to be locked in a credit-cycle with the agents, who aggregate market risks and supply mangoes to the market. What is essentially lacking for the farmers is the lack of credit and access to markets, a gap which commission agents try to fill and exploit. For this reason, the removal of intermediaries from the value chain does not seem to be the solution. The farmer-agent relationship is mostly credit based, and the agents do not provide technical advice. However, the presence of an intermediate marketing agent is essential for access to high value markets to aggregate and minimise market risk.

It has been recognised that traders can play an important role in linking farmers with markets (Zamil and Cadilhon 2009). A United Nations Development Programme (UNDP) project in Bangladesh successfully linked small farmers to local traders in a mutually beneficial relationship, which involved training and providing technical support to the farmers to meet customer requirements. Prices should be linked to the local demand conditions and should not be allowed to vary beyond a fixed band. Policy interventions such as these should be done with an understanding of the regional markets involving the stakeholders so that a win-win situation emerges for the eco-system as a whole. The implementation of schemes that boost productivity through sustainable agriculture practices, rather than indiscriminate exploitation of natural resources, will go a long way in restoring the health and productivity of this region.

Appendix A1: Cost distribution by Age group

	< 9 years	9 to < 12 years	12 to < 20 years	20 to < 30 years	> =30 years
Variable costs per acre (including material and labour costs) (₹)	7,406	12,044	12,186	9,099	8,244
Tillage	2,607	2,247	1,956	2,457	2,150
Manure	2,495	3,346	2,274	2,209	1,599
Fertiliser	13	46	641	133	183
Transplantation	581	751	4489	1201	947
Irrigation	676	2204	542	533	615
Weeding	429	1,127	925	1,118	795
Pesticides	419	409	831	703	1,164
Topping	26	361	76	165	168
Harvesting	145	474	330	464	298
Grading	0	7	121	118	325
Storing	15	1071	0	0	0
Fixed costs per acre (₹)	2,279	3,453	4,741	2,486	11,124
Planting (including seedling cost)	1,465	1,653	1,210	1,538	6,857
Field preparation	562	759	882	464	620
Support	183	661	696	413	158
Irrigation	0	318	179	68	3125

Source: Generated by the author using data collected from the field survey.

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NOTES

[1] The potential for horticulture exports is indicated by the fact that India is the second largest producer of fruits and vegetables globally. According the National Horticulture Board, as per the horticulture statistics in 2017 India produces 11% of the world's vegetables and 13% of fruits (excluding melons). However, India's share of world exports in fruits and vegetables is insignificant. It accounts for only 1.7% of global trade in vegetables and 0.5% in fruits, the main reasons being high logistics cost, trade barriers, and lastly gaps in quality, health and safety stanadards (Aaditya Mattoo et al 2007).

[2] According to the erstwhile Planning Commission, Kolar falls under agro-climactic zone 10 which covers the Southern Plateau and Hills region. As per the finer classification of the National Agricultural Research Project (NARP), Kolar falls under Eastern Dry Zone KA-5. See http://www.crida.in/CP-012/statewiseplans/Karnataka%20(Pdf)/GKVK,%20Bangalore/KAR15-KOLAR%2031.03.2011.pdf

[3] Promotion of Eucalyptus plantation in Kolar district was a subject of great debate in the 1980s and was criticised as a main reason for the decline in water tables in the district (Shiva et al 1981; Poore and Fries 1985).

[4] The statistics on area and production of mango at the state level differ considerably from those available with the National Horticulture Board because of differences in the methodology employed. The estimates with the Directorate of Economics and Statistics are relatively conservative and based on sampling survey.

[5] The Horticultural Producers' Co-operative Marketing and Processing Society or HOPCOMS was established with the principal objective of establishing a proper system for the marketing of fruits and vegetables.

[6] The market is supported by 250 Horticultural Farmers' Associations organised throughout India with more than 20,000 members. The farmers' associations are linked to 40 collection centres that are equipped to meet the specific or special requirements of buyers, in terms of quality, packing and weight.

[7] Global G.A.P is a scheme for Good Agricultural Practices at the farm level, developed by EUREP, an association of European fresh produce retailers and importers. It was originally started by retailers belonging to the Euro-Retailer Produce Working Group and renamed as GlobalG.A.P in 2007.

[8] The data was transformed as x=sign(x) *log(abs(x)+1), see http://fmwww.bc.edu/repec/bocode/t/transint.html Cox (2005)