Innovative Technology Transfer for Perennial Trees

The case of coffee stumping

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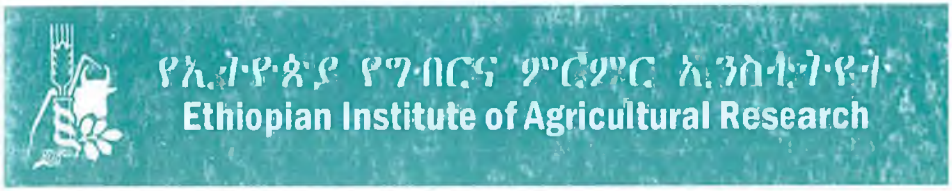

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Introduction

Perennial tree crops such as coffee and fruits play prominent role in the national economy and livelihood of the farming communities in different parts of Ethiopia. In particular, coffee is of particular significance in the socio-economic and cultural lives of the people. At present, it contributes over 40% of the export earning as well as provides livelihood to over 25% of the population (about 15 million people) engaged in its production, processing, and marketing. The total area under coffee is estimated at 600,000 hectares, with a total annual production of 350,000-400,000 tons (Alemayehu, 2006), making Ethiopia Africa's first largest producer of Arabica coffee. Being the centre of origin and genetic diversity for Arabica coffee, Ethiopia is endowed with numerous coffee types that are recognized in international markets for their unique taste and flavor.

Despite its important role in the national economy and given the wealth of genetic diversity and climatic suitability, productivity of the crop remained low with a national average of about 472 kg ha^{-1} (Workafes and Kassu, 2000). Realizing the immense potential and contribution of this crop, research has committed considerable resources and efforts to generate technologies that would enhance its production and productivity. Attempts have also been made both by Jimma Research Center and extension agencies to transfer the research outputs to end-users. However, most of the improved technologies have not reached and been widely used by the farming communities. In general, efforts made in the last two decades to improve the productivity

of coffee in the peasant sector have achieved little success (Workafes and Kassu, 2000). One of the reasons that limited productivity of the crop is believed to be the low adoption of improved technologies.

One of the major factors limiting adoption of improved coffee technologies in particular and that of perennial tree crops in general in the Ethiopian context is, undoubtedly, lack of effective and efficient mechanisms and approach to disseminate the technologies and ensure wider acceptance among end-users. The challenges and difficulties in transferring these technologies primarily emanate from the perennial nature and long juvenile growth stage of the crops. Several years experience with research-center based technology transfer shows that relying on the commonly used methods of technology transfer such as on-farm demonstration, classical training, and extension publication have proven to be less effective with perennial crops.

It is apparent that demonstration fields have to be well managed; treatments should be properly applied, and they should clearly show the effects and performance of innovations as compared to the traditional ones if demonstrations are to have the desired effects. Experiences of JRC with demonstration on coffee technologies show that, unlike the case with annual crops, on-farm demonstration of perennial tree crops is challenging and it sometimes can fail to achieve the intended objective. Van den ban, *et al* (1996), underline that failure of demonstration leads to loss of faith in the innovation, which may take a long time to overcome because of the psychological resistance.

The Challenges

Coffee is a perennial tree crop and farmers have made huge investment and often were not willing to superimpose treatments (such as stumping). They feel that changing existing practices with new ones would be a risky business as it takes long time to correct any faults; or even failures might be irreversible. So, it was not easy to secure farmers' fields, willingness and heartfelt cooperation for on-farm demonstration, especially for practices such as stumping.

Unlike annual crops, it takes longer time to show the performance and effects of new practices on coffee. Owing to the length of time, the trials are very likely to be exposed to external interventions and distortion. Farmers often appeared to lack the patience, commitment, and time to carefully apply recommended practices and properly manage the demonstration fields for several years.

Unlike annual crops, it requires large field, which is difficult to obtain from smallholder farmers. In most cases, large plots are not available, or farmers are not willing to commit larger field to demonstration trials due to fear of risk.

Owing to these problems, though attempts were made both by the extension agents and the Jimma Research Center (JRC) to promote improved coffee management practices such as stumping, they have not been widely accepted by farmers. Thus, experience and the facts

outlined above necessitated the search for other alternative approaches and complementary methods of technology transfer. To this end, the Research-Extension division of JRC has designed and implemented an effective approach to address this concern. This study was initiated with the objective of introducing and popularizing improved coffee technologies, with major emphasis on stumping and associated coffee management practices using alternative and innovative approaches. Investigation of farmers' preference for the rejuvenation methods (and evaluating the effectiveness of the approaches and strategies used were among the objectives of the project. This research report thus presents how on-station demonstration, hands-on training exercises, video, farmer-to-farmer extension and other complementary approaches were effectively used to promote coffee stumping and related practices in the Jimma areas of South-West Ethiopia.

The Study Area

The activity was initially started on Jimma Research Centre main station and gradually extended to Mana and Goma *woredas* – the major coffee producing woredas of Jimma Zone, situated on Northwest of Jimma town. The two woredas were selected because of the importance of coffee in their farming systems and their proximity to the center. With a total area of 134,913 hectares, Goma *woreda* has a total population of about 99,870; while Mana has an estimated population of around 146,407 and a total area of 399.96 km^2. The vast majority of the population of the two *woredas* is smallholder farmers residing in rural areas.

The area has enormous resource-base and favorable agro-ecology for agricultural activities. Thus, agriculture is the main economic activity in the area, mainly with small-scale mixed farming systems—combining crop cultivation and livestock production. The area particularly has highly conducive agro-ecology for coffee production and a significant proportion of the population derive their livelihood from this sector. In addition to coffee, different types of crops are grown in the area, including cereals (such as maize, sorghum, and tef), some pulses, fruits, vegetables, and root crops. The woredas also have considerable livestock population, the major ones being cattle, sheep, goats, bovine, and poultry. However, despite the tremendous efforts made by research in generating improved technologies and the proximity of the woredas to JRC, traditional farming practices still predominate in the area.

Technologies Popularized

Exhaustion of coffee trees due to old age, lack of proper rejuvenation practices, disease and pests, and traditional ways of management employed by the smallholder producers are often mentioned as some of the major factors limiting the production and productivity of coffee (Yacob et al, 1996; Tesfaye et al, 1998). Over the past decades, the Jimma Research Centre has been making relentless efforts to address most of these problems by generating various improved coffee technologies or management practices. Recommendation on old coffee rejuvenation techniques is one of the improved coffee technologies developed by the center.

More than two third of the coffee managed by smallholders in Ethiopia is very old with declining productivity. Especially, most of the forest coffee consists of extremely aged coffee trees. These old coffee trees are extremely exhausted and give low yield, produce beans of low quality, as well as create difficulties during harvesting, in tree/field management, and during disease and pest control. Thus, these old, exhausted, unproductive, and uneconomical coffee trees need to be rejuvenated to renovate and invigorate their bearing capacity as well as to adjust the height to manageable proportion to facilitate harvesting and tree/field management. There are several ways of old coffee rejuvenation, which include stumping, agoviado, layering, eskeltamento and decote. Morphology (spatial arrangement) of coffee trees, stem nature of the cultivars (flexible or stiff), spacing (plant population density)

(Yacob et al, 1996), economy and energy of the people who carry out the operation and management system could influence the adoption of the different rejuvenation methods (Anteneh and Wosene, 2002). For instance, it would be difficult to practice layering and agoviado on coffee trees with huge and stiff stem. Particularly, the bulk of the forest and semi-forest coffee have very huge and stiff stem, necessitating selection of stumping practice. In view of this reality, JRC had conducted a number of on-farm demonstrations especially to introduce stumping and associated practices. The government extension agency also attempted to introduce stumping practices to the farming community. However, stumping has not been well adopted and widely used by farmers. Thus, the vast majority of farmers remained with old coffee with extremely low productivity. Apart from low adoption of stumping practice, it was also realized that farmers were not fully aware of the improved management practices that should follow stumping. Even those farmers who stumped their coffee tended to neglect and deny necessary management after stumping; thus most of the stumped fields were left un-weeded, lacked proper sucker control and population adjustment, shade management, etc. Generally, little or no attempt was made to equip farmers with the necessary information, knowledge, and practical skills. Realizing the shortfalls of the previous technology transfer approaches, on the one hand, and the necessity of widely disseminating stumping practice, on the other hand, this project was launched with an innovative approach to popularize and disseminate coffee rejuvenation techniques mainly stumping and associated management practices.

Stumping is one of the commonest methods of rejuvenating old coffee. It is a rejuvenation technique whereby the stem is stumped at 30-45cm height above the ground and normally takes place after harvest in the months of January and February. In order to increase the success of rejuvenation, the exhausted coffee tree has to be stumped back at 45 degree angle; i.e. in slant position. It is the following advantages

- provides manageable tree height, and facilitates harvest and other management practices,
- improves productivity as well as sustains yield over years,
- improves quality, especially bean size,
- renovates the tree and prolongs its life, and
- mnimizes disease incidence; especially, facilitates disease and pest control.

Methods and Approaches

It was noticed that farmers had distorted views and negative perception and attitude about stumping. Necessary knowledge and skills of stumping were also meager among farmers. The approach, therefore, aimed at persuading farmers of the merits and performance of stumping to boost their confidence and stimulate them to accept and use. Effort was also made to equip both farmers and extension workers with the necessary knowledge and skills on proper coffee rejuvenation techniques (stumping), post-stumping management and other complementary practices. A number of complementary methods were used to expose farmers to the recommended practices and provide adequate information to enable them make informed decision regarding their use.

Technology Transfer Mechanisms

A combination of on-station demonstration and other complementary methods were used to attain the above-mentioned broad purposes. The principal mechanisms used include:

- on-station demonstration,
- hands-on training,
- on-farm demonstration of selected technologies,
- field days and field visits,
- use of video, and
- farmer-to-farmer diffusion and follow-up.

On-station *versus* on-farm demonstration

On-farm demonstration is a demonstration activity that is carried out on farmers' fields and implemented through various degrees of involvement of farmers, researchers, and/or extension workers. It is the most commonly used technology transfer method. Because it is believed that on-farm demonstration:

- allows farmers to actively take part in the implementation of the trials,
- enables farmers to evaluate the performance of the new innovation under actual field condition, and
- facilitates dissemination of information and innovation through farmer-to-farmer extension.

In view of these merits, many proponents of participatory research and extension stress that on-farm demonstration should be used in evaluating and introducing new technologies/practices to users. It has also practically proved to be effective, especially, for annual crops, but was found to be challenging for perennial crops. Though the main essence of taking demonstrations to farmers' fields is to promote farmers' active participation in different stages of the activity, experience, however, shows that researchers and extensionists tend to be the major players in the implementation of on-farm demonstrations. In most cases, farmers' role is limited to offering trial fields and in carrying out some field management activities.

In the case of on-station demonstration, demonstration trails are established on research station specifically for this purpose or existing experimental trials can be

modified and used to show how to perform certain tasks or the performance and results of the improved technologies. In fact, on-farm demonstration had been predominantly used by Jimma Research Center to transfer improved technologies of perennial crops for several years, but the outcome had not been encouraging. Thus, drawing on lessons and experience, on-station demonstration has been considered an effective complementary or alternative mechanism for perennial crops technology transfer and used for this specific activity. It was seen as a viable way of overcoming the challenges of on-farm demonstration for perennial crops such as coffee.

Technology transfer processes

Initially, on-station demonstration plots were prepared with two common alternative ways of coffee rejuvenation techniques (stumping and agoviado). For this purpose, two separate on-station old coffee fields were selected from already established trial fields at JRC to demonstrate both techniques of rejuvenation. One of the fields was divided into five plots and coffee trees on four of the plots were stumped at the right time (right after harvesting). Each plot was assigned a specific number of suckers (two, four, six, and uncontrolled), while the fifth plot remained un-stumped to serve as a control plot. On the second coffee field, agoviado was practiced by dividing the field into two plots. Coffee trees on one of the plots bent down to initiate sucker growth, while the second plot served as a control. All necessary management practices were applied to the demonstration fields.

Then Goma and Mana *woredas* were visited by the Research-extension staff of JRC and a series of

discussions were held with farmers and relevant staff in the agricultural development offices. The objectives and plans were clearly explained to relevant woreda staff and officials and their commitment was secured. Then thirty volunteer farmers who own old coffee fields were selected from the two woredas in collaboration with extension staff. The selected farmers along with their respective extension workers were invited to JRC to visit those on-station demonstration fields and to receive training on the recommended practices. They were encouraged to closely observe the different plots and evaluate their performance.

Other associated coffee production and protection practices such as fertilizer application, proper spacing, sucker control, soil conservation practices, weed management, disease control/management, and shade regulation were also demonstrated to the participating farmers. During the same event, they received practical training on the how-to-do of the recommended practices, and were also given an opportunity to practice the stumping operation and received feedback from researchers on their performance. Then all farmers were encouraged to select technologies/practices of their interest, which they think will alleviate their production constraints and want to use on their farms. Interested farmers were registered and action plan was prepared for each of them. Based on the action plan, farmers received additional training and technical assistance from JRC staff in their village and stumped their coffee and properly applied the necessary inputs and recommended management practices. In particular, close follow-up was

made and farmers were assisted on proper sucker control and fertilizer application practices.

The process was repeated for three years with three groups of different farmers. In addition, localized field days were organized on the farmers' stumped fields from the second year onwards and the events were attended by local government officials, extension staff, neighboring farmers, and researchers. Apart from demonstrating the performance of the stumping practices, the field days were also used as important forum to select and register volunteers to be involved in the next years' program. The practices, experiences, and opinions of those farmers who stumped their coffee were recorded by video and used to teach and convince other farmers. Finally, a simple survey was carried out using brief questionnaire to assess extent of lateral diffusion of information and stumping practice, and to evaluate the effectiveness of the approach.

Results and Discussions

Achievements

Based on the action plan prepared for each farmer, the Research-Extension staff of JRC together with the local extension staff visited each farmer and provided technical support in implementing the plan (stumping or agoviado) during the right season. Almost all participating farmers showed preference for stumping as the best method to rejuvenate their old coffee trees. However, during the first year, two of the 30 farmers visited the on-station demonstration chose to apply agoviado, while three farmers decided to adopt both stumping and agoviado. The remaining (25 farmers) practiced stumping.

Farmers were encouraged and allowed to stump as many number of coffee trees as they wanted (Table 1). After stumping, close follow-up had been made, and farmers received technical backstopping and applied recommended practices. In particular, proper fertilization, sucker control, weed management, and shade regulation were performed on the stumped field.

Table 1. Number of coffee trees stumped in Mana and Goma woredas (2002 – 2004)

No of coffee trees stumped	2002	2003	2004	Total
Maximum number of coffee trees stumped per farmer	135	618	200	
Minimum number of coffee trees stumped per farmer	11	14	18	
Mean number of coffee trees stumped per farmer	58	89	76	
Total number of coffee trees stumped	758	2768	1827	5353

After one year, a second batch consisting of 31 volunteer farmers were selected and visited the on-station demonstration as well as received practical training on coffee stumping techniques and associated practices. Localized field days were also organized and stumped coffee fields of participating farmers were visited. The field days helped to observe and evaluate the performance or results of stumping practice on farmers' fields, to discuss and share ideas and experiences, as well as to obtain feedback. The performance of the practice under farmers' real condition and the experiences of fellow farmers helped neighboring farmers to develop confidence in stumping and encouraged them to copy the practices. During the second year, all the 31 farmers participated in the project chose to apply only stumping.

During the third year, instead of on-station fields, stumped farmers' fields were used as demonstration and training sites to show, teach and convince farmers. Accordingly, field days were locally organized and 30 farmers were registered voluntarily to stump their coffee trees. It was realized that farmers were very much enthusiastic to take part in the activity and large number of farmers were asking to be involved in the project and to get JRC's technical support. This clearly indicates that the approach used by the project played crucial role in convincing farmers and in boosting their confidence in stumping practice. The field days and open days were also important platforms for researchers to obtain feedback on the performance of the technologies, as well as helped to identify gaps and researchable areas. Table 2 indicates categories and number of participants attended the field days during the second and third years.

Over the three years, 87 farmers directly participated in the activity and stumped their coffee. In addition, though it was not yet quantified, it was noted that large number of farmers adopted the practice after attending the field days and by copying from their friends, without direct technical support from research. In addition, 18 extension workers received training on stumping techniques and related coffee management practices. In general, about 5353 coffee trees were stumped with direct assistance and follow up from JRC (Table 1). The figures indicated in Table 1, however, represents only the number of coffee trees stumped by those farmers who were directly involved in the project. The result of the questionnaire assessment also shows that there was enormous lateral diffusion of stumping and related practices.

Table 2. Number and categories of participants attended the field days on farmers' fields

Year	Farmers	Development agents	Woreda experts and officials	Researchers	Total
2002/03	112	5	6	10	133
2003/04	119	6	7	12	144
Total	231	11	13	22	277

Enhanced application of stumping

One of the most important positive outcomes of the project is that farmers are now fully aware of and able to apply necessary cares/precautions and activities related to stumping. Because the effectiveness and success of stumping practices heavily depend on proper application of the complementary activities precedes and following stumping.

Prior to the initiation of the project, there was widespread lack of knowledge and reluctance among farmers regarding the cares and pre-cautions that need to be taken before, during and following stumping. Extension workers also often tended to put much emphasis on the number of stumped trees to fulfill the assigned quota with little or no attention to other important aspects. This particularly aggravated transmission of diseases such as coffee wilt, and ultimately led to lack of confidence and interest in stumping. Thus, the current activity made enormous effort to address these issues, and consequently farmers now started demonstrating proper use and application of necessary cares and precautions. All farmers who participated in the project as well as those who attended the field days received awareness raising training with regard to the potential role stumping can play in spreading coffee wilt disease, if necessary cares are not taken. The following issues were given emphasis in this respect:

- how to identify coffee trees infected by coffee wilt disease,
- the role of stumping in spreading coffee wilt disease, and
- precautions to be taken prior to, during and after stumping such as:
  - avoiding stumping of infected trees,
  - avoiding sharing farm tools among neighbors,
  - disinfecting farm tools,
  - protecting tree or root damage during cultivation and weeding,
  - proper tree and field management, and other related issues.

Moreover, farmers have now clearly understood the importance of maintaining recommended tree population density, shade management (thinning or planting as necessary), proper fertilization and weed management as the newly developed suckers need care and intensive management. In addition, selection of suckers to be retained on the stumped coffee trees and desuckering is crucial operations that should be performed carefully and regularly following stumping. In determining number of suckers to be left on a stumped coffee tree, a number of factors need to be considered. These include, among others: fertility of the soil, shade level, plant population density, and variety, especially, the nature of the canopy. Experience, however, shows that sucker control is often overlooked or undermined by both farmers and extension workers. Farmers were inclined to retain as many suckers as possible. The current activity, however, clearly demonstrated to and convinced farmers about the importance of sucker control; preferably two suckers. As a result, farmers have now started practicing proper and timely sucker control activities.

Impact on technology transfer

Drawing on the insights and lesson learned, and after thorough assessment of the results so far achieved, the center identified stumping as one of the promising potential areas of intervention and decided to massively scale-up through its "Research for Development" program. Moreover, the stumped farmers' fields, participating farmers' experience, and opinion regarding the performance and merits of stumping were recorded by a video and is being used to teach others as farmers are more likely to accept what they have heard or seen from

their colleagues. This also played prominent role in convincing and encouraging farmers to adopt stumping. In addition, it was noted that the activity helped the government's extension effort in promoting coffee stumping as a major extension package activity in recent years. Farmers were stimulated to visit the stumped farms in their villages. Participating farmers were also encouraged to disseminate the information to their neighbors on various forums. It was clearly noted and acknowledged by the extension workers that farmers of the two woredas near the JRC's stumping activities were convinced of the importance of stumping and tended to accept the practice. This activity also played important role in developing the capacity of local extension workers with regard to stumping and related coffee management practices.

Results of an Assessment

An assessment was carried out in 2005, using a brief questionnaire to assess the extent of farmer-to-farmer lateral diffusion of the information and stumping practices, as well as the effectiveness of the process. For this purpose, 51 farmers who took part in the stumping activity were interviewed, of which 41 were from Mana and 10 from Goma woreda. About 94% (48 respondents) were male while 6% were female, with a mean age of 41 years. Respondents' coffee farm size ranges from 0.13 to 2.00 ha, with a mean holding of 0.50 ha. This shows that participating farmers were smallholder coffee producers.

Extent of lateral diffusion and prospect of stumping

As indicated in the following table, 26% of the respondents started stumping in 2002, while 35% and 40% reported starting in 2003 and 2004, respectively.

Table 3. Percent of respondents stumped their coffee and number of trees stumped each year (N = 51)

Year	% of respondents stumped their coffee	Number of coffee trees stumped by respondents		
		Minimum	Maximum	Mean
First (2002)	26	15	250	84
Second (2003)	35	0	600	42
Third (2004)	40	* -	* -	* -

* *Data was not taken for the third year in terms of individual farmer*

The interviewed farmers indicated that on average, they stumped 84 trees during the initial year of participation. Though the mean number of trees stumped per farmer decreased during the second year of participation, some farmers developed confidence and stumped as large as 600 coffee trees. The reduction in mean number of stumped trees per farmer in their second year of participation could also be because they stumped the large part of their field during their initial year of participation. It was also interesting to note that more than three-quarter of the respondents (79%) indicated that they stumped their coffee during the second year of participation as well, with a mean of 42 stumped trees. This thus shows that farmers realized the importance of stumping and continued to stump on their own during subsequent years. Similarly, almost all respondents (98%) indicated that they will continue stumping the remaining old coffee trees in the future, similarly implying that farmers were

convinced and realized the importance of stumping. This also shows the effectiveness of the approach in bringing attitudinal change among farmers regarding stumping. When asked weather they taught some one about stumping, 69% of the respondents said they taught some friends or neighbors, while 31% said they did not. Similarly, 34% of the respondents indicated that at least one person has practically copied from them and started using the practice. This also shows the effectiveness of the approach followed in promoting farmer-to-farmer technology/information dissemination.

Age of coffee trees stumped

The age of the coffee trees stumped by respondents ranges between 30 and 90 years, with an average of 48.5 years. Surprisingly more than 8% and 4 % reported that they stumped trees older than 60 and 70 years, respectively. Similarly, the age of the coffee trees stumped by the overwhelming majority of the respondents (80%) ranged between 40 and 70 years. This clearly shows that most farmers possess or manage very old and exhausted coffee trees that critically need to be rejuvenated.

Opinion of respondents on advantages of stumping

When respondents were asked about the advantages they realized from stumping, the majority (78%) mentioned newness of the coffee trees as the main advantage, though some respondents mentioned improved yield, ease of harvesting, and presence of free space for intercropping – thus contributes to food security. More than 92% of the respondents mentioned yield loss (for one or two years),

and intensive management requirement as the major drawbacks of stumping.

Opinion of respondents on cares during stumping

Virtually all respondents mentioned disinfecting farm tools and avoiding stumping infected trees as the major precautions that need to be taken during stumping, showing that those farmers who were involved in the activity were fully aware of the potential of stumping in transmitting coffee wilt disease unless the necessary care is taken. But they appeared to be reluctant to avoid slashing which is believed to be one of the practices aggravating transmission of coffee wilt disease.

Lessons Learned

It has become obvious that on-station demonstration can play crucial role, especially in the transfer of perennial crops technologies. The role of other complementary methods was also prominent. Apparently that different technology popularization and transfer mechanisms have greater complementary role and should be used in combination.

It was clearly noticed that on-station demonstration, farmers' days and on-station visit give farmers the opportunity to see what the research station is doing and what is available in the center. It helps farmers to develop interest and encourages them to make requisition for new technologies that are available in the research center, especially for improved seeds. It also plays important role in establishing good rapport between researchers, extension workers and farmers.

It was noticed that after stumping, farmers tend to keep as many number of suckers as possible. But it has become evident that through close follow up and training/advice farmers can realize the importance of keeping desirably few and only productive suckers.

It has been realized that farmers are instrumental in lateral diffusion of agricultural technologies and information; as farmers tend to readily accept what they are told by or have seen from fellow farmers.

Conclusion and Recommendations

The need for the initiation of this activity emanated from a practical experience and challenges encountered in the course of coffee technology transfer, especially stumping and associated practices, using the conventional technology transfer approaches such as on-farm demonstration. It became evident that on-station demonstration can play prominent role in developing positive attitude and confidence among farmers and in persuading them about the effectiveness of the improved practices. Therefore, it can be concluded that on-station demonstration can be effective alternative for perennial crops technology transfer if properly used and backed by other complementary mechanisms such as field days, hands-on training exercises, on-farm demonstration of the activities, video, written extension materials, close follow-up, and provision of technical backstopping.

The following recommendations were made based on the experience with coffee technology transfer:

- The powerfulness and potential (role) of on-station demonstration, field days, and farmer-to-farmer extension in accelerating transfer of perennial crops technologies should not be overlooked by research centers and other relevant institutions. It needs to be tapped and utilized to complement other strategies and approaches. In particular, the fact that research centers have limited human and other resources to conduct extensive on-farm demonstrations and the presence of already established trial fields on station

underscores the need for considering on-station demonstration,

- In the efforts of the government extension agency, stumping should be preceded by creation of adequate awareness, interest and positive attitude and developing sufficient knowledge and skills through training, farmer-to-farmer visit, field days, and other relevant mechanisms,
- It is also important to promote production of simple and user-friendly production guidelines and leaflets along with demonstration and other technology transfer activities,
- Research needs to revise recommendations and prepare appropriate packages for stumping and associated practices. In particular, definite and up-to-date guidelines on optimum time of stumping, number of suckers and selection of sucker position; and rate and type of fertilizer application are some of the issues that research should concentrate on in this regard, and
- In order to come up with appropriate and more relevant recommendations, it is also necessary to increase end-users active involvement in the development and transfer of agricultural technologies.

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