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Keywords

Coffee Arabica, leaf rust, coffee varieties, fungicides, small farmers

Research

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Dr. M.R. Narayana

Abstract

Management of coffee leaf rust (CLR) disease is essential to avoid its resultant production losses of Arabica coffee. Communication channels provide coffee farmers with the required knowledge for management by the recommended disease control methods and their applications. In this context, this paper analyses the role of communication channels for management of CLR by using a newly collected household level data of 575 Arabica coffee farmers in India. Management is focused on cultivation of resistant varieties and application of chemical sprays. Two methods of analyses are developed: Descriptions based on spatially aggregate data. Second, estimations based on Binary Logit Model using individual data. Descriptions show that prevalence of CLR is universal; key channels of communication are fellow farmers, extension workers and television; and desired channels of communications include on-farm demonstration and training workshops. While individual communication is most preferred channel, farmers' associations are considered useful institutional channels of communication. Estimations distinguish communication channels by fellow farmers and extension workers and show significant differences in nature and extent of impact of these communication channels on CLR management by resistant varieties and chemical sprays. These results have important implications for identifying and improving the current and future information needs and channels of communication for effective management of CLR, especially for small farmers with lower educational attainments in India. However, the approach and implications of this paper are of general relevance and applicability for other coffee growing countries in Asia and Africa.

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Introduction

Coffee Leaf Rust (CLR) is an important disease which affects the coffee production, especially Arabica coffee that is more susceptible to CLR than Robusta. According to the Coffee Board (2009a), when the disease is severe, loss of foliage up to 50 per cent and berries up to 70 per cent can occur. Thus, management of CLR management is essential to increase production and productivity of coffee and to attain long run sustainability of income generation from coffee cultivation and improvement in livelihood of coffee farmers, especially small farmers. Management of CLR refers to all coffee farming practices which are directly or indirectly aim at prevention of occurrence and spread of the disease. The management practices include chemical sprays, intercropping, weeding, pruning, shade regulation, topping, de-suckering, uses of fertilizers and nutrients. This paper focuses

on cultivation of CLR resistant varieties and application of chemical sprays or fungicides as the most important CLR management practice for Arabica coffee because of their relevance for channels of communication. This approach presumes that all other CLR management practices are uniformly followed by all farmers.

Analyses of communication channels in the management of CLR by household coffee farmers raise following research questions because of multiple channels and management practices. What are the channels of communication by which farmers receive the required information for management of CLR? Are the channels different or common between the management practices? Do these channels and management practices differ by coffee regions? What is the nature and extent of impact of communication channels on different CLR management practices? What are the desired future information needs and channels of communications for management of CLR? Can CLR management be effective if we improve the current and future channels of communications? If so, which of the channels can be singled out for effective CLR management? Can there be a communication-based strategy or policy for promotion of adoption of recommended CLR management practices? If yes, can such a strategy be targeted for small and less educated farmers?

To our knowledge, there exists no study or analysis which provides plausible answers to the above research questions for household coffee farmers in India. This research gap is evident, for instance, in the Indian studies on Arabica coffee [Babu Reddy et al., (2003) and Babu Reddy (2004)]; international studies on CLR by Schieber's (1972), Hillocks et al (1999) and Phiri et al (2001); and extensive review of studies on information and communication technology based on agricultural extension services in Asia and Africa, such as, Siraj (2011) for Pakistan, Ortmann (2000) for Nigeria and Meera et al., (2004) for India. A notable exception is Aker (2011) who provides with an excellent review of economic studies by types of agricultural extension (e.g. farmer field schools, training and visit, farmer to farmer, and social networks) and the role of information and communication technologies for non-coffee specific agricultural extension in developing countries of Asia and Africa with special reference to the role of mobile phones. However, this paper fills in the research gap on the role of channels of communication for management of CLR in India.

The main objective of this paper is to analyze the role of different channels of communication in the management of CLR by household coffee farmers in India. This analysis is approached in two ways by using a newly collected household survey data of 575 household coffee farmers in traditional coffee growing regions of India. First, description of grouped data (or spatially aggregated data by the coffee regions). Second, estimation of relationships between adoption of CLR management practices and channels of communication based on individual data. Descriptions are focused on assessing the nature and extent of current utilization of existing channels of communication, identifying plausible channels by types of management of CLR and by assessing future information needs by the channels. Throughout, all descriptions are disaggregated by traditional coffee growing states and districts to highlight the uniqueness of inter-regional variations. Estimations are based on Binary Logit Model with different channels of communication to obtain empirical evidence on the impact of channels of communication on CLR management practices. These descriptions and estimations are intended to draw implications and argue for a communication based policy for management of CLR by household coffee growers in India and find their generality for other developing coffee growing countries in Asia and Africa.

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Methods

Sample survey of household coffee farmers

Due to unavailability of a nationally representative and disaggregate database on the household farmers, a new database is created through a sample survey of 575 farmers in traditional Arabica coffee growing regions from 23 February 2010 to 31 August 2010. Traditional coffee growing states (all located in Southern India) are Karnataka, Kerala and Tamil Nadu. Major coffee growing districts in Karnataka State are Chikmagalur, Hassan and Kodagu. These traditional regions contributed about 98 per cent of total coffee production or 94 per cent of total Arabica coffee production by post-monsoon estimates as well as post-blossom estimates in 2010-11. Further, Karnataka is the largest producer of Arabica coffee in India. Its share is about 80 per cent in total production of Arabica coffee. The national share of its three districts is: Chikmagalur: about 40 per cent; Kodagu: about 22 per cent; and Hassan: about 18 per cent. Other major Arabica coffee growing regions include Pulneys, Shevroys and Annamalais in Tamil Nadu and Nelliampathis in Kerala.

The selection and allocation sample household coffee farmers is based on multi-stage and simple random sampling method. The multi-stage sample design is distinguished by three stages. In Stage I, total sample is allocated to three states in proportion of the average combined share by five variables: (a) Planted area (Arabica) in 2007-08, (b) Planted area (Arabica) in 2008-09, (c) Production of coffee (Arabica) in 2007-08, (d) Production of coffee (Arabica) in 2008-09 and (e) Production of coffee (Arabica) in 2009-10. In Stage II, sample size in Stage I is allocated in proportion of the distribution of farmers by estate size of planted area under Arabica coffee in each state. This has the objective of giving sufficient representation to the small farmers. In Stage III, sample farmers are randomly drawn from all the Liaison Zones of the Coffee Board of India. In the absence of a complete household listing of coffee farmers by the Zones, however, the entire fieldwork is executed in coordination with the officials and staff in extension services of the Coffee Board and local coffee estate workers for identification and location of sample estates or farmers.

Structured questionnaire is the instrument of collection of primary data from the sample farmers. Trained investigators canvassed the questionnaire by direct personal interview with the farmers at their estates. The questionnaire sought information including coffee farming activities, CLR prevalence and control methods, farmers' awareness of CLR management practices and current and future information needs and channels of communication for CLR management. The survey data is the basis for the entire descriptions and analyses in this paper.

Technique of analyses

Two techniques of analyses are developed based on the above primary data. First, descriptions based on spatially aggregate data. Second, empirical estimations based on Binary Logit Model using individual data.

Descriptive technique. This technique focuses on descriptions of basic data by tabular presentation and using ratios and percentages. All descriptions are given by traditional coffee growing regions by using grouped data at state and district levels of aggregation.

Empirical technique. Whether or not a farmer is an adopter of a CLR management practice is a qualitative response in the sample survey. This response can be quantified by the familiar dummy-endogenous variable and modeled in the framework of a Binary Logit model as follows.

$$\text{In } [\rho ki / (1-\rho_{ki})] = \alpha_j + \beta_j C_{jki} + \varepsilon_{ki} \qquad (1)$$

Where In $[\rho ki / (1-\rho_{ki})]$ is the logit for application of k-th CLR management practice by chemical sprays (e.g application of Bordeaux mixture, Systemic fungicides or both Bordeaux mixture and Systemic fungicides); In is the base of natural logarithms; ρ_{ki} is the probability (defined by the standard Logistic distribution function) of applying k-th practice by i-th farmer; $(1- \rho_{ki})$ is the probability of non-adopting a CLR management practice; C_{jki} is j-th channel of communication for k-th application of a CLR management for i-th farmer; α_j and β_j are intercept and slope parameters to be estimated; and ε is random disturbance term.

The model in (1) is inherently non-linear and estimated by the technique of non-linear maximum likelihood estimation. We predict the sign on β_j to be positive. This implies that, other things being equal, an increase in communication of information by the j-th channel of k-th management practice will have positive impact on the odds in favour applying the k-th management practice by i-th farmer.

Using the estimated parameters [denoted by asterisk (*)], the probability of application of k-th practice by i-th farmer is equal to:

$$\rho_{kj}^* = \text{In}(Z_{ki}^*) / \{1 + \text{In}(Z_{ki}^*)\}. \qquad (2)$$

Where Zki* is the estimated odds-ratio and is equal to $[\alpha_j^* + \beta_j^*.C_{jki}]$. Equation (2) is computed separately for each of the channels of communication. Next, the elasticity of probability by the j-th channel of the k-th management practice is computable at its sample mean value $[A_{jk}]$ as follows.

$$\eta_{kj} = A_{jk}.(1- \rho_{ki}^*).\beta_j^* \qquad (3)$$

The elasticity is computed for each CLR management practice by channels of communication. If all the channels are measured by dummy variables, then the elasticity shows the responsiveness of a CLR management practice to a discrete change of the communication channel variable from 0 to 1.

The above framework is focused on impact of communication channels on CLR management by chemical sprays. This framework can be extended to incorporate the importance of j-th communication channel for CLR management by resistant varieties for i-th farmer (R_{ji}) and level of educational attainment of i-th farmer (E_i) in the following way.

$$\text{In}\,[\rho_{ki} / (1-\rho_{ki})] = \alpha_j + \beta_j C_{ji} + \theta_j R_{ji} + \lambda E_i + \varepsilon_{ji} \qquad (4)$$

We predict the sign on θj to be negative. This means that, other things being equal, an increase in communication of information of CLR management by resistant variety will reduce the odds in favour of adoption of CLR management by chemical sprays. This prediction implies that management of CLR by resistant varieties and chemical sprays are substitutes when the substitutability is estimable by channels of communication. In addition, we predict the sign on λ to be positive and interpret that a farmer with higher educational attainment would have higher odds in favour of applying the CLR management by cultivation of resistant varieties.

Results

Descriptive results

Select background characteristics of farmers. Of the total 575 sample farmers, 73 percent (or

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417 farmers) belong to Karnataka, 18 percent (or 103 farmers) to Tamil Nadu and the rest 9 percent (or 54 farmers) to Kerala. Of the 417 sample farmers within Karnataka, the distribution by districts is as follow: Chikmagalur (44 percent), Kodagu (31 percent) and Hassan (25 percent).

Farmers with estate size of less than 10 hectares or about 25 acres are called small farmers. They constitute the highest share of sample farmers at the national, state and district levels. For instance, share of small farmers is equal to 90 percent at all India level. Within Karnataka, this share varies from 86 per cent in Chikmagalur to 94 percent in Hassan and to 94 per cent in Kodagu. In particular, the sample is dominated by the smallest farmers with less than 5 acres or smaller farmers with less than 10 acres of estate size. For instance, share of smallest (or smaller) farmers is equal to about 43 (or 24) percent in Karnataka, 81 (or 7) percent in Kerala, 64 (or 14) percent in Tamil Nadu and 51 (or 21) percent at all India level. Thus, the results of this paper are of special relevance for these vulnerable sections of India's coffee farmers whose livelihood depends exclusively on income from coffee farming.

Prevalence rates of CLR are the bases for analysis of role of communication in management of CLR. Educational background of farmers is useful to identify the particular channels of communication for management of CLR, especially for the focus group of farmers by their lower educational attainments. Table 1 summarizes the survey results on prevalence rates and education background of farmers by coffee regions.

CLR is not new for coffee farmers in India because more than 50 per cent of total farmers have identified it from the beginning of their farming or may not even remember when it did first occur in their estates. A notable exception is Kerala where prevalence rate is higher for new growers since 2005. In the same way, new growers since 2001 and 2005 have identified CLR in all districts in Karnataka and in other states. Thus, CLR has continued to live with the India's coffee farming from past to the present.

Household heads with completed levels of education show interesting variations. Higher number of household heads has completed primary, upper primary, high school and higher secondary levels of education. Non-professional graduates are highest in completed levels of higher education. Household heads with non-formal education are highest in Tamil Nadu and Hassan district in Karnataka. These diversities in educational attainments of farmers have important implications for adoption of CLR management practices, especially when it involves technical and economic details to be disseminated and translated into production and business strategies at the individual and community levels.

In the absence of non-formal education, however, the farmers would have been left with illiteracy. Of the total farmers, share of farmers with non-formal education and primary education (or up to high school) accounts for about 18 (or 59) per cent in Karnataka, 11 (or 70) per cent in Kerala and 20 (or 48) per cent in Tamil Nadu. Overall, they account for about 18 (or 58) per cent of total farmers in India. These farmers with completed lower education levels constitute the focus group for dissemination of information on CLR management practices by distinct communication channels, because they may have less technical capacity to self- learn the CLR management details.

Channels of communication by management practices. CLR management methods are distinguished by cultivation of CLR resistant varieties and applications of chemical sprays in the form of Bordeaux mixture and systemic fungicides. Six important varieties of Arabica coffee are grown in traditional coffee regions of India. They are called Selection 3 (or S.795), Selection 5A, Selection 6, Selection 9, Selection 12 (Cauvery/Catimore) and Chandragiri. Except for S.795, all other varieties

Table 1
Prevalence rates of CLR and educational background of farmers by coffee regions of India

Identification	*Karnataka*				*Kerala (N=54)*	*Tamil Nadu (N=104)*	*Total (N=575)*
	Chikmagalur (N=185)	Hassan (N=104)	Kodagu (N=128)	Total (N=417)			
	Prevalence rates						
CLR was identified first							
• From the beginning	61.08	54.81	54.69	57.55	37.04	60.58	56.17
• Since 2001	19.46	26.92	26.56	23.50	3.70	14.42	20.00
• Since 2005	19.46	18.27	16.41	18.23	42.59	22.12	21.22
• Not known	0.00	0.00	2.34	0.72	16.67	2.88	2.61
	Percent of farmers						
Level of completed education							
• Non-formal education (e.g. adult education)	6.49	15.38	4.69	8.15	1.85	13.46	8.52
• Primary school education	8.11	10.58	10.94	9.59	9.26	6.73	9.04
• Upper primary or middle school education	22.16	13.46	16.41	18.23	16.67	10.58	16.70
• High school education	36.22	30.77	28.13	32.37	44.44	30.77	33.22
• Higher secondary or pre-university education	7.57	13.46	14.06	11.03	12.96	13.46	11.65
• Graduate in non-professional education	16.76	16.35	17.97	17.03	12.96	18.27	16.87
• Post-graduate in non-professional education	0.54	0.00	0.78	0.48	0.00	3.85	1.04
• Graduate or post graduate in professional education	0.00	0.00	5.47	1.68	0.00	0.96	1.39
• Diploma holder	2.16	0.00	1.56	1.44	1.85	1.92	1.57

Note: N is total number of sample farmers. All figures under each background characteristic are per cent to total number of sample growers in the respective State/District. Number of growers with Post-graduate in professional education is nil.

are considered CLR-resistant [Coffee Board (2009b)]. The recommended application of chemical sprays by dosages and input combinations of fungicides by Bordeaux mixture and Systemic fungicides (i.e. Bayleton and Contaf) are as follows [Coffee Board (2009a)]. (a) Copper Sulphate (1Kg.) + Lime (1 Kg.) to prepare the Bordeaux mixture @ 0.5% for 5 barrel/acre/spray. (b) Bayleton@160g/barrel or Contaf@400ml/barrel for preparation of Systemic fungicide for 3 barrel/acre/spray. In total, 5 spray schedules and 9 fungicide combinations are recommended: (i) two-rounds of Bordeaux mixture, (ii) two-rounds of Systemic fungicides (Contaf or Bayleton), (iii) three-rounds of Systemic fungicides, (iv) two-rounds of Systemic fungicides and one-round of Bordeaux mixture, and (v) one-round of Bordeaux mixture and one round of Systemic fungicides. Further, recommended application of fungicides are distinguishable by coffee seasons in India. That is, Bordeaux mixture spray is recommended during pre-monsoon (May-June); Systemic fungicides during break in monsoon (August); and combination of Bordeaux mixture and Systemic fungicides during post-monsoon (September-October). Access to and awareness of these scientific and technical details is

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required for effective management of CLR by all coffee farmers. In the absence of appropriate channels of communication, however, the required information may not reach to all the individual farmers. This creates asymmetric information and its differential impacts on CLR management across coffee farmers.

Current channels of communication are identified below by three CLR-management practices: (a) Planting CLR resistant varieties, (b) application of Bordeaux mixtures by three times (pre-monsoon alone, post-monsoon along and pre and post monsoon) and (c) application of systemic fungicides (e.g. Bayleton/Contaf) by three times (pre-monsoon alone, post-monsoon along and pre and post monsoon).

Planting CLR-resistant varieties. Extent of planting the CLR resistant varieties and its channels of communication are given in Table 2. About 34 per cent of farmers in Karnataka, 70 per cent in Kerala and 37 per cent in Tamil Nadu have planted the CLR resistant varieties. Within Karnataka, this per cent varies from 26 per cent in Chikmagalur, 35 per cent in Hassan and 45 per cent in Kodagu. The important communication channels on the application of CLR-resistant varieties are fellow farmers and extension workers in all the states and districts. Other communication channels are specific to states and districts, such as, television in Karnataka and visiting researchers in Hassan. It is important to recognize that both fellow farmers and extension workers are forms of inter-personal channels of communication. In contrast, TV is a form of impersonal channel of communication and

Table 2
Channels of communication for household farmers' management of CLR by resistant varieties

Management by channels of communication	*Karnataka*				*Kerala (N=54)*	*Tamil Nadu (N=104)*	*Total (N=575)*
	Chikmagalur (N=185)	Hassan (N=104)	Kodagu (N=128)	Total (N=417)			
Per cent of farmers who planted the CLR resistant varieties	25.95	34.62	44.53	33.81	70.37	36.54	37.74
Channels of communication	Among the farmers who planted CLR resistant varieties						
• Fellow farmer	35.42	27.78	31.58	31.91	47.37	10.53	30.88
• Visiting researchers	0.00	11.11	1.75	3.55	0.00	0.00	2.30
• Radio	2.08	0.00	0.00	0.71	0.00	0.00	0.46
• Extension worker	41.67	30.56	43.86	39.72	50.00	86.84	49.77
• Training workshop	4.17	0.00	0.00	1.42	0.00	0.00	0.92
• TV (own)	16.67	22.22	21.05	19.86	2.63	2.63	13.82

Note: N refers to total number of sample farmers.

beneficial to the largest number of farmers by providing information on CLR resistant varieties.

Application of chemical sprays. Table 3 summarizes the extent of application of chemical sprays by Bordeaux mixture and Systemic fungicides and their channels of communication. There are remarkable inter-regional variations in the adoption of chemical sprays. Farmers in Karnataka (or Kerala) are the highest (or lowest) appliers of both the Bordeaux mixture and Systemic fungicides. The main reason for low application of chemical sprays by farmers in Kerala is due to their highest cultivation of CLR resistant varieties of Arabica coffee as shown in Table 2. Of the districts within Karnataka State, Hassan has the lowest number of farmers who apply both the chemical sprays.

The major channels of communication for application of chemical sprays are fellow farmers, visiting researchers, extension workers and TV. Interestingly, TV and visiting researchers as channels

of communication are relevant only for Karnataka State. In contrast, fellow farmers and extension workers, as forms of inter-personal communication, are the important and common channels of communication in all regions.

It is important to recognize that the major channels of communication for resistant varieties and chemical sprays exhibit more similarities than differences.

In particular, fellow farmers, extension workers and TV may be considered as the most common channels of communication for CLR management in all coffee regions of India. Further, many channels of communication in Table 2 and Table 3 are not reported because of their zero values. These channels include print media (e.g. newspapers and pamphlets), radio, on-farm demonstrations, and local leader, telecommunications (e.g. fixed and mobile phones and information technology (e.g. email and internet resources).

Future demand for information and channels of communication. Farmers' responses on their particular future information needs, desired communication channels and important informational constraints for management of CLR are summarized in Table 4. These responses show interesting insights and are useful to match supply of and demand for information by desired channels of communication.

First, farmers' information needs and communication channels to cope with the CLR are many and diversified The crucial information needed include knowledge on preparation of chemical sprays, disease control inputs and exact time of application of various fungicides. The most desired channels of communication to receive these information are the visiting researchers, fellow farmer, extension workers, training workshop and on farm demonstration. Second, most farmers desire to receive the needed information individually/personally (about 71 per cent in Karnataka and 100 per cent in Kerala and Tamil Nadu). In addition, farmers desire to receive the information by selects institutions, such as, growers' (general farmers', general coffee farmers' and small coffee farmers') associations and partnership with government. Third, two major constraints to take up a new technology for improving the control of CLR are lack of awareness/ information/ knowledge on new technology and its applications and impact of new technology on increase in production and income.

Surprisingly, mass media (print, audio and audio-visual) and telecommunication services (e.g. telephones and internet) are of less importance for coffee farmers to receive the needed information. A general presumption for this insignificant role of telecommunication channels is lack of resources to access and utilize the telecommunication services, especially among the large number of very small and poor farmers. In reality, however, this presumption is not plausible because access to telephone in terms of household teledensity (i.e. number of telephones per 100 households) is remarkably higher: 64 per cent for mobile phones; 31 per cent for landlines; 86 per cent for combined mobile and landline. However, the teledensity is lower if calculated for total household population (1874 persons). That is, 18 for landlines and 25 for mobile phones. Nevertheless, as compared to the national level rural teledensity, coffee regions have a higher teledensity for landlines and lower for mobile phones. This reality provides a strong factual basis for introduction of a broader telecommunication-based information services for future management of CLR in India, given the experiences of mobile-based agricultural extension services in Asian countries [Aker (2011)].

Empirical results

Using the sample survey data 575 farmers, equations from (1) through (4) are estimated. To start with, we used three dependent variables for estimation of equation (1): (a) Adopter of Bordeaux mixture [=1 if adopter of Bordeaux mixture (one or two times), =0 otherwise], (b) Adopter Sys-

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Table 3
Channels of communication for household farmers' management of CLR by application of chemical sprays

Management by channels of communication	*Karnataka*				*Kerala*	*Tamil Nadu*	*Total*
	Chikmagalur (N=185)	Hassan (N=104)	Kodagu (N=128)	Total (N=417)	*(N=54)*	*(N=104)*	*(N=575)*
1. Per cent of responses among the farmers who applied pre-monsoon Bordeaux mixture (or Systemic fungicides)	19.46 (24.32)	5.77 (14.42)	23.44 (13.28)	17.27 (18.47)	9.26 (9.26)	22.12 (14.42)	17.39 (16.87)
Among the farmers who applied pre-monsoon Bordeaux mixture (or Systemic fungicides)							
1.1. Channels of communication							
➢ Fellow farmers	30.56 (42.22)	16.67 (26.67)	50.00 (5.88)	37.50 (31.17)	40.00 (0.00)	86.96 (13.33)	49.00 (26.80)
➢ Visiting researchers	0.00 (0.00)	16.67 (6.67)	0.00 (11.76)	1.39 (3.90)	0.00 (0.00)	0.00 (6.67)	1.00 (5.15)
➢ Extension worker in coffee Liaison zone	13.89 (35.56)	16.67 (33.33)	20.00 (29.41)	16.67 (33.77)	60.00 (0.00)	13.04 (80.00)	18.00 (43.30)
➢ TV (own)	55.56 (22.22)	50.00 (26.67)	30.00 (52.94)	44.44 (29.87)	0.00 (0.00)	0.00 (0.00)	32.00 (23.71)
2. Per cent of responses among the farmers who applied post-monsoon Bordeaux mixture (or Systemic fungicides)	4.86 (5.41)	12.50 (8.65)	1.56 (9.38)	5.76 (7.43)	0.00 (0.00)	3.85 (1.92)	4.87 (5.74)
Among the farmers who applied post-monsoon Bordeaux mixture (or Systemic fungicides)							
2.1. Select channels of communication							
➢ Fellow farmers	11.11 (30.00)	30.77 (22.22)	50.00 (16.67)	25.00 (22.58)	0.00 (0.00)	50.00 (0.00)	28.57 (21.21)
➢ Visiting researchers	11.11 (10.00)	0.00 (0.00)	0.00 (0.00)	4.17 (3.23)	0.00 (0.00)	0.00 (0.00)	3.57(3.03)
➢ Extension worker	0.00 (30.00)	0.00 (44.44)	0.00 (66.67)	0.00 (48.39)	0.00 (0.00)	50.00 (100.00)	1.00 (51.52)
➢ TV	77.78 (30.00)	69.23 (33.33)	50.00 (16.67)	70.83 (25.81)	0.00 (0.00)	0.00 (0.00)	0.00 (24.24)
3. Per cent of responses among the farmers who applied pre and post monsoon Bordeaux mixture (or Systemic fungicides)	66.49 (57.84)	75.96 (67.31)	45.31 (51.56)	62.35 (58.27)	3.70 (1.85)	7.69 (3.85)	46.96 (43.13)
Among the farmers who applied pre and post monsoon Bordeaux mixture (or Systemic fungicides)							
3.1. Select channels of communication							
• Fellow farmers	54.47 (27.10)	23.75 (28.57)	50.00 (27.27)	44.06 (27.57)	0.00 (0.00)	87.50 (0.00)	44.07 (27.02)
• Visiting researchers	4.07 (3.74)	6.25 (10.00)	12.07 (1.52)	6.51 (4.94)	0.00 (0.00)	0.00 (0.00)	6.27 (4.84)
• Extension worker	15.45 (43.93)	11.25 (44.29)	20.69 (50.00)	15.33 (45.68)	50.00 (100.00)	12.50 (100.00)	15.50 (46.77)
• TV	25.20 (24.30)	58.75 (17.14)	17.24 (21.21)	33.72 (21.40)	50.00 (0.00)	0.00 (0.00)	32.84 (20.37)

Note: N refers to total number of sample farmers

Table 4
Coffee growers' future needs for management of CLR in India

Farmers' information needs by channels of communication	*Karnataka*				*Kerala*	*Tamil*	*Total*
	Chikmagalur (N=185)	Hassan (N=104)	Kodagu (N=128)	Total (N=417)	*(N=54)*	*Nadu (N=104)*	*(N=57*
1. Crucial information needed							
➢ Preparation of chemical sprays	54.59	48.08	63.28	55.64	7.41	10.58	42.96
➢ Disease control inputs	34.05	30.77	43.75	36.21	22.22	8.65	29.91
➢ Exact time of application of various fungicides	55.14	62.50	50.78	55.64	92.59	97.12	66.61
2. Desirable channels of communication							
➢ Fellow farmers	31.35	30.77	39.84	33.81	1.85	0.00	24.70
➢ Visiting researchers	23.24	20.19	24.22	22.78	72.22	78.85	37.57
➢ Newspapers/pamphlets (Print media)	1.08	1.92	3.91	2.16	0.00	0.96	1.74
➢ Radio	1.62	7.69	3.13	3.60	5.56	0.00	3.13
➢ Extension worker	54.05	62.50	60.94	58.27	100.00	100.00	69.74
➢ On-farm demonstration	35.68	32.69	39.84	36.21	24.07	32.69	34.43
➢ Training workshop	40.54	43.27	56.25	46.04	94.44	90.38	58.61
➢ Electronic media	2.16	0.96	0.00	1.20	5.56	2.88	1.91
➢ Internet	2.16	1.92	0.00	1.44	3.70	0.00	1.39
➢ Telephones	0.54	0.00	0.00	0.24	0.00	0.00	0.17
3. Proposed channels of communication							
➢ Growers' association	46.49	64.42	35.94	47.72	1.85	31.73	40.52
➢ Size-specific (e.g. small growers') association	48.11	39.42	59.38	49.40	25.93	11.54	40.35
➢ General farmers' association	31.89	22.12	19.53	25.66	12.96	7.69	21.22
➢ Individually	75.68	67.31	65.63	70.50	100.00	100.00	78.61
➢ Partnership with NGOs	4.32	3.85	0.78	3.12	7.41	0.96	3.13
➢ Partnership with government	40.54	28.85	32.03	35.01	1.85	2.88	26.09
➢ Others including telephones	3.24	0.00	0.00	1.44	0.00	0.00	1.04
4. Major informational constraints for management of CLR by lack of awareness/ information/ knowledge on							
➢ new technology and its applications	57.30	69.23	62.50	61.87	3.70	46.15	53.57
➢ impact of new technology on increase in production and income	66.49	62.50	69.53	66.43	59.26	48.08	62.43

Note: N is number of sample farmers. NGOs refer to non-governmental organizations.

temic fungicides [=1 if adopter of Systemic fungicides (one or two times), =0 otherwise] and (c) Adopter of both Bordeaux mixture and Systemic fungicides [=1 if adopter of both Bordeaux mixture and Fungicides (one or two times), =0 otherwise]. Independent variables are three channels of communication for each management practice: fellow farmer [=1 if a farmer received communication from a fellow farmer, =0 otherwise], extension worker [=1 if a farmer received communication from an extension worker, =0 otherwise] and TV [=1 if a farmer received communication from the TV, =0 otherwise]. Due to high collinearity between communication channels and few adopters, estimation of (1) by using the dependent variable (a) and (b) was not possible. Hence, all estimations are obtained by using the dependent variable (c) which is one the recommended chemical sprays for CLR management. In addition, education attainment of farmer (Ei) is measured by a dummy-variable (=1 if a farmer is higher educated, = 0 otherwise).

Table 5 presents the estimation results of 6 models by the estimated intercept and slope coef-

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Table 5
Determinants of CLR management practices by household famers in India: Estimates of Binary Logit Model for channels for communication and education

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Dependent variable	Adopter of both Bordeaux mixture and Systemic fungicides [=1 if adopter of both Bordeaux mixture and Fungicides (one or two times), =0 otherwise]					
Independent variables						
Intercept	-2.232 (9.24)*	-.2.187 (9.73)*	0.535 (4.98)*	-6.301 (10.29)*	-6.190 (9.79)*	-6.556 (9.71)*
Fellow farmer as a channel of communication for						
• Bordeaux mixture	3.994 (13.70)*			5.452 (9.25)*	5.634 (9.11)*	5.752 (9.07)*
• Systemic fungicides		4.336 (13.12)*		5.994 (9.26)*	6.116 (9.09)*	6.301 (9.12)*
• Resistant varieties			-0.411 (1.77)***		-1.303 (2.31)*	-1.513 (2.64)**
Extension worker as a channel of communication for						
• Bordeaux mixture	3.042 (8.42)*			4.772 (6.46)*	4.584 (6.47)*	4.554 (6.44)*
• Systemic fungicides		3.763 (12.49)*		4.772 (8.84)*	4.955 (8.76)*	5.164 (8.72)*
• Resistant varieties			-0.872 (3.91)*		-0.751 (1.49)	-0.863 (1.66)**
Education						0.960 (2.27)**
-2 Log likelihood	236.790	212.385	384.036	107.834	104.219	101.583
Chi-square	310.93#	359.74#	16.44#	568.84#	576.07#	581.34#
Number of observations	575	575	575	575	575	575
Estimated probability	0.566	0.582	0.575	0.626		0.613
Estimated elasticity of probability						
Fellow farmer						
• Bordeaux mixture	0.934			1.114	1.169	1.217
• Systemic fungicides		0.574		0.710	0.735	0.773
• Resistant varieties			-0.029		-0.083	-0.098
Extension worker						
• Bordeaux mixture	0.149			0.186	0.197	0.199
• Systemic fungicides		0.479		0.543	0.573	0.609
• Resistant varieties			-0.070		-0.535	-0.063
Education						0.080

Note: Figures in the parentheses are t-ratios. * (or **) indicates (or indicate) that the t-statistic is significant at 1 (or 5) percent level or more.
# indicates that the Chi-square statistic is significant at 1 percent level or more.

ficients and their asymptotic t-ratio. Goodness of fit of the estimated models is shown by the Log-likelihood test statistic and significance of Chi-square test. In addition, estimated probability of

adoption of CLR management and elasticity of probability by variables are given.

Channels of communication for Bordeaux mixture and systemic fungicides are distinguished by fellow farmers and extension workers. In Model 1 and Model 2, the coefficients of these variables are positive and significant. The magnitude of estimated coefficient for fellow farmer variable is higher than for the extension worker variable in both the models. However, the magnitude of coefficient for systemic fungicides is bigger than for the Bordeaux mixture. These results imply the relative size of impact of channels of communication on the adoption of both Bordeaux mixture and systemic fungicides for management of CLR by household farmers.

Interestingly, the coefficients of channels of communication for resistant varieties in model 3 are negative and significant. This implies that, in the presence of communication channel for adoption of resistant varieties, probability of management of CLR by chemical sprays is reduced. This indicates that resistant varieties and chemical sprays are substitutes for management of CLR in India.

Model 4 include all variables of channels of communication of chemical sprays. Model 5 extends the model 4 by including the channels of communication of resistant varieties as well as chemical sprays. In these models, all the coefficients have predicted signs and significant. Thus, the interpretation of the results is qualitatively similar as in case of Model 1 through Model 3.

Model 6 shows the consistency of results on channels of communications of chemical sprays and resistant varieties. In addition, the model shows that the estimated coefficient of education variables is positive and significant. This implies that, other things being equal, a farmer with higher education has a higher probability of adopting the CLR management practices than a farmer with lower levels of education. Thus, level of educational attainment does matter for management of CLR in India.

Estimation results in Table 6 clearly imply that the probability of adoption of CLR management is highest for channels of communication for Bordeaux mixture. This result offer empirical bases for prioritizing the improvement and strengthening of channels of communication of Bordeaux mixture for effective management of CLR in India.

Discussion/Conclusions

Using a newly collected sample survey of 575 farmers on Arabica coffee in traditional coffee growing regions of India, this paper has described the importance of communication channels for management of CLR by household coffee farmers and estimated the empirical relationship between CLR management practices and channels of communication. The descriptions and analyses lead to the following major conclusions.

The prevalence of CLR is universal and its management continues to be relevant due to its expected negative impacts on production. Channels of communication are important for coffee farmers to receive information on management of CLR by cultivation resistant varieties and application of chemical sprays. The major current channels of communications are inter-personal and in the form of fellow farmers and extension workers. These channels are common across CLR management practices in all coffee growing regions. However, the magnitude of impact of different channels on CLR management practices. Among the inter-personal channels, fellow farmers can be singled out by its biggest impact on management of CLR by application of Bordeaux mixture. Surprisingly, except for TV, farmers do not consider other communication channels, such as, print media, radio, on farm demonstration, training workshops and local leaders as remarkable sources of information and channels of communication.

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Farmers' are explicit on their future needs of information in terms of preparation of chemical sprays, disease control inputs and exact time of application of various fungicides. The most desired channels of communication to receive these information are inter-personal [i.e. visiting researchers, fellow farmer, extension workers, training workshop and on farm demonstration] rather than impersonal channels [i.e. mass media and telecommunication services]. In addition, most farmers opt to receive the needed information in future through personal channels [i.e. individually/personally] or institutional channels [i.e. farmers' or growers' associations and partnership with government]. This implies a strong need for improving and strengthening the inter-personal channels of communication for effective management of CLR, both at present as well as in future.

More than 90 percent of coffee farmers are small and 50 per cent of coffee farmers have no education beyond high school. The presence of farmers with no formal education and up to primary education makes them a focus group to target the needed information through individual, interpersonal and institutional channels of communication. Thus, a policy for promotion of recommended CLR management practices may target the small farmers by educational levels and provide them the needed information on the management practices by communicating with them through the individual, interpersonal and institutional channels. The results of this paper are relevant for design of such a targeted communication-based policy for promotion at all India level of aggregation as well as state or district level of disaggregation. Other things being equal, a promotional policy for successful management of CLR may include specific measures for promotion and improvement of three major channels of communication: fellow farmer, extension worker and mass media. In addition, the use of information and telecommunication based technologies may also be explored for effective implementation of such a promotional policy.

This paper has shown that the presence of communication channel for adoption of resistant varieties reduces the probability of management of CLR by chemical sprays. In this context, whether or not a farmer may substitute the CLR cultivate resistant varieties for CLR tolerant varieties of Arabica coffee depends on long term assessment of cost and returns from cultivation of these varieties. This assessment is an important extension of this paper. In addition, the approach, results, conclusions and implications of this paper are of relevance and applicability for other coffee growing countries in Asia and Africa where the information needs and communication channels for management of CLR may be generally comparable with that of India. To establish this generality on empirical grounds, this study may be replicated in other countries.

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