

KNOWLEDGE ASSESSMENT OF INTEGRATED PEST MANAGEMENT PRACTICES AMONG HYBRID TOMATO GROWERS

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ABSTRACT

This study investigates the knowledge levels of hybrid tomato growers in Karnataka, India, regarding Integrated Pest Management (IPM) practices. Through structured interview schedule and standardized knowledge tests, data were collected to assess growers' understanding of cultural, physical, chemical, and biological IPM practices. Findings reveal that majority of respondents (69.17%) had medium level knowledge about IPM practices apropos in tomato cultivation. Among different IPM practices, respondent possess highest knowledge in chemical practices ($\bar{x} = 0.7208$, ranked Ist) followed by cultural practices ($\bar{x} = 0.6991$, ranked IInd), mechanical or physical practices ($\bar{x} = 0.5167$, ranked IIIrd) and the least knowledge in biological practices ($\bar{x} = 0.1583$, ranked IVth). In the Standardized Multi-variate Regression Analysis (SMRA), coefficient of determination ($R^2 = 0.621$) interpreted as 62.1% of total variation in knowledge level explained by a set of nine independent variables collectively considered under this study. However, standardized β -value shows the amount of variation in dependent variable explained by particular independent variable. Furthermore, Independent variables – posing positive effect on dependent variable – were year of schooling (standardized β -value = 0.298), cosmopolitness (standardized β -value = 0.236) found significant at 1% ($p < 0.01$); occupation (standardized β -value = 0.110) at 5% ($p < 0.05$); tomato farming experience (standardized β -value = 0.129), annual family income (standardized β -value = 0.113) and extension contact (standardized β -value = 0.111) found significant at 10% ($p < 0.10$). On contrary, age was found negatively significant at 1% ($t = -7.163$; $p < 0.01$) level with standardized β -value -0.443. By addressing knowledge gaps and promoting environmentally friendly alternatives to chemical pesticides, can contribute to more efficient and sustainable hybrid tomato cultivation. The study advises policies need to be formulated by focusing targeted training for older farmers and enhanced extension and media outreach across all age groups.

Keywords: knowledge test, tomato growers, integrated pest management, standardized multi-variate regression analysis and sustainable agriculture

INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is the fourth most valuable food crop globally and is cultivated in most countries (Schreinemachers *et al.*, 2018). India contributes 11% to global tomato production, ranking second after China (FAO, 2020). However, tomatoes are highly vulnerable to numerous insect pests and pathogens, collectively known as “pests,” causing significant economic losses and prompting heavy pesticide use. Worldwide, over 385 million people suffer from unintentional acute pesticide poisoning annually (Boedeker *et al.*, 2020). Due to limited knowledge, farmers often overuse chemical pesticides to protect their crops (Depenbusch *et al.*, 2023), which negatively impacts

farmer profits, farmworker health, consumer safety, and the environment (Mancini *et al.*, 2005; Stehle & Schulz, 2015; Kariathi *et al.*, 2016). Integrated Pest Management (IPM) strategies have been developed as an effective approach to managing pest threats (Ndereyimana *et al.*, 2020).

FAO (2017) defined IPM as “careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems

and encourages natural pest control mechanisms". This method is considered to be economical, effective, practical, protective and eco-friendly. The primary aim of IPM is to prevent pest issues and apply control measures only when needed, prioritizing options that are both safe for humans and the environment, and cost-efficient. Unlike a fixed "packaged technology", IPM is tailored to specific crops and regions, considering local ecology and socio-economic factors. It acknowledges that complete pest eradication is often unnecessary and unrealistic, accepting some level of damage as manageable. In essence, the presence of pests does not always equate to a pest problem.

Adoption of any innovative technology is very challenging at farmer's end due to several factors related to production, technical, communication and so on. Similarly, in case of IPM, despite its techno-economic superiority and sustainability nature, adoption of is too limited due to lack of proper information and significant knowledge. Though, Knowledge is a key factor influencing farmers' behavior, significantly impacting both their covert or overt behaviour (Manhas, 2022; Tankodara et al., 2022; Mallappa et al., 2023; Pratik and Vinaya, 2022). In current era, popularization of various ICT tools among farmers resulting easy access of real time information (Samadder et al., 2024; Shukla et al., 2024a; Singh et al., 2024), still farmers are struggling for sufficient knowledge in relevant field. Poor knowledge and ill understanding of the IPM technologies among the farmers affecting even more typically vegetable crops where the crop loss is more due to pest and disease attack. Interestingly, Shukla et al., (2024b) reported that farmers need information about IPM practices utmost prominent basis by realizing its sustainable and cost-effective pest management way. In order to address the issue, present study was formulated with the following objectives:

OBJECTIVES

- (1) To assess the knowledge level regarding IPM technology among hybrid tomato growers.
- (2) To determine the factors affecting the knowledge level among hybrid tomato growers.

METHODOLOGY

An ex-post facto study was conducted for measuring knowledge level of hybrid tomato growers in Karnataka (India) state during 2019-2020. The Kolar district of Karnataka state was selected using purposive sampling technique as selected district was secured first position in terms of area as well as production both among districts of Karnataka. Two blocks of Kolar district viz., Srinivaspura and Mulbagal; and 3 villages from each selected block were chosen through simple random

sampling method. Furthermore, from each selected village, 20 respondents were selected on random basis. Thus, a total sample consisted of 120 respondents. Data were collected by interviewing respondents one-to-one, using a structured interview schedule.

In the context of the present study, 29 IPM practices were identified and considered in Knowledge Test for assessing the knowledge level of the respondents under 4 major heads viz., Cultural Practices (09), Physical Practices (08), Chemical Practices (06) and Biological Practices (06) after the consultation with Entomologist, subject matter specialist and the relevant literature. The respondents were asked to answer each question. The answer to each question may be 'Yes' or 'No' and the obtained knowledge score could range from 0 to 29.

For determining the effect of socio-economic variables over the knowledge level of respondents, multi-variate regression analysis was applied. Multivariate regression analysis explains the magnitude of variation over dependent variable *i.e.*, knowledge level, caused by independent variables (Lal et al., 2021; Shukla et al., 2022; Mallick et al., 2023; Singh et al., 2022 and Singh et al., 2023). In standardized multivariate regression analysis (SMRA), there is two Beta coefficients namely unstandardized regression coefficient (B) and standardized regression coefficient *i.e.*, Beta (β) obtained. The Beta (β) coefficient is more useful in comparing the importance of each variable predicting dependent variable (Nardi, 2006; Lal et al., 2016).

RESULTS AND DISCUSSION

The knowledge among the hybrid tomato cultivators about different IPM practices namely cultural, physical, chemical, and biological were measured on 29 particulars of knowledge test constructed for the purpose of study. The results of knowledge of respondents for different IPM practices encapsulated in Table 1, and discussed under the following headings:

Knowledge regarding cultural practices

The data on cultural practices of IPM were collected and the results related to the knowledge of farmers regarding these cultural practices are presented in the Table 1. The Table 1, reveals that majority of the respondents had knowledge about stacking immediately after flowering with the help of eucalyptus/bamboo sticks (96.67%) followed knowledge about by crop-rotation with different crops like (beans, field bean, capsicum, chilli) (95%), knowledge about timely removal and destruction of tomato stubbles and burning of residues (93.33%), knowledge about non-stocking of diseased plant near the field (91.67%), knowledge about summer

ploughing (90%), knowledge about different intercrops grow in hybrid tomato crop (okra, onion, radish) (71%), knowledge about different trap crops grown in hybrid tomato (marigold, maize, cucumber, cowpea) (35%), knowledge about non-burning of ldpe mulch papers (29.17%), and knowledge about photodegradable and biodegradable plastic mulch (26.67%).

Table 1: Knowledge level about IPM practices among hybrid tomato growers (n=120)

(A)	Cultural practices	Knowledge	No Knowledge
		Frequency (Percentage)	Frequency (Percentage)
1	Do you know about summer ploughing?	108 (90.00)	12 (10.00)
2	Do you know timely removal and destruction of tomato stubbles and burning of residues?	112 (93.33)	08 (6.67)
3	Do you know about non-stocking of diseased plant near the field?	110 (91.67)	10 (8.33)
4	Do you know about non-burning of LDPE mulch papers?	35 (29.17)	85 (70.83)
5	Do you know about photodegradable and biodegradable plastic mulch?	32 (26.67)	88 (73.33)
6	Do you know about the different trap crops grown in hybrid tomato (Marigold, Maize, Cucumber, Cowpea)?	42 (35.00)	78 (65.00)
7	Do you know about crop-rotation with different crops like (Beans, Field Bean, Capsicum, Chilli)?	114 (95.00)	06 (5.00)
8	Do you know about different Intercrops grow in hybrid tomato crop (Okra, Onion, Radish)?	86 (71.00)	34 (28.33)
9	Do you know about stacking immediately after flowering with the help of eucalyptus/bamboo sticks?	116 (96.67)	04 (3.33)
(B) Physical/mechanical practices			
1	Do you know about rouging of plants affected by bacterial wilt?	45 (37.50)	75 (62.50)
2	Do you know use of yellow sticky traps to control white flies?	104 (86.67)	16 (13.33)
3	Do you know use of flower model traps to control thrips?	17 (14.17)	103 (85.83)
4	Do you know use of mulching with black low-density polyethylene (LDPE) sheet to control weed growth and conserve moisture?	108 (90.00)	12 (10.00)
5	Do you know use of biodegradable plastic mulch which increases fruit yield and quality?	17 (14.17)	103 (85.83)
6	Do you know the use of light traps (2units/acre)?	34 (28.33)	86 (71.67)
7	Do you know use of green nylon net around hybrid tomato field to control white flies?	84 (70.00)	36 (30.00)
8	Do you know use of methyl eugenol pheromone trap to control fruit flies?	87 (72.50)	33 (27.50)
(C) Chemical practices			
1	Do you know about different systemic fungicides? (To control late blight)	99 (82.50)	21 (17.50)
a)	Dimethomorph 50% WP		
b)	Tebuconazole 25% EC		

c)	Metalaxyl 35% WP		
d)	Tricyclazole 45% + Hexaconazole 10% WG		
2	Do you know about different systemic and contact fungicides?	117 (97.50)	03 (2.50)
a)	Metalaxyl 8% + Mancozeb 64% WP		
b)	Tricyclazole 18% + Mancozeb 62% WP		
c)	Carbendazim 12% + Mancozeb 63% WP		
d)	Famoxadone 13% + cymoxanil 70% WP		
3	Do you know about different insecticides?	115 (95.83)	05 (4.17)
a)	Acephate 75% SP		
b)	Fipronil 5% SC		
c)	Spinosad 45% SC		
d)	Abamectin 1.9% EC		
e)	Lambda-cyhalothrin 150% ZC		
f)	Thiamethoxam 25% WG		
g)	Imidacloprid 40% WG		
4	Do you know about different systemic and contact insecticides?	111 (92.50)	09 (7.50)
a)	Betacyfluthrin 8.49% + Imidacloprid 19.81% OD		
b)	Fipronil 40% + Imidacloprid 40% WG		
c)	Cyantraniliprole 10.26% OD		
5	Do you know about selective and non-selective herbicides?	54 (45.00)	66 (55.00)
a)	Metribuzin 70% WP (selective)		
b)	Oxyfluorfen 23.5% EC (selective)		
c)	Paraquat Dichloride 24% SL (Non selective)		
d)	Glyphosate 41% SL (Non selective)		
6	Do you know about ETL of pest control?	23 (19.66)	97 (80.83)
D)	Biological practices		
1	Do you know about use of larval parasite like (<i>Bracon spp</i> , <i>Ichneumon spp</i> , <i>Campoletis spp</i>)?	04 (3.33)	116 (96.67)
2	Do you know about use of egg parasitoids like (<i>Trichogramma spp</i> , <i>Tetrastichus spp</i> , <i>Telonomus spp</i>)?	08 (6.67)	112 (93.33)
3	Do you know about use of predators like (Red ants, Dragonfly, Ladybird beetle)?	04 (3.33)	116 (96.67)
4	Grow pulses or cowpea on the bunds to build natural enemy fauna	83 (69.17)	37 (30.83)
5	NPV (Nuclear Polyhedrosis Virus) 100 LE /acre	03 (2.50)	117 (97.50)
6	Seed treatment with <i>Trichoderma viride</i> / <i>Trichoderma harzianum</i> (2g/100gm seed)	12 (10.00)	108 (90.00)

Knowledge regarding physical practices

The findings of Table 1, reveals knowledge about physical practices of IPM that majority of the respondents had knowledge about use of mulching with black low-density polyethylene (LDPE) sheet to control weed growth and conserve moisture (90%), followed by knowledge about use of yellow sticky traps to control white flies (86.67%), knowledge about use of methyl eugenol pheromone trap to

control fruit flies (72.05%), knowledge about use of green nylon net around hybrid tomato field to control white flies (70%), knowledge about rouging of plants affected by bacterial wilt (37.05%), knowledge about use of light traps (2units/acre) (28.22%), knowledge about use of flower model traps to control thrips (14.17%), and knowledge about use of biodegradable plastic mulch which increases fruit yield and quality (14.17%).

Knowledge regarding chemical practices

The Table 1 shows the results about chemical practices of IPM that majority of the respondents had knowledge about different systemic and contact fungicides (97.5%), followed by knowledge about different insecticides (to control chewing and sucking pest) (95.83%), knowledge about systemic and contact insecticides (92.05%), knowledge about different systemic fungicides (to control late blight) (82.05%), knowledge about selective and non-selective herbicides (to control weeds) (45%), knowledge about ETL of pest control (19.66%).

Knowledge regarding biological practices

The knowledge level of respondents regarding biological practices shown in the Table 1. These observations revealed that majority of the respondents had knowledge about grow pulses or cowpea on the bunds to build natural enemy fauna (69.17%), followed by knowledge about Seed treatment with *Trichoderma viride* / *Trichoderma harzianum* (2g/100gm seed) (10%), knowledge about use of egg parasitoids like (*Trichogramma spp.*, *Tetrastichus spp.*, *Telonomus spp.*) (6.67%), knowledge about use of larval parasite like (*Bracon spp.*, *Ichneumon spp.*, *Campoletis spp.*) (3.33%), knowledge about use of predators like (Red ants, Dragonfly, Ladybird beetle) (3.33%), knowledge about NPV (Nuclear Polyhedrosis Virus) 100 LE /acre (2.5%).

Over all Knowledge level of respondents about different IPM practices

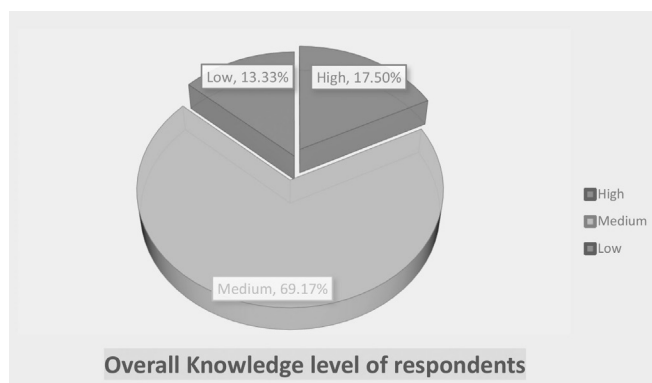


Fig. 1: Overall, Knowledge level of respondents about different IPM practices

From the Fig. 1, it can be said that overall knowledge level of respondents regarding various Integrated Pest Management (IPM) practices indicated a predominant medium level of understanding, comprising 69.10% of the sample, followed by 17.50% classified as high knowledge, and 13.33% categorized as low knowledge. These findings suggested a generally positive trend in knowledge acquisition

among respondents, with a notable portion exhibiting a high level of understanding. However, the presence of individuals with low knowledge underscores the importance of targeted educational interventions to address gaps and ensure comprehensive understanding of IPM practices. Efforts should focus on enhancing awareness and providing training opportunities to further elevate knowledge levels, thereby facilitating more effective and sustainable pest management strategies among practitioners.

Table 3 : Mean rank score of various broad categorise IPM practices (n=120)

Sr. No.	IPM Practices	Mean Score (\bar{x})	Rank
1	Cultural Practices	0.6991	II
2	Physical / mechanical practices	0.5167	III
3	Chemical practices	0.7208	I
4	Biological practices	0.1583	IV

The Table 2 presented the mean (\bar{x}) rank scores of various broad categories of Integrated Pest Management (IPM) practices. The Chemical practices ranked first (\bar{x} = 0.7208), indicating they were the most commonly used or preferred by farmers. Cultural practices (\bar{x} = 0.6991) were ranked second, suggesting a significant role in pest management. Physical/mechanical practices (\bar{x} = 0.5167) were ranked third, while biological practices (\bar{x} = 0.1583) ranked lowest *i.e.*, fourth. This suggested a higher knowledge in chemical control measures, with too limited knowledge of biological methods. The data reflected farmers' preference for quick and effective pest control but highlighted the need for broader adoption of sustainable IPM methods.

Regression analysis between socio-economic variables and knowledge level of hybrid tomato cultivators

Multi-variate regression analysis used to predict the magnitude of effect caused by various socio-economic (independent) variables over knowledge level (dependent variable) (Bandhavya *et al.*, 2022). From the Table 2, Coefficient of determination (R^2) was found 0.621 and could be interpreted as a percent ($R^2 \times 100$) of changes (*i.e.*, 62.1%) resulted in the consequent variable is due to variation in predictive variables. Unstandardized coefficient (unstandardized β - value) explore the magnitude of the effect, predictors have over a consequent variable *i.e.* knowledge level of tomato growers along with the direction of effect whether positive or negative. The p-value is determined by analysing the sampling distribution of the test statistic under the null hypothesis, along with the sample data and the type of test conducted. It is primarily used to assess the significance

of the relationship being studied.

Table 2: ANOVA value representing the robustness of multivariate regression model (n=120)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1035.406	9	115.045	20.018	.000***
Residual	632.186	110	5.747		
Total	1667.592	119			

Relational Analysis of Knowledge level (KL) and independent variables

There were seven out of nine independent variables,

Table 3: Multivariate regression analysis of socio-economic variables with knowledge level (KL) of the respondents (n=120)

Model	Unstandardized Coefficients		Standardized Coefficients β -Value	t-Value	p-Value	99.0% CI for Unstandardized β	
	B-Value	SE				Lower Bound	Upper Bound
Constant	11.035	2.129		5.182	0.000	5.453	16.616
1 Age	-0.164	0.023	-0.443	-7.163	0.000***	-0.223	-0.104
2 Year of schooling	0.332	0.074	0.298	4.495	0.000***	0.138	0.526
3 Tomato farming experience	0.056	0.031	0.110	1.829	0.070*	-0.024	0.136
4 Social participation	-0.026	0.057	-0.028	-.464	0.644	-0.175	0.123
5 Occupation	0.473	0.219	0.129	2.160	0.033**	-0.101	1.047
6 Annual family income	0.039	0.022	0.113	1.747	0.083*	-0.020	0.097
7 Extension contact	0.131	0.073	0.111	1.809	0.073*	-0.059	0.322
8 Mass media exposure	-0.028	0.065	-0.025	-.421	0.675	-0.199	0.144
9 Cosmopolitness	0.873	0.240	0.236	3.640	0.000***	0.244	1.502

R = 0.788
 $R^2 = 0.621$
 Adjusted R Square = 0.590
 Std. Error of the Estimate = 2.397

***Significant at 1% level
 **Significant at 5% level
 *Significant at 10% level

(1) Age

Age of the respondents was found to be negatively significant at $p < 0.01$, with 't' statistics value -7.163. The probability of Knowledge level was likely to decrease by a factor of 0.443 (standardized β -value) with unit increase in age of respondents, which is in line of the expectation because higher age group of respondents were not participating in training programmes frequently. This is expected as older respondents often do not participate in training programs regularly, leading to reduced exposure to new farming techniques and innovations.

(2) Year of Schooling

It was found to be statistically significant at $p < 0.01$ with the 't' statistics value of 4.495. The probability of

considered for regression analysis in this study, found significantly associated with the knowledge level of hybrid tomato cultivators at different levels of significance (Table 3). It is noteworthy that all of these significant variables were positively associated except one i.e., age which was found negatively associated and significant at 1% level. Variables like the year of schooling and cosmopolitness of farmers were positively significant at 1% level, while the occupation was significant at 5% level and experience in tomato farming, annual family income and extension contact were significant at 10% level of significance. However, social participation and mass media exposure were not found significantly associated with the knowledge level of tomato growers.

Knowledge level (KL) was likely to increase by a factor of 0.298 (standardized β -value) with unit increase in the schooling years of respondents. This shows that better-educated farmers are likely to acquire more knowledge, likely due to their ability to understand and adopt new methods efficiently.

(3) Tomato farming experience

It was found to be statistically significant at $p < 0.10$, with the 't' statistics value of 1.829. The probability of KL was likely to increase by a factor of 0.110 (standardized β -value) with unit increase in tomato farming experience of respondents. More experienced farmers are likely to accumulate practical knowledge, although experience alone may not always equate to advanced techniques or innovations.

Occupation: It was found to be statistically significant at $p < 0.05$, with the 't' statistics value of 2.160. The probability of KL was likely to increase by a factor of 0.129 (standardized β -value) with unit increase in the occupation variable. This reflects the commitment of full-time farmers to stay informed and develop expertise in their trade compared to part-time farmers.

(4) Annual family income (AFI)

AFI was found to be statistically significant at $p < 0.10$, with the 't' statistics value of 1.747. The probability of KL was likely to increase by a factor of 0.113 (standardized β -value) with unit increase in AFI. Wealthier farmers are better positioned to invest in education, resources, and technologies, enhancing their knowledge levels over time.

(5) Extension contact

It was found to be statistically significant at $p < 0.10$, with the 't' statistics value of 1.809. The probability of KL was likely to increase by a factor of 0.111 (standardized β -value) with unit increase in extension contact. This demonstrates the importance of agricultural advisory services in helping farmers stay informed and adopt best practices.

(7) Cosmopolitanness

It was found to be statistically significant at $p < 0.01$, with 't' statistics value of 3.640. The probability of KL was likely to increase by a factor of 0.236 (standardized β -value) with unit increase in cosmopolitanness. Farmers who engage with wider networks are more likely to adopt new knowledge and innovative techniques, enhancing their farming outcomes.

In a nutshell, this could be concluded that knowledge level about hybrid tomato cultivation will increase along with the improvement in educational status, cosmopolitanness, occupation, tomato farming experience, annual family income and proximity with extension personnel of the farmers. On the contrary, younger age farmers might be more knowledgeable than the older one.

CONCLUSION

The study conducted in Karnataka assessed the knowledge level of hybrid tomato growers regarding Integrated Pest Management (IPM) practices. It found that the majority of respondents exhibited medium-level knowledge of IPM methods, with chemical practices being the most understood, followed by cultural, physical, and biological practices. However, knowledge of biological practices was notably low. Across cultural, physical/mechanical, chemical, and biological practices, growers generally exhibit strong understanding in certain areas, such as crop rotation and the use

of systemic fungicides and insecticides. However, significant knowledge gaps persist, particularly concerning practices like the use of biodegradable mulch and certain biological pest control methods like the application of larval and egg parasitoids. In addressing these gaps, particular attention should be paid to enhancing awareness about biological pest control methods and the utilization of environmentally friendly alternatives to chemical pesticides. Training programs should emphasize the importance of practices such as using natural enemies to control pests and promoting biodiversity in agricultural ecosystems. The standardized multivariate regression analysis (SMRA), explored the factors such as education, cosmopolitanness, and occupation were positively associated with higher knowledge levels, while age showed a negative association. These findings underscore the need for targeted interventions aimed at improving educational access, extension services, and support systems to promote sustainable pest management practices and reduce reliance on chemical pesticides. By enhancing understanding and implementation of effective farming practices, such initiatives can contribute to more efficient and environmentally friendly hybrid tomato cultivation among farmers.

POLICY IMPLICATIONS

- (1) Targeted Training for Older Farmers: Policies should focus on tailored training programs for older farmers, addressing their lower knowledge levels and participation in IPM practices.
- (2) Enhanced Extension and Media Outreach: Strengthen agricultural extension services and media-driven education to increase access to information, improving knowledge of IPM and promoting sustainable farming practices across all age groups.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

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