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# Social Network Analysis - A Tool for Leveraging Effective Extension Work

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**The present study used the concepts of social network analysis to identify the communication networks of farmers of Chittambalam village, Palladam block of Tiruppur District in Tamil Nadu. Whole network approach was followed in the study to explicitly identify the communication network of vegetable farmers in the village. Name generator technique was used to collect network data. Comprehensive social network analysis software UCINET 6 was used to measure the network properties and NETDRAW for visual representation of network data. The findings revealed that only 9 % of all possible direct linkages are present in the network and the farmers were not well connected. This emphasized the need to increase the interconnections among the farmers in the network.**

**Key words:** Farmers, Social networks, Innovation, Adoption.

India is known as the country of villages with 70 per cent of its people residing in rural areas practicing agriculture as their livelihood (Deshpande, 2017). Indian agriculture dominated by subsistence farming activities is characterized by small farmers with high dependence on monsoon. Several breakthroughs in agricultural research supported by outreach activities have made India as one of the top producers of several crops. Despite this, agriculture growth has been varying widely due to lower levels of productivity brought about by lower levels of adoption of scientific technologies by farmers. Hence, facilitating the adoption of innovation by farmers is the need of hour to sustain agricultural productivity. In this regard, information of innovations is an important prerequisite for the successful adoption by farmers. To provide reliable information to farmers, an effective and efficient information delivery system is crucial (Demiryurek, 2008). Information dissemination role is now being played by public and private extension agencies mediated by information and communication technologies. But, considering formal channels as the only source of information to farmers may mask the reality as farmers heavily rely on informal interpersonal communication networks through social relationships for making decision on technology adoption. Thus, social ties are crucial for influencing the decision of farmers regarding the adoption of innovation. It is imperative to identify the key actors in the farmers' information network to increase the spread of innovations as farmers share with each other the profitability and optimal use of agricultural innovations to cope up with the uncertainties associated with the new technologies (Foster and Rosenzweig, 1995). Hence, extension efforts should focus on farmers' social networks for the promotion of agricultural innovations. The knowledge on information networks may help extension functionaries to get sensitized to the critical roles played by central actors in the diffusion process (Goswani and Basu 2011). Besides, this will facilitate policy makers to deliver reliable information with the aid of these influential actors (Haldar *et al.,* 2016). But the extension services and other programs that promote agricultural innovations may benefit from social networks only if the right networks that exclusively involve information exchange regarding agriculture were identified (Mekonnen *et al.,* 2016). This emphasized the need to study farmers' social networks. In this paper, the 'Social Network' analysis is different from the present-day usage of 'Social network' denoting virtual community. With this background, the present study was undertaken with the following objectives:

a) To study the profile characteristics of farmers.
b) To identify the existing information network of farmers.
c) To identify the network positionality of farmers in terms of prominence, influence and gatekeepers role.
d) To provide suggestions to facilitate extension work by effectively utilizing the identified key actors.

***Theoretical background***

A social network is described by two elements *i.e.* "nodes" represented by actors and "edges" that represent the relationships connecting the actors. The term node is often substituted with ego, vertices, entities, actors and the term edges is interchanged with ties throughout the paper. Farmers' social network is an interconnection of farmers, extension organization, and scientist facilitated by information

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exchange. Both tangible resources such as goods, money, etc., and intangibles such as information, social support or influence are being shared between the actors in the network (Haythornthwaite, 1996). Hence, the present study used the concepts of social network analysis to identify the farmers (actors) and their relationships. Social Network Analysis (SNA) approach is widely employed for studying the social networks of farmers. SNA developed as a distinct area of social science research that focuses on relationships of individuals rather concerned with the attributes of individuals. SNA is an innovative tool that maps and measures the relationship between units in the network (Wellman and Berkowitz, 1988). Further according to Wasserman and Faust (1994), SNA is the inquiry of a set of actors and a set of relations between them, the ways in which people are connected through various social familiarities ranging from casual acquaintance to close familiar bonds. Hence, modeling the relationship between farmers through SNA will give us insights about the most central actors such as opinion leaders, influencers, knowledge brokers, etc in the social network. The position/power or importance of different actors in the network can be measured by a network metrics called centrality. Degree, closeness and betweenness were the three most widely used indicators of centrality (Freeman, 1979). Degree centrality measures the direct connections each actor occupies in a relationship (Wasserman and Koehley, 1994). An actor with largest number of direct connections with other actors occupies the central position in the network. This measure defines the degree of participation of each actor in relation to the total number of ties between the actors of the network (Borgatti and Everett, 1997).

Closeness centrality is the measure of autonomy or independence of the actors (Freeman, 1979). Closeness centrality refers to the distance of an actor to other actors in the network i.e. how fast can an actor reach everyone in the network. To calculate the Closeness Degree, the geodesic distance of the actor in relation to all other actors in the network is added together, and then inverted, as the more distant, the less closeness (Borgatti and Everett, 1997).

Betweenness centrality identifies how likely is the actor to be the most direct route between two people in the networks. As an intermediary, actors with high betweenness centrality can play an important information role as knowledge brokers or gatekeepers by filtering and importing information into the network (Burt 1992b; Bodin and Crona 2009). Actors with high centrality scores are at the core of networks and are most important for the prioritization and coordination of joint actions (Bodin and Crona 2009). Further the characteristics of whole networks can be measured by network size denoting the no. of actors and density representing the cohesion of the network.

Networks can be classified as the sociocentric (whole network) and egocentric (personal network) depending on the selection of respondents for network data collection. Whole-network approach covers the entire population of a specific region to collect the information on connections among all existing pairs of actors in the network. Once the data of whole network are collected, the connections of an individual actor which is called an ego network can be extracted from the whole network data (Borgatti *et al.,* 2013).

## Material and Methods

The study was conducted in Chittambalam village, Palladam block of Tiruppur district. Based on the discussion with extension officials, the study area was selected considering the high level of group dynamism among farmers that was measured in terms of highest number of farmer groups and self help groups in the village. On this basis, Chittambalam village of Palladam block of Tiruppur district was purposively selected as it was relatively found to have good group cohesion among other villages. Whole network approach was followed in the study to explicitly identify the communication network specific to the selected group of farmers in a village. Farmers cultivating vegetable crops were exclusively selected. Snowball sampling method was employed for the selection of respondents. Name generator technique *i.e.* farmers were asked to mention the name of the farmers whom they consider for advice was used to elicit the network data. The data collection began with the progressive farmers of the village and each of the farmers was asked to name some of the farmers whom they seek and share farming related information. Then, all those farmers named were traced and asked for the same information until no new farmers were identified. Comprehensive social network analysis software UCINET 6 for windows was used for analyzing the network data and NETDRAW software for network visualization (Borgatti *et al.,* 2002). Network metrics i.e., cohesion was calculated for measuring whole network characteristics. For determining the central actors in the network, measures such as centrality (link among farmers), out-degree centrality (influence), in-degree centrality(prestige/prominence), closeness centrality (proximity) and betweenness centrality (liaison/strategic position) (Haldar *et al.,*2016) were calculated.

## Results and Discussion

### *Whole network properties*

The cohesion in the network is measured by the network size, density, number of ties and average degree in the network. The size of the network is 36 (34 farmers and two formal sources of information *viz.,* Agriculture officers (AOs) from State Department of Agriculture and Tamil Nadu Agricultural University) and the total no of ties is 117, which indicate that all the actors were connected with the web of 117 relations in the social network. The average degree value of 3.250 indicates that every farmer has an average of 3.250 connections in the network. Network density, which is a measure of cohesion in

the network, is 0.093. This implies that only 9 % of all possible direct linkages are present in the network and the farmers were not well connected.

**Table 1. Whole network properties of the information network**

| Whole network properties | Mean | Standard deviation | Maximum | Minimum |
|---|---|---|---|---|
| In Degree Centrality | 3.25 | 2.52 | 11 | 0 |
| Out Degree Centrality | 3.25 | 2.05 | 10 | 0 |
| In Closeness centrality | 118.89 | 26.74 | 245 | 86 |
| Out Closeness centrality | 118.89 | 34.82 | 245 | 79 |
| Betweenness centrality | 66.72 | 91.75 | 480.98 | 0 |

Hence, if any of the connections are removed, then the information may not reach all the farmers in the network. This emphasizes the need to increase the interconnections among the farmers in the network.

Table.1 reveals that the maximum in degree centrality score is 11 which indicate that a farmer was contacted by a maximum of 11 other farmers in the network to seek information related to their farming. So the farmer with highest indegree centrality score was considered to have high prestige among other farmers in the network. The maximum outdegree centrality score is 10 which indicate that a farmer has shared the information to a maximum of 10 other farmers in the network. This implies that the farmer with highest out degree centrality score was more influential than other farmers in the social network. The mean in closeness and out closeness centrality score of 118.89 denotes the average distance of the

**Table 2. Properties of ego networks**

| Degree centrality | | | | Closeness centrality | | | | Betweenness centrality | |
|---|---|---|---|---|---|---|---|---|---|
| Out degree centrality | | In degree centrality | | Out closeness centrality | | In closeness centrality | | | |
| Ego | Score | Ego | Score | Ego | Score | Ego | Score | Ego | Score |
| 5 | 10 | 12 | 11 | 23 | 245 | 22 | 245 | 5 | 480.98 |
| 15 | 6 | 5 | 10 | 36 | 245 | 33 | 148 | 20 | 222.26 |
| 16 | 6 | 10 | 8 | 4 | 143 | 2 | 145 | 13 | 194.10 |
| 19 | 6 | 13 | 6 | 24 | 141 | 24 | 138 | 10 | 169.57 |
| 20 | 6 | 15 | 6 | 26 | 138 | 36 | 135 | 12 | 146.46 |
| 28 | 6 | 20 | 6 | 9 | 130 | 23 | 133 | 21 | 120.14 |
| 12 | 5 | 21 | 5 | 14 | 129 | 30 | 131 | 28 | 119.63 |
| 1 | 4 | 1 | 4 | 32 | 129 | 9 | 127 | 1 | 93.99 |
| 2 | 4 | 6 | 4 | 30 | 128 | 17 | 127 | 6 | 93.96 |
| 6 | 4 | 19 | 4 | 3 | 127 | 29 | 127 | 19 | 88.42 |
| 10 | 4 | 25 | 4 | 31 | 126 | 8 | 126 | 11 | 64.51 |
| 11 | 4 | 31 | 4 | 17 | 125 | 16 | 126 | 15 | 60.99 |
| 18 | 4 | 34 | 4 | 8 | 120 | 3 | 122 | 34 | 60.08 |
| 29 | 4 | 35 | 4 | 34 | 119 | 14 | 120 | 32 | 58.88 |
| 8 | 3 | 17 | 3 | 25 | 115 | 19 | 119 | 25 | 55.45 |
| 13 | 3 | 26 | 3 | 1 | 114 | 31 | 119 | 29 | 50.45 |
| 17 | 3 | 3 | 2 | 6 | 114 | 7 | 118 | 26 | 49.45 |
| 22 | 3 | 4 | 2 | 21 | 113 | 27 | 118 | 4 | 48.47 |
| 24 | 3 | 8 | 2 | 35 | 111 | 18 | 117 | 35 | 42.01 |
| 27 | 3 | 11 | 2 | 7 | 109 | 28 | 116 | 30 | 36.76 |
| 31 | 3 | 16 | 2 | 22 | 109 | 32 | 116 | 17 | 35.53 |
| 33 | 3 | 18 | 2 | 29 | 107 | 1 | 113 | 31 | 34.41 |
| 34 | 3 | 23 | 2 | 33 | 107 | 15 | 112 | 2 | 26.10 |
| 3 | 2 | 24 | 2 | 27 | 105 | 6 | 111 | 24 | 13.23 |
| 4 | 2 | 28 | 2 | 2 | 100 | 11 | 111 | 18 | 12.32 |
| 7 | 2 | 30 | 2 | 11 | 99 | 34 | 110 | 16 | 8.98 |
| 21 | 2 | 32 | 2 | 20 | 99 | 4 | 103 | 3 | 7.88 |
| 25 | 2 | 36 | 2 | 18 | 98 | 25 | 103 | 27 | 3.50 |
| 30 | 2 | 2 | 1 | 12 | 97 | 20 | 99 | 8 | 3.00 |
| 9 | 1 | 7 | 1 | 13 | 96 | 26 | 97 | 33 | 0.50 |
| 14 | 1 | 9 | 1 | 15 | 96 | 35 | 97 | 7 | 0.00 |
| 26 | 1 | 14 | 1 | 16 | 96 | 12 | 95 | 9 | 0.00 |
| 32 | 1 | 27 | 1 | 19 | 96 | 21 | 92 | 14 | 0.00 |
| 35 | 1 | 29 | 1 | 10 | 94 | 10 | 90 | 22 | 0.00 |
| 23 | 0 | 33 | 1 | 28 | 81 | 13 | 88 | 23 | 0.00 |
| 36 | 0 | 22 | 0 | 5 | 79 | 5 | 86 | 36 | 0.00 |

farmer to all other farmers in the network. Maximum in centrality and out centrality score is 245, which indicate the maximum distance of a farmer to all other

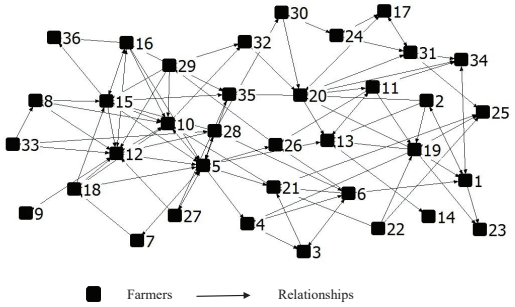


**Fig 1. Farmers Information Network**

farmers in the network is 245. The highest in and out centrality scores of the farmers represent their level of autonomy i.e. low level of participation in the network. The lowest in centrality score is 86. This refers to the nearness of the farmer to all other farmers in seeking information. Hence, a farmer with in centrality score of 86 is highly accessed by other farmers for getting information. The lowest out centrality score is 79. This refers to the nearness of the farmer to all other farmers in sharing information i.e. a farmer without centrality score of 79 is actively involved in the sharing of information in the network. The mean betweenness centrality score is 66.72. The maximum betweenness score is 480.98. Hence, the farmers with highest betweenness score are likely to play the gatekeepers role in the network.

To identify the central role played by few farmers in the network, properties of ego networks were determined. The properties of the entire ego's *i.e.* 34 (No. 1-34 in Fig 1) farmers and 2 (No. 35, 36 in Fig.1) formal institutions were presented in the table 3. The farmers/actors with highest degree and betweenness centrality scores were considered to be the central actors in the network and those with highest closeness centrality scores were found to be the isolates.

Table.2 reveals that in terms of degree centrality, actors 5, 15, 16, 19 (out-degree) and actors 12, 5, 10 (in-degree) were the central actors in the network. Overall, actor 5 has the highest out degree centrality score and actor 12 followed by 5 has the highest in degree centrality scores. Hence, actor 5 is more influential in the network and actor 12 and 5 has gained prestige/prominence in the network.

Regarding betweenness centrality scores, central actors in the network are 5, 20, 13, 10. Actor 5 has the highest betweenness centrality score which means he played the broker/gatekeeper role in the network. Actor 5 controls the flow of information in the network.

In terms of closeness centrality, actors with lowest centrality scores were the central actors. Here actors 5 followed by 28, 10 has the lowest out closeness centrality scores and 5 followed by 13, 10 has the lowest in closeness centrality scores. Actors 23 followed by 4 has the highest out closeness centrality scores and actor 22 followed by 33 has the highest in closeness centrality scores. Here the actors 23 and 22 were far to all other actors in the network with respect to information sharing and seeking respectively. Hence, these actors were found to be the isolates in the network.

**Table 3. Distribution of respondents based on their profile**

| Profile | Category | Number | Per cent |
|---|---|---|---|
| Age | Young | 2 | 5.88 |
| | Middle | 12 | 35.30 |
| | Old | 20 | 58.82 |
| Gender | Male | 32 | 94.12 |
| | Female | 2 | 5.88 |
| Educational Status | Illiterate | 0 | 0.00 |
| | Functionally literate | 0 | 0.00 |
| | Primary education | 10 | 29.41 |
| | Middle education | 17 | 50.00 |
| | Secondary education | 6 | 17.65 |
| | Collegiate education | 1 | 2.94 |
| Farming Experience | Low | 8 | 23.53 |
| | Medium | 16 | 47.06 |
| | High | 10 | 29.41 |
| Extension Participation | Participated | 15 | 44.12 |
| | Not participated | 19 | 55.88 |

Table.3 shows that more than half of the respondents (58.82 %) belonged to old age category followed by 35.30 % of respondents in the middle aged category and 5.88 % of farmers in the young aged category. From the visual check of networks in Fig. 2 (a), it was observed that young farmers had more no of relationships with the fellow farmers than middle and old farmers which shows their interests to information exposure and their active involvement in the information exchange.

A vast majority of the respondents (94.12 %) were male farmers and the remaining 5.88 % of them were female farmers. It is visible from the network structure from Fig. 2(b) that male farmers are well embedded in the network than female farmers. Female farmers have only sparse connections with other farmers. This might be due to the geographical proximity because female farmers' information network is confined only to their relatives and neighbours. In case of male farmers, they tend to establish more connections as they actively participate in meetings, trainings etc which pave way for them to get along with other farmers. Hence, male farmers played the central roles in the network.

Regarding educational status, about half (50.00 %) of the respondents had middle education followed by 29. 41, 17.65, 2.94 % of the respondents in the primary, secondary and collegiate levels of education respectively. From the network appearance in Fig. 2

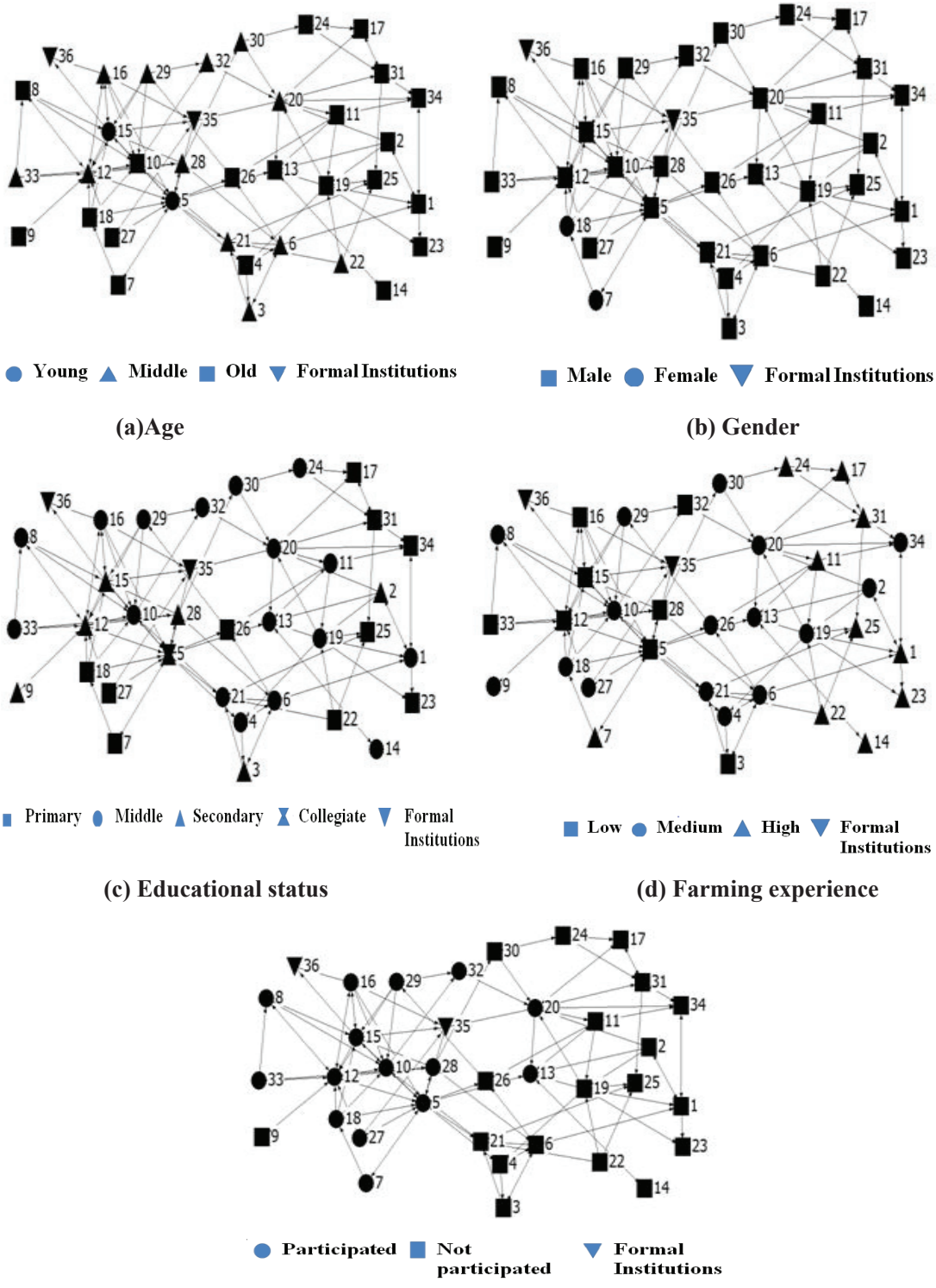


**Fig 2. Distribution of respondents based on their profile**

(c), it is clearly seen that farmers with higher levels of education has higher no of connections in the network.

About 47.06 % of the respondents had medium level of farming experience followed by high (29.41 %) and low (23.53 %) levels of farming experience. From the network's visual appearance in Fig. 2(d), it is visible that the farmers with higher connections are equally distributed at all levels of farming experience.

Regarding extension participation, more than half of the respondents (55.88 %) had not participated in any trainings, exposure visits, farm schools, meetings,

etc. About 44.12 % of the respondents had actively participated in the extension activities. From the network structure depicted in Fig. 2 (e), it could be concluded that farmers who participated in extension activities has gained more prominence in the network that is represented by more no of relationships with fellow farmers.

***Policy suggestions for effective extension work***

The following policy suggestions are proposed for improving the extension work: The central of key farmers in the identified information network could be effectively used to disseminate the information of new scientific technologies, development programmes, subsidies, *etc.,* needed by the farming community. Extension agency should strengthen peer-to-peer interactions by creating more new links among farmers through mobilizing them into viable groups, organizing frequent group meetings, exposure visits, trainings *etc.,* and thereby ensuring information flow to the isolated actors in the network. Active women farmers may be selected and used as contact farmers for ensuring active involvement of women in the network. The information generated on social networks can be used for the design and development of extension strategies for future innovation adoption process specific to that area.

## Conclusion

The study revealed that majority of the respondents were old aged, male farmers with middle level of education and possessing medium level of farming experience with more than two-fifths of the respondents participating in extension activities. From the visual check of networks, it was found that young aged male farmers with higher levels of education and extension participation were well connected in the network. It was found that only 9 % of all possible direct linkages are present in the network and the farmers were not well connected. Regarding positionality of farmers in the network (Fig.1), farmer No. 5 was found to be the most influential, playing the gatekeeper role in the network and farmer No. 12 has gained more prestige/prominence in the network. Hence, the extension officials could increase the interconnections in the existing communication network by effectively utilizing the identified key farmers for faster information delivery.

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