Comparative Analysis on Causal Conditions of Forest Regeneration
- The Case of Tamil Nadu Afforestation Project (II) -
(Trial application of QCA)

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Abstract

BACKGROUND: JICA's afforestation projects have been conducted to attain forest regeneration and livelihood improvement as outcomes of the projects. Although there are several interventions regarded as causal conditions bringing about the outcomes, sufficient surveys to identify conditions or combinations of conditions significantly affecting the occurrence of the outcomes have not been conducted in detailed way. Qualitative Comparative Analysis (QCA) has been increasingly recognized as an evaluation tool through its development since late 80's.

OBJECTIVE: (1) To identify causal conditions and combinations which significantly contribute to regeneration of forests in JICA-assisted Tamil Nadu Afforestation Project (II) (TAP-II) by QCA; and (2) To draw lessons from the exercise of the above analysis.

METHODS: Twenty four VFC villages[1] under "Tamil Nadu Afforestation Project (II)" were selected as a set of cases to verify the purpose, and survey sheets were distributed to 5 key informants in each village with Village Forest Council (VFC), who are expected to know the effect from the project deeply, in order to judge presence (1) or absence (0) of each outcome and causal condition for each VFC village. Ten causal conditions that may have led to the forest regeneration by this project were extracted and the extent to which those conditions and their combination are associated with the forest regeneration through cross tabulations and QCA were shown.

RESULTS: Good relationship with forest department and recognized role of community development works were identified as necessary conditions. It is the result that verifies firstly the importance of joint approach between Forest Department and VFC for forest regeneration and secondly the effectiveness of introduction of community development works. In addition, causal conditions identified as sufficient conditions suggest that planning and implementation based on microplan and high commitment of forest department are also important causal conditions for achieving forest regeneration.

One of the four combinations identified as sufficient conditions for forest regeneration: that of planning and implementation based on microplan, or appropriate distribution of non-timber benefits between Forest Department and VFC may imply the importance of agreement of benefit sharing of forest resources. The result on the remaining three combinations suggests that the project concerned make sure that the reinforcing conditions such as high commitment of forest department, good relationship with the forest department, recognized role of community development are met in villages in order to maintain control of excessive tree cutting ultimately for forest regeneration.

As lessons drawn from the study, firstly the study made a certain contribution in making JICA-assisted forestry projects more evidence-based. Secondly it has clarified the important topics for further studies; (a) QCA of causal conditions leading to two outcomes - forest regeneration and livelihood improvement, (b) effectiveness of micro-credit scheme for forest regeneration, (c) QCA in consideration of "sustainability" and "inclusiveness" factors in the concept of outcomes, (d) broadening causal conditions beyond JICA's intervention, for example to include core drivers of afforestation and deforestation. Thirdly, QCA as an evaluation tool, though it is less powerful than impact evaluation for accountability purpose, has a strength in drawing practical lessons by generating more systematic evidence than classic case studies through "limited generalization."

CONCLUSIONS: By the QCA of 10 causal conditions that may have led to the forest regeneration, continuation of direction that JICA is pushing forward in forestry projects in India was justified to a certain extent. Implications for JICA-assisted forest projects and important topics to be considered in the future and the possible roles of QCA in evaluation were elucidated.

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[1] The word, "village" in this report is used to describe "forest village" unless any specific explanation is made.

Main messages

- The study has verified the effectiveness of Joint Forest Management (JFM) approach through collaboration between Forest Department and Village Forest Councils (VFC) of State of Tamil Nadu in India under JICA-financed "Tamil Nadu Afforestation Project (Phase II)" for forest regeneration to a certain extent.

- Effectiveness of additional input to conventional JFM, i.e., "community development works" has been indicated.

- Good relationship with forest department, planning and implementation based on microplan and high commitment of forest department have been identified as important conditions for achieving forest regeneration.

- Agreement of benefit sharing of forest resources through planning and implementation based on microplan, or appropriate distribution of non-timber benefits between Forest Department and VFC may be a key for the success of forest regeneration.

- In addition to control of excessive tree cutting for the fuel use, either of reinforcing conditions such as high commitment of forest department, good relationship with the forest department, or recognized role of community development is met, is important for forest regeneration to take place.

- The study has shown that QCA can facilitate JICA-assisted forestry project more evidence-based and assist practitioners to prioritize activities systematically.

- To make the study more comprehensive, both outcomes and causal conditions must be broadened.

  - The outcomes are suggested to cover livelihood improvement in addition to forest regeneration and consider sustainability and inclusiveness factors.

  - The causal conditions should not be limited to JICA intervention and are suggested to include factors such as core drivers of afforestation and deforestation.

- QCA as an evaluation tool has a strength in drawing practical lessons through "limited generalization" by generating more systematic evidence than classic case studies.

Keywords: Qualitative Comparative Analysis (QCA), Forest Regeneration, Joint Forest Management, India, Evaluation

Abbreviations and Acronyms

QCA	Qualitative Comparative Analysis
DAC	Development Assistance Committee
TAP -I	Tamil Nadu Afforestation Project (I)
TAP-II	Tamil Nadu Afforestation Project (II)
TGBP	Tamil Nadu Biodiversity Conservation and Greening Project
JFM	Joint Forest Management
BZA	Buffer Zone Activity
ITDP	Integrated Tribal Development Program
IWDP	Integrated Watershed Conservation Afforestation Program
VFC	Village Forest Council
SHG	Self-Help Group
JAXA	Japan Aerospace Exploration Agency
HFD	Haryana Forest Department

Glossary of QCA

Term	Description
Causal Condition	Variables that can affect an outcome among all non-unifiable conditions. Preconditions and external conditions can be included in this depending on the analysis.
Implicant	If the formula $A + B \rightarrow Y$, A and B are considered as implicants.
Necessary Condition	The causal condition (X) which is necessary or prerequisite for the occurrence of an outcome (Y). The logical expression is $Y \rightarrow X$.
Necessary Condition Consistency	Indicates the degree to which the corresponding causal condition is consistent without being contradictory. Necessary condition consistency = (the number of cases where the outcome is 1 and the causal condition is 1) / (the number of cases where the outcome is 1).
Necessary Condition Coverage	Indicates how big the outcome is relative to the causal condition through Venn diagram. It is a measure of the importance of the necessary condition as a causal condition.
Outcome	Outcome analyzed by QCA. In this paper, forest regeneration was selected.
Parsimonious Solution	A logically simple solution which consists of the product and sum of a minimized number of causal conditions based on simplifying assumptions for the logical remainders.
Raw Coverage	Raw coverage = (number of cases belonging to each term) / (number of cases with outcome of 1).
Solution	The solution, called a logical expression, is indicated as $A + B \rightarrow Y$ and so on.
Solution Coverage	Solution coverage = (number of cases belonging to an implicant of any one of the solutions) / (number of cases with outcome 1)
Sufficient Condition	The causal condition (X) which is sufficient for outcome (Y) to occur $(X \rightarrow Y)$.
Sufficient Condition Consistency	Consistency of rows in the truth table = (number of cases where the outcome of that row is 1) / (number of cases belonging to that row). Although the threshold value depends on analysis, the default value in fsQCA is set as 0.8.
Sufficient Condition Coverage	Denotes the ratio of the causal condition of the truth table to the outcome. It is a measure of the importance of X as a sufficient condition. There are three degrees of coverage of sufficient conditions: raw coverage, unique coverage, and solution coverage.
Unique Coverage	Unique coverage = (Number of cases of each implicant that are not covered by the implicant) / (Number of cases with outcome 1)

Note) Drafted by Noriyo Aoki, Alfapremia Co., Ltd. and revised partly by the authors.

1. Background and Objectives
  1.1 Background
    In the ex-post evaluations for the JICA's afforestation projects in India based on DAC Five Evaluation Criteria, the criterion of effectiveness is evaluated through confirming status of outcomes, which are forest regeneration and livelihood improvement of poor people living on fringes of forests. There are several interventions that are regarded as causal conditions bringing about the emergence of above outcomes. They include several functions of Joint Forest Management (hereinafter referred to as "JFM") [2], planting seedling by members of Village Forest Council (hereinafter referred to as "VFC") [3], income-generating activities by Self-help Group (hereinafter referred to as "SHG"), rural infrastructure development surrounding VFC settlements. However, sufficient surveys to clarify which condition or combinations among the causal conditions bring about occurrence of the outcomes have not been conducted in a systematic way.

    Qualitative Comparative Analysis (hereinafter referred to as "QCA") is an analytical method introduced by American social scientist Charles Ragin (1987), and developed and advanced by researchers in order to resolve restrictions on the method during its progress (Schneider and Wagemann 2012). This method is increasingly considered as a valuable alternative or complement to existing evaluation methods and widely disseminated via studies on broadening the range of designs and methods.

    Based on the background, JICA launched a systematic survey using QCA in order to clarify the causal conditions and combinations resulting in the forest regeneration as one of the outcomes of the afforestation project named "Tamil Nadu Afforestation Project (II) (hereinafter referred to as TAP-II)", which takes JFM approach in the same way as other JICA's afforestation projects in India.[4] Several villages in the state of Tamil Nadu are surveyed as cases for QCA, and QCA tries to find out consistent rules about relationships between causal conditions and outcomes among the surveyed cases in order to obtain suggestions and concrete lessons learned to make JFM approach more effective and help a similar type of community participatory afforestation project turn successful in future.

1.2 Objectives
    (1) To identify causal conditions and combinations which significantly contribute to regeneration of forests in JICA-assisted Tamil Nadu Afforestation Project (II) (TAP-II) by QCA.
    (2) To draw lessons from the exercise of (1).

2. Method
2.1 Project Outline[5]
(1) Background of the project
     The state of Tamil Nadu is located in south-east India facing the Indian Ocean, with an area of 130,000 km^2 and a total population of 72.13 million. It is an industrial state that is representative of South India. The western part of the state is a mountainous area in the Western Ghats, while it has a wide plain

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[2] JFM is a forest management approach implemented in India. It is that the state forest department and communities living in/around the forests jointly conduct forest management by forming Village Forest Council (VFC). Under VFC management, Self-help Group (SHG) is organized for income generation activities for improvements of livelihood. The project is a sort of the program with various components. The components are, for example, training of staff of Forestry Department, representatives of VFC, and members of Management Committee of VFC, making a ten-year plan called as a microplan for the management of plantation as well as VFC /SHG activities, building soil and moisture conservation facilities, improvement of village infrastructure nearby VFC village and so forth. (*JICA Assisted Forestry in India* by JICA Indian Office), https://www.jica.go.jp/india/english/office/others/c8h0vm00004cesxi-att/brochure_06.pdf (accessed on 6th December 2018)
[3] VFC is established with understanding of importance of afforestation and willingness to conduct a series of activities which are required for JFM. One female and one male from each household participate as members, and the total number of participants shall be 60% or more of the population of village or settlements.
[4] Outcome of this project is set as two: forest regeneration and livelihood improvement. However, due to the limited data availability, the study focused only the forest regeneration.
[5] Outline of the project studied is based on "FY2017 Ex-Post Evaluation Report of Japanese ODA Loan Project, Tamil Nadu Afforestation Project (II)" drafted by External Evaluators: Noriyo Aoki, Alfapremia Co., Ltd. and Miwa Hayashi, Alfapremia Co., Ltd..

spreading to the Bay of Bengal of the eastern part. The western mountainous area is warm year-round with an annual mean temperature of 20 to 24°C. Since the eastern plain is in the subtropical zone, it is hot year-round, with temperatures around 30°C. The annual mean precipitation of the state is 925 mm and it is affected by the Northeast Monsoon.

Tamil Nadu began the Tamil Nadu Afforestation Project in 1997, planting trees in 430,000 ha of scrub. However, cutting of fuel trees and grazing by free-range livestock put a burden on forests, and about 130,000 ha of the 270,000 ha remaining scrub that were not covered in Phase I, needed afforestation and regeneration of forest through Phase II by the ODA loan.

(2) Project summary

Item	Description
Name	Tamil Nadu Afforestation Project (II) (TAP-II)
Implementing Agency	Department of Forest, Government of Tamil Nadu
Approved Amount / Disbursed Amount	9,818 million yen / 9,199 million yen
Exchange of Notes Date /Loan Agreement Signing Date	March 2005/ March 2005
Terms and Conditions	Interest Rate: 0.75% Repayment Period (Grace Period): 40 years(10 years) Conditions for Procurement: General Untied
Borrower/Executing Agency	The President of India/ State Government of Tamil Nadu, Forest Department
Project Completion	March 2013
Main Contractor	No
Main Consultant	No
Related Study	"Tamil Nadu Afforestation Project(Phase II)" State Government of Tamil Nadu, Forest Department (February 2001)
Related Projects	Japanese ODA Loan Project "Tamil Nadu Afforestation Project" (1997)
Project Purpose	
To regenerate forests and improve the standard of living of local residents at the village level in the state of Tamil Nadu in Southeast India by afforestation and livelihood improvement activities using a community participatory method, thereby contributing to the improvement of the local socio-economic situation.	
Project Scope	
(1) Afforestation ("Joint Forest Management: JFM")	1) Integrated Watershed Development Program (IWDP): targeted 757 villages in 25 districts, area is 189,250 ha 2) Integrated Tribal Development Program (ITDP): targeted 193 tribal villages in 16 districts, area is 19,300 ha (7,500 ha is a forest area called 'scrub')
(2) Livelihood improvement activities ("Buffer Zone Activity: BZA")	1) Community Development Works: construction of community halls, drinking water facilities and tanks, etc. 2) Income Generation Activities: Self-help Group (hereinafter referred to as SHG) activities, and micro credit, etc.
(3) Soil and Moisture Conservation	1) Check Dams: 5271 facilities 2) Percolation Ponds: 2026 facilities
(4) Strengthening Forestry Management	Extension Training, Information System Training, etc.
Target Area	

Item	Description
	25 Districts, 208,550ha in total (Actually planted area)[6]

Project Activities	
	・The project activities centering on plantation works were implemented in the framework of the existing organizational structure of the Forestry Department .
	・At the village level activities, firstly Village Forest Council (hereinafter referred to as VFC) was formed, the Forestry Department with VFC made a microplan which covers a 10-year action plan for plantation activities, and management of VFC. The Forestry Department provided VFC with the fund. Then VFC provided micro credit for income generating activities.
	・On the pre-condition that a VFC was formed in each target village, for poverty reduction activities, "self-help groups" (hereinafter referred to as SHG) comprised mostly of females in poverty were formed in each target village with 10 to 15 members. With a condition that they would work on savings activities, they took micro credit from the Forestry Department through VFC, using these to engage in income generation activities.
	・The planting trees and construction works, making check dams and percolation ponds for soil and moisture conservation were done by members of VFCs as paid labor by the Forestry Department.

(3) Ex-post condition of forest in the state of Tamil Nadu

The forest cover rate in Tamil Nadu in 2001 before the start of this project was 16.5%, which was lower than the average forest cover rate in India (20.1%). Therefore, improving the quality of forest (decreasing areas of scrub and open forest) and expanding the area of forest were major issues.

In Tamil Nadu, before the start of this project, forests were deteriorating and scrub requiring immediate measures was spreading to about 700,000 ha. However, at the ex-post evaluation, it was found that forest cover rate in India increased to 21.3% in 2015 from 20.6% in 2005. The forest cover rate in the state of Tamil Nadu was 17.7% in 2005, increased to 20.3% in 2015, which was still below the national average in India, but did show an increasing trend.

According to India's State of Forest Report, based on satellite data of India, in the case of targeted districts of Integrated Watershed Conservation Afforestation Program[7] (hereinafter referred to as "IWDP") of this project, the area of scrub was 177,700 ha in 2005, which decreased by136,800 ha to 40,900 ha in 2015. In contrast, the area of open forest was 9,404 ha in 2005 but increased by 1,941 to 11,345 ha in 2015. Area of dense forest was 1,076,900 ha in 2005, and increased by 87,000 ha to 1,163,900 ha in 2015.

Such achievements (as an offset of the decrease in scrub and increase in the area of open and dense) forests can not necessarily be said to be the result of this project as there are many other factors are involved.[8] Still, this information indicates that the forests of the state of Tamil Nadu have been regenerated to a certain extent.

2.2 Case Selection

There are 950 VFC villages in the state of Tamil Nadu under the JICA's afforestation project, and 24[9]

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[6] This project (TAP-II) and the previous project (TAP-I) targeted different VFCs. The third phase of TBGP which began in 2011 is different from both TAP-I and TAP-II which focused on planting in state properties, and TBGP promotes afforestation in private property. Each phase has different purposes and coverages.

[7] Tamil Nadu Afforestation Project (II) has various types of the Program in accordance with the canopy rate. IWDP is major Program in Tamil Nadu Afforestation Project (II). That is why IWDP was selected.

[8] Many factors include the following:
  1) Seedlings planted during this project had different growth rates depending on tree species.
  2) Young seedlings had few branches.
  3) The tree of the growth in TAP-I started in 1997 were visible.

[9] Nowadays, the various academic area has discussion papers by using QCA which cover the number of cases 24 is considered as common. Mr. Masaki Tamura who wrote the book on QCA uses the number of prefectures 47 cases for his

VFC villages were selected as cases for QCA through the following steps.

First of all, QCA analytically requires both cases showing presence (1) of outcome and absence (0) of outcome, which means both of VFC villages where forests have been regenerated and forest haven't been regenerated need to be surveyed for QCA. Therefore, the areas of the project in Tamil Nadu were generally categorized into the areas where forest has been well regenerated and the areas where forest has been poorly or not regenerated based on JAXA satellite data.

Secondly, preconditions that should be similar among all the cases as much as possible in order to get consistent rules were set. 6 preconditions, which are considered to significantly affect occurrence of the outcome (forest regeneration) and regarded as criteria of case selection, were selected: VFC villages having an amount of annual rainfall around 1000mm[10], VFC Villages depending on agriculture or animal husbandry[11], VFC villages located far away from major commercial towns[12], VFC villages of IWDP <0.4 canopy[13], VFC villages located within one-day traveling accessibility for surveyors from Chennai[14], VFC villages where a large scale eucalyptus tree planation is not present near by the plantation area and surrounding forest areas of VFC villages[15].

Thirdly, the survey team[16] visited VFC villages one after another based on the categories extracted by JAXA satellite data and accessibility, and checked whether the visited VFC village was satisfied with the preconditions and could be used as a case for QCA through asking staffs of the district/division offices about information on the VFC villages and directly confirming with the eyes. The survey team kept visiting VFC villages until collecting 24 proper cases.

As a result, 17 cases were selected from VFC villages where forest regeneration occurred and 7 cases were from VFC villages where forest regeneration poorly or not occurred. The areas where forest regeneration took place were larger than the others, thus, it was hard to find out cases where forests did not regenerate and the number of the cases was comparatively small. Please refer to Annex 2 for more details on the selected cases.

2.3 Data Processing of Cases

In order to prepare data consisting of presence (1) or absence (1) of causal conditions and outcomes for each case, the survey team collected information on the VFC villages selected as cases for QCA through distributing the survey sheets to and interviewing with five respondents introduced by the Forest department in each case who are considered to sufficiently apprehend the VFC village. The five respondents[17] are as follows.

1. Staff of the Forest Department, such as watcher, guard in beat office, forester, or ranger in range

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study in *Comparative Qualitative Analysis on Management Cases (2015)*. Mr.Yasuhiro Hattori, in his research paper on recruiting Japanese companies, dealt with 43 companies (cases). Mr.Ryusei Komorita, studied "Conditions for separating suicide from overworked death(2016)" by analyzing 54 cases.

[10] The 10-year rainfall data was taken.

[11] According to the surveyor, the following VFC villages were basically excluded: the villages which have been affected by the factors such as some other industry like lime stone industry, leather processing industry that have large factories even in the rural area, because the existence of such factories influences the farmer's lifestyle, which tends to neglect the agriculture and forestry. However, justification of this exclusion is not clear.

[12] It was basically conditioned that 50 km or more away from a district town and 10 km or more away from a block town. The important thing for selection is that there are few influences on VFC village from these commercial towns. The information on influences was checked and confirmed in advance visit by the survey team. Especially, it was considered that if many VFC members work in commercial towns, it affects the agricultural and livestock-based life.

[13] Canopy, in other words, crown rate is obtained by dividing the area of lush trees within 1 ha by the geographic area. If the crown rate is less than 0.4, it means open forest.

[14] With respect to the altitude, an area with high altitude is avoided, and border areas' sub-districts were also not chosen due to difficulties of accessibility and remoteness for clerical work by the surveyors. The sub-districts were selected where are located near by the capital of the State of Tamil Nadu for clerical work by the survey team.

[15] A large scale eucalyptus tree planation areas were seriously damaged and became saline, even in forest areas nearby.

[16] The survey team consisted of five people including a Japanese consultant, a local senior consultant, a language interpreter, and two data collection surveyors. Only the two data collection surveyors had continued the survey since May 10th due to contract duration.

[17] If there were several candidates for the respondents, the survey team made short interviews with all of them, and then the survey team found the most appropriate respondents.

office (one person)
2. VFC members (one male and one female member)
3. Members of woman's SHG (two female members)

Regarding the staff of the Forest Department, the survey team selected the person who knew the progress of the project as much as possible from the beginning of the project. As for VFC members, the members who did not belong to management committee of VFC were selected. Regarding SHG members, the persons who came from various Caste /Class groups and knew well about the SHG activities from the initial to the present situation were chosen.

When it was hard to make final judgment of presence (1) or absence (0) for the casual conditions and outcomes based on only the information derived from the above respondents, for example, the answers were not consistent among the respondents, the survey team had informal interviews with several VFC members in addition to the 5 respondents.

On the basis of results of the interviews and discussion among the survey team, presence (1) or absence (0) for each causal condition and outcome in each case was judged.

In addition, except the items and questions of the survey sheet, the two-page summary sheet was made to describe about the village life in a more in-depth qualitative way.

The survey was conducted from April 10 to August 9 in 2018, including case selection, interviews, and processing data of each case.

2.4 Procedure of Analyses

In this paper, two main analyses were conducted: analysis of cross tabulation tables whose purpose is to confirm one-to-one relationships between each causal condition and an outcome, and QCA for identifying combinations among the causal conditions affecting the outcome. The analysis of cross tabulation tables was conducted by MS Excel 2016, and QCA was by fsQCA3.0[18].

2.5 QCA

Qualitative analysis is generally conducted when researchers investigate special circumstance of a case and the result is descriptively expressed. The analysis is useful in understanding a narrative story of each case, however, it is difficult to find the structured rules between causal conditions and outcomes that are applicable to other cases as with quantitative analysis. Based on Set Theory and Boolean Algebra, QCA has been developed to break through the above limitation of qualitative analysis and tries to figure out the structured rules that are consistent with all the surveyed cases.

QCA requires the qualitative status of causal conditions[19] and outcomes[20] of each case to be converted into the form of quantitative data (1 or 0)[21] through judging presence (1) or absence (0) of the conditions and outcomes. Based on the dataset consisting of 1 or 0, QCA finds out two consistent conditions among the surveyed cases, namely necessary condition and sufficient condition.

Necessary condition means a causal condition that is prerequisite for occurrence of an outcome. For example, if success of an income-generating activity is confirmed as a necessary condition for the outcome of forest regeneration, it means successful income-generating activity is confirmed in all or most of all cases where forest regeneration occurs. However, it doesn't mean income-generating activity causes forest regeneration because there is a possibility that successful income-generating activity will be confirmed in some cases where forest regeneration hasn't occurred.

The logical formula of the necessary condition is expressed as Y (outcome) $\rightarrow$ X (causal condition) , that is, Y is a subset of X, and Y cannot be achieved without X. If Y is 1, X is also 1, but since Y is a subset of X, Y may not occur even if X is 1 (Figure 1).

Sufficient condition means a causal condition or a combination of causal conditions that cause occurrence of an outcome. For example, if successful income-generating activity is confirmed as a sufficient condition for forest regeneration, it indicates that forest regeneration has been partly caused by successful income-generating activity because forest regeneration is confirmed in all or most of all cases

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[18] http://www.socsci.uci.edu/~cragin/fsQCA/software.shtml (access to September 2017). The technical terms are explained in Glossary of QCA (Tentative).

[19] A causal condition is an explanatory variable that influences the outcome, and it corresponds to the causes or factors. Please refer to "Glossary of QCA" of this report for the technical terminology of QCA.

[20] An outcome is also an explained variable which corresponds to a result.

[21] This is an example of Crisp Set Analysis. QCA has various analysis methods.

where income-generating activity has been successful.

The logical formula of sufficient condition is X (causal condition or combination among causal conditions) → Y(outcome), it means X is a subset of Y. If X is 1, Y is also 1, but X may not be confirmed even if Y is 1 (Figure 2).
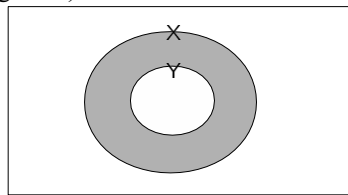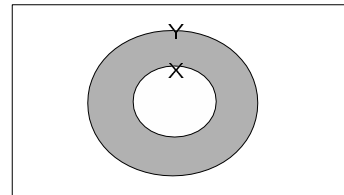

Figure 1 Necessary Condition

Figure 2 Sufficient Condition

QCA estimates two types of values, which are called "consistency" and "coverage", in analyzing necessary and sufficient conditions. Consistency is expressed by the rate that indicates how consistent the rules identified by QCA is among the surveyed cases and used in judging whether a causal condition or a combination of causal conditions can be regarded as necessary condition or sufficient condition for an outcome based on threshold values. In this paper, 0.9 is used as the threshold value for necessary condition and 0.8 is used as that of sufficient condition since these high values are widely recommended by European or USA scholars in order to identify rigorous results[22]. For example of interpretation of values of consistency, if consistency of successful income-generating activity (a causal condition) in analysis of sufficient condition for forest regeneration (an outcome) is estimated as 0.9, it means 90% of the cases where successful income-generating activity is confirmed have forest regeneration, and the value is over 0.8, thus, successful income-generating activity is considered to be a sufficient condition for forest regeneration. The below figures are examples of low consistency (Figure 3) and high consistency (Figure 4).
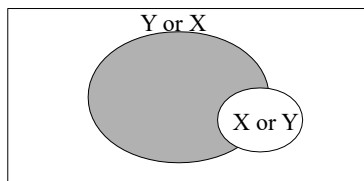
Figure 3 Low Consistency
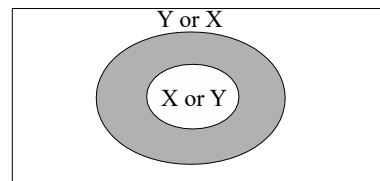
Figure 4 High Consistency

Coverage is expressed by the rate that indicates how much a causal condition covers an outcome (X → Y) or an outcome covers a causal condition (Y → X). For example, on interpretation of values of coverage, if coverage of successful income-generating activity (a causal condition) for forest regeneration (an outcome) is estimated as 0.6, it means 60% of the cases where forest regeneration is confirmed have successful income-generating activity. The below figures are examples of low coverage (Figure5) and high coverage (Figure 6).
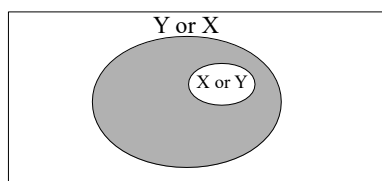
Figure 5 Low Coverage
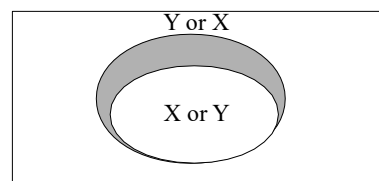
Figure 6 High Coverage

As for analysis of sufficient condition, a combination among causal conditions can also be extracted by QCA (Figure 7). If combination among causal conditions (in this case, X1 or X2) is extracted as sufficient conditions for an outcome (in this case, Y), solution coverage, which is coverage of combination for an outcome, is estimated. If part of coverage of X1 and X2 are shared by each other, the part which is not shared by the other sufficient conditions is called unique coverage and the coverage including the shared and non-shared part for a sufficient condition is called raw coverage. Combination is expressed by Boolean

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[22] Rihoux (2008), pp39-44.

algebra. For example, "Y ← X1*X2" means the existence of both X1 and X2 causes Y, and "Y ← X1 + X2" means the existence of either X1 or X2 causes Y.
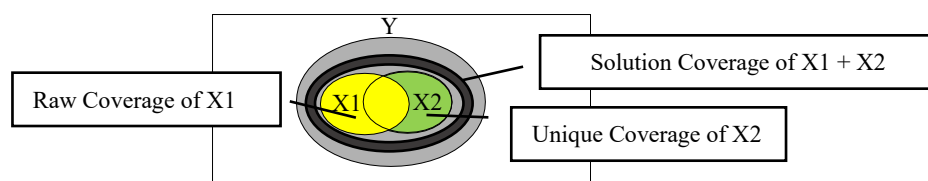
Figure 7 Combination among causal conditions

In this detailed paper, interventions, inputs, and outputs of JICA's afforestation project are regarded as causal conditions, and forest regeneration is considered to be outcome. QCA is applied to identify which causal conditions or combinations among the causal conditions are necessary or sufficient for the outcome to clarify complexity of how JICA's afforestation projects contribute to forest regeneration.

2.5 Outcomes and Causal Conditions

1 outcome and 10 causal conditions are prepared for QCA (Table 1). The outcome is forest regeneration (hereinafter referred to as *regeneration*) as mentioned on project purpose of TAP-II.

4 causal conditions are the ones that are considered to be fundamental JFM functions contributing to forest regeneration for long time in international cooperation domain: planning and implementation based on microplan (hereinafter referred to as *microplan*), clear boundaries of the reserved forest areas for JFM (hereinafter referred to as "*boundary*"), appropriate distribution of non-timber benefits between Forest Department and VFC (hereinafter referred to as *non_timber*), and awareness of livestock management (hereinafter referred to as "*livestock*").

6 causal conditions are the ones, which have been introduced to support the above fundamental JFM functions and synergistically contribute to forest regeneration: control of excessive tree cutting for fuel use (hereinafter referred to as *tree_cutting*), micro-crediting benefits (hereinafter referred to as *micro_credit*), strong commitment of forest department (hereinafter referred to as *commitment_FD*), good relationship between VFC and forest department (hereinafter referred to as *relationship_FD*), collaboration with other departments except forest department (hereinafter referred to as *collaboration*), community development works (hereinafter referred to as *community*).

For the following reasons, the above 10 causal conditions are selected. On each causal condition, there are certain assumptions on how the causal condition is related to forest regeneration and the assumptions are considered to be worth being analyzed.

Table 1: Outcome and Causal Conditions

Outcome		Q. No. Note)	
regeneration	Forest Regeneration	1	One of the outcomes of TAP-II
Causal Conditions (fundamental JFM functions)		Q. No.	Reasons for selection
Microplan	Planning and implementation based on microplan	35	To start plantation and other activities under JICA project, a VFC is supposed to make a microplan where the Council identifies the plantation area in collaboration with India Forestry Department and guide VFC members on how to manage and conserve the forest. It is stipulated in the JFM guideline agreed between India Forest Department and JICA. They also decide the content of community development works, management of microcredit activities and distribution of forest resources among villagers in the VFC meetings. Thus the microplan forms a basis of forest related activities of VFC. Whether or not microplan is made and implemented as per the plan is generally considered to be a barometer of functioning of VFC which is largely related to the result of forest regeneration.
boundary	Clear boundaries of	17	Among various activities by VFC in collaboration with Forest Department, one of the important interventions is considered to be an identification of

12

	the reserved forest areas		clear boundaries of forest areas for plantation and monitoring. In the context of India, it is difficult, due to the vastness of forest area, even for Forest Department to grasp the forest condition on all the areas under their jurisdiction in a scientific manner. A clear distinction between forest areas managed by JFM and others is generally a key to the success of forest regeneration. It is also a first step for science-based forest monitoring.
Livestock	Awareness of livestock management	14	Livestock can be a driver of deforestation if it is not kept appropriately. Villagers living around the forest need to control their own livestock not to enter the forest when grazing. Awareness raising among villagers on livestock control is a basic activity under JFM. Thus, the awareness level of the surveyed villages is set as one of the causal conditions as that which may be related to forest regeneration.
tree_cutting	Control of excessive tree cutting for fuel use	10	A main driver of deforestation is assumed to be villagers' dependency on forest resources as villagers cut wood from forest for their fuel use. Under JFM, VFC and Forest Department are supposed to induce villagers to use other resources such LPG[23] not the forest wood for fuel. It is important to check whether this core activity of JFM is leading to forest regeneration or not. Thus, a change of villagers' behavior in collection of forest wood over the project period is set as a causal condition and the study tries to check whether this has something to do with forest regeneration.
Causal Conditions (synergistically contributing to outcomes with the fundamental JFM functions)		Q. No.	Reasons for selection
non_timber	Appropriate distribution of non-timber benefits between Forest Department and VFC	21	Distribution of benefits from forest resources between VFC and Forest Department is assumed to be a core function of JFM. The way in which or how fairly the benefit is distributed may affect villagers' incentive to protect the forest. The study sets only the distribution of non-timber forest resources as a causal condition as the planted trees were still young and the distribution of timber was not taking place. Distribution ratio of forest resources is different depending on the kind of resources and on the states in India. In Tamil Nadu, all the benefit of non-timber forest resources is supposed to be distributed to VFC.
micro_credit	Micro-crediting Benefits	24	Micro-credit scheme to facilitate income generating activities was introduced as it is assumed that the scheme will help reducing villagers' dependency on the forest resources, thus will facilitate forest regeneration. The micro-credit scheme is an additional intervention to the basic function of JFM, which JICA introduced in collaboration with the Forest Department. It was tested in Tamil Nadu for the first time and nowadays is spread to forestry projects in other states. However, the effect of this intervention is not verified scientifically, thus it is worth setting it as a causal condition to check whether it actually affects forest regeneration.
commitment_FD	Commitment of forest department	29	It has been said that commitment of forest department is one of the key factors for the successful forest management through JFM approach. It is considered that the way and the extent that forest department monitor actions by forest officers including the foresters, rangers and watchers who actually interact with villagers heavily influence the result of forest management. In some villages, the forest officers visit project site regularly and motivate villagers to participate forest protection activities. In other villages, even if villagers ask forest officers for help in getting rid of illegal cutting, it is not properly reported to the higher management of forest department or it takes time for necessary actions to be taken. Such difference in behaviors or actions among forest officers which can appear as commitment of forest department is also likely to matter the outcome of forest regeneration. Thus, this aspect is set as one of the causal conditions.
*relationship_*	Relationship	30	Due to a history of distrust between forest department and forest villagers

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[23] LPG is Liquefied Petroleum Gas.

FD	with the forest department		since British colonial era, to build trust between them has always been a challenge in forest management in India. To conserve and manage the forest, especially in joint law enforcement or fire control, Forest Department needs to cooperate with villagers living around the forest but the Department has difficulties in mobilizing and interacting with the villagers when starting any new activities through Joint Forest Management approach. The relationship between them has overall improved but it is still considered to be an important factor to manage the forest. Thus, it is worth including this factor as a causal condition and checking to what extent this factor matters to the outcome of forest regeneration.
collaboration	Collaboration with other departments	31	It is more often the case than before that there are several line departments are involved for different projects in one village. If the different line departments are well coordinated, it may bring a synergy effect to the project outcome. In the case of forest villages, it is assumed that collaboration with other departments for community development works or other schemes may be generating a synergy effect on forest generation and it is promoted through training and workshop on JFM as a "conversion approach." Thus, it is worth paying attention to this aspect and setting it as one of the causal conditions.
community	Community development works	39	In view of the background on the strained relationship between forest department and forest villagers mentioned above, the component of community development works is considered to be one of the strategies to ease the tension and support building trust each other. The strategy was jointly thought through by JICA and Forest Department in India, and experimented in Tamil Nadu for the first time. Nowadays it has been introduced in most of the JICA funded forestry projects in India. Its effectiveness has been discussed and pointed out in earlier reports but has not been scientifically investigated. Thus it is worth paying attention to the relation of this factor with forest regeneration.

Note) Q. No. means question number in the survey sheet.

Survey sheet consisting of items assessing those outcomes and causal conditions was developed (Please refer to Annex 1). Each item of the sheet was prepared with four-level response[24]. The survey sheet also contains the items asking other several situations of VFC village and information about other forest area except planted area under the JICA's project, which is referred to as B area in the survey sheet, however, only the items and results related to the outcomes and causal conditions mentioned in Table 1 were used in this paper. Final judgement on causal conditions of each VFC village used for this case study can be referred in Annex 3.

3. Results
  3.1 One-to-one Relationship (between each causal condition and outcome)
    The below cross tabulation tables between each causal condition and *regeneration* (forest regeneration) (Table 2) was made, and each condition was checked whether it could be a necessary condition or a sufficient condition before analyzing impact of combinations among causal conditions.
    As for Table 2, *relationship_FD* and *community* were extracted as necessary conditions for *regeneration* because the value of each consistency was above 0.9. Regarding *relationship_FD*, the consistency was 0.941 and it means that 94.1% of the cases where forest regeneration was confirmed have good relationship with the forest department (*relationship_FD*). In the case of *community*, the consistency was 1.0, and it indicates that all of the cases where forests regenerated had successful community development works (*community*). These necessary conditions (*relationship_FD* and *community*) are prerequisite for bringing

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[24] If the 5-level response is adopted, the central value would be at an intermediate point which is called 'excluded middle' or 'non-discriminative point'. As a membership to a set, 0.5 signifies that it is not a membership of a set. If results have this kind of intermediate point would presumably affect the results of the analyses. There are two choices to answer in 2–level response and 4-level response, but 4–level response was selected. The reason why is that respondents can easily speak out by answering with graded answers. Also, since the surveyors know the degree of the answer of the respondent and the surveyors are able to triangulate the background of the answer.

about forest regeneration, even though some cases where forest regeneration did not occur also had *relationship_FD* and *community*.

Microplan, *non_timber*, *commitment_FD*, and *collaboration* were extracted as sufficient conditions since the values of consistency are above 0.8. The number of the cases where *microplan* was confirmed was 9. It means JFM was planned and implemented by microplan in only the 9 cases out of 24, however, forest regeneration was confirmed in all of the 9 cases. The number of cases where *non_timber*, which was 5, was also small. It indicates that appropriate distribution of non-timber benefits between Forest Department and VFC were confirmed only in 5 cases out of 24, but forest regenerated in all of the 5 cases. Forest department's strong commitment and support to the project activities (*commitment_FD*) were confirmed in 18 cases, and forest regeneration was confirmed in 15 cases out of the 18 cases (83%). Collaborations with other departments (*collaboration*) was confirmed in only 2 cases, but forest regenerated in the 2 cases.

Relationship_FD and *community*, which were extracted as necessary condition, were also selected as sufficient condition because each value of consistency for sufficient condition was above 0.8. Thus, *relationship_FD* and *community* can be said to be necessary and sufficient conditions for forest regeneration, though there are some exceptions because consistency is not 1.0 and it means the result is not consistent among all the surveyed cases.

Although *boundary*, *livestock*, *tree_cutting*, and *micro_credit* were not extracted as necessary nor sufficient condition because the values of consistency were not above thresholds, these conditions also showed relatively high coverages. It indicates that consistent rules between these causal conditions and forest regeneration among 24 cases were not found while relationships between the conditions and forest regeneration may not be so weak.

Table 2: Cross Tabulation between forest regeneration and each causal condition

1(*regeneration/ microplan*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ microplan*	NC[1]	SC[2]
	microplan = 0	7	8	15	Consistency	0.529	1.000
	microplan = 1	0	9	9	Coverage	1.000	0.529
	Totals	7	17	24			
2(*regeneration/ boundary*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ boundary*	NC	SC
	boundary = 0	1	3	4	Consistency	0.824	0.700
	boundary = 1	6	14	20	Coverage	0.700	0.824
	Total	7	17	24			
3(*regeneration/ livestock*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ livestock*	NC	SC
	livestock = 0	0	2	2	Consistency	0.882	0.682
	livestock = 1	7	15	22	Coverage	0.682	0.882
	Total	7	17	24			
4(*regeneration/ tree_cutting*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ tree_cutting*	NC	SC
	tree_cutting = 0	3	2	5	Consistency	0.882	0.789
	tree_cutting = 1	4	15	19	Coverage	0.789	0.882
	Total	7	17	24			
5(*regeneration/ non_timber*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ non_timber*	NC	SC
	non_timber = 0	7	12	19	Consistency	0.294	1.000
	non_timber = 1	0	5	5	Coverage	1.000	0.294
	Total	7	17	24			
6(*regeneration/ micro_credit*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ micro_credit*	NC	SC
	micro_credit = 0	3	6	9	Consistency	0.647	0.733
	micro_credit = 1	4	11	15	Coverage	0.733	0.647
	Total	7	17	24			
7(*regeneration/ commitment_FD*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ commitment_ FD*	NC	SC

		regeneration = 0	regeneration = 1	Total		NC	SC
	commitment_FD = 0	4	2	6	Consistency	0.882	0.833
	commitment_FD = 1	3	15	18	Coverage	0.833	0.882
	Total	7	17	24			
8(*regeneration/ relationship_FD*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ relationship_FD*	NC	SC
	relationship_FD = 0	4	1	5	Consistency	0.941	0.842
	relationship_FD = 1	3	16	19	Coverage	0.842	0.941
	Total	7	17	24			
9(*regeneration/ collaboration*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/ collaboration*	NC	SC
	collaboration = 0	7	15	22	Consistency	0.118	1.000
	collaboration = 1	0	2	2	Coverage	1.000	0.118
	Total	7	17	24			
10(*regeneration/ community*)	Frequency	*regeneration = 0*	*regeneration = 1*	Total	*regeneration/c ommunity*	NC	SC
	community = 0	6	0	6	Consistency	1.000	0.944
	community = 1	1	17	18	Coverage	0.944	1.000
	Total	7	17	24			

1) NC: Necessary Condition, 2) SC: Sufficient Condition
2) The values of consistency exceeding threshold are underlined.

3.2 QCA for identifying combinations affecting forest regeneration

Relationships between combinations among the causal conditions and forest regeneration (*regeneration*) were confirmed by QCA (Table 4). First, it was checked whether there were any combinations among the causal conditions of fundamental JFM functions (*microplan*, *boundary*, *livestock*, and *tree_cutting*). This is expressed by "*regeneration* = f (*microplan*, *boundary*, *livestock*, *tree_cutting*)" as the model of Analysis No.1 in Table 3. Then, the causal conditions synergistically contributing to outcomes with the fundamental JFM functions (*non_timber*, *micro_credit*, *commitment_FD*, *relationship_FD*, *collaboration*, and "*community*") were added to the model of Analysis No.1 one by one. These are shown as models from Analysis No.2 to No.7 in Table 3. As combinations affecting forest regeneration could not be identified in analyses from Analysis No. 3 to No. 6 due to a possibility of the effect of *microplan*, analyses without *microplan* were also conducted. These are shown as analyses from Analysis No.8 to No.14 in Table 3.

Table 3: Relationship between forest regeneration and combinations among the causal conditions

Analysis No.	Model	Sufficient Condition	RC [1]	UC [2]	SC [3]	C [4]
1	*regeneration* = f(*microplan, boundary, livestock, tree_cutting*)	*microplan*	0.529	0.529	0.529	1.000
2	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, non_timber*)	*microplan*	0.529	0.471		1.000
		non_timber	0.294	0.235		1.000
		microplan + non_timber			0.765	1.000
3	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, micro_credit*)	*microplan*	0.529	0.529	0.529	1.000
4	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, commitment_FD*)	*microplan*	0.529	0.529	0.529	1.000
5	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, relationship_FD*)	*microplan*	0.529	0.529	0.529	1.000
6	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, collaboration*)	*microplan*	0.529	0.529	0.529	1.000
7	*regeneration* = f(*microplan, boundary, livestock, tree_cutting, community*)	*tree_cutting * community*	0.882	0.882	0.882	1.000

No.	Model	Solution	RC	UC	SC	C
8	regeneration = f(boundary, livestock, tree_cutting)	~boundary*tree_cutting	0.176	0.176	0.176	1.000
9	regeneration = f(boundary, livestock, tree_cutting, non_timber)	non_timber	0.294	0.235		1.000
		~boundary*tree_cutting	0.176	0.118		1.000
		non_timber + ~boundary*tree_cutting			0.412	1.000
10	regeneration = f(boundary, livestock, tree_cutting, micro_credit)	tree_cutting*~micro_credit	0.235	0.235		0.800
		~boundary*tree_cutting	0.176	0.000		1.000
		~boundary*micro_credit	0.176	0.000		1.000
		tree_cutting*~micro_credit + ~boundary*tree_cutting + ~boundary*micro_credit			0.412	0.875
11	regeneration = f(boundary, livestock, tree_cutting, commitment_FD)	tree_cutting*commitment_FD	0.765	0.765	<u>0.765</u>	0.867
12	regeneration = f(boundary, livestock, tree_cutting, relationship_FD)	tree_cutting*relationship_FD	0.824	0.824	<u>0.824</u>	0.875
13	regeneration = f(boundary, livestock, tree_cutting, collaboration)	collaboration	0.118	0.059		1.000
		~boundary*tree_cutting	0.176	0.118		1.000
		collaboration + ~boundary*tree_cutting			0.235	1.000
14	regeneration = f(boundary, livestock, tree_cutting, community)	tree_cutting*community	0.882	0.882	<u>0.882</u>	1.000

1) RC: Raw Coverage
2) UC: Unique Coverage
3) SC: Solution Coverage. All solutions are "parsimonious solution", which is the simplest and easy-to-understand combination derived from QCA.
4) C: Consistency
5) High values of coverage worthy of discussion are underlined.

As for analysis of JFM fundamental functions (Analysis No.1), only planning and implementation based on microplan (*microplan*) was confirmed as sufficient condition for forest regeneration, and no combinations among the causal conditions were extracted.

Regarding Analysis No.2, *microplan* and appropriate distribution of non-timber benefits between Forest Department and VFC (*non_timber*) were extracted as sufficient conditions, and it was indicated that having *microplan* or *non_timber* causes forest regeneration. 76.5 % of the cases where forest have regenerated had *microplan* or *non_timber* as a result (*microplan + non_timber → regeneration*).

As mentioned above, no combination was extracted concerning Analyses from No.3 to No.6 due to a possibility of effect of *microplan*.

In regard to Analysis No.7, combination between control of excessive tree cutting for fuel use (*tree_cutting*) and community development works (*community*) was confirmed as a sufficient condition for forest regeneration. It is implied that having both *tree_cutting* and *community* causes forest regeneration, and 88% of the cases where forests regenerated had both of the causal conditions. In other words, 12% of the cases where *regeneration* was confirmed didn't have *tree_cutting*, *community*, or both of them.

Model of Analysis 8 is the same as that of Analysis No.1 without *microplan*. It is implied that if clear boundaries of the reserved forest areas in a VFC village were not confirmed (*~boundary*), control of excessive tree cutting for fuel use (*tree_cutting*) was sufficient for causing forest regeneration (*~boundary * tree_cutting → regeneration*). However, based on the solution coverage of 0.176, it is indicated that only 3 cases, where forest regeneration was confirmed, had both *~boundary* and *tree_cutting* at the same time. Therefore, the solution might have been obtained by chance since there was a high possibility that only the 3 cases were just accidentally matched with 3 cases out of the 17 cases, where forest regenerated, and the solution (*~boundary * tree_cutting → regeneration*) was extracted as sufficient condition.

In relation to Analysis No.9, appropriate distribution of non-timber benefits between Forest Department and VFC (*non_timber*) was extracted as a sufficient condition in addition to the sufficient condition derived from Analysis 8 (*non_timber + ~boundary * tree_cutting → regeneration*). It can be interpreted that having *non_timber* or both *~boundary* and *tree_cutting* cause forest regeneration, although *~boundary * tree_cutting* are selected as sufficient condition by chance based on the low coverage (0.176) compared to large number of the cases where forest have regenerated like Analysis No.8. 41.2 % of cases where forests

have regenerated had *non_timber* or both *~boundary* and *tree_cutting*.

As for Analysis No.10, having both *tree_cutting* and no micro-crediting benefits (*~micro_credit*) , both *~boundary* and *tree_cutting* (*~boundary * tree_cutting*), both "*~boundary*" and micro-crediting benefits (*micro_credit*) are extracted as sufficient conditions for forest regeneration (*tree_cutting * ~micro_credit* + *~boundary * tree_cutting* + *~boundary * micro_credit* → *regeneration*) . The consistency of a sufficient condition of *tree_cutting * ~micro_credit* was not 1.0 but 0.8, and it means 20% of the cases where both *tree_cutting* and *~micro_credit* were confirmed did not have forest regeneration. The value of coverage of each sufficient condition is low, thus, these might be extracted by chance similarly to Analsis 8. 41.2 % of the cases where forest regeneration was confirmed had both *tree_cutting* and *~micro_credit*, *~boundary* and *tree_cutting*, or *~boundary* and *micro_credi*t with consistency of 0.875.

Combination of commitment of forest department (*commitment_FD*) and *tree_cutting* was extracted as a sufficient condition for forest regeneration in Analysis No.11 (*tree_cutting * commitment_FD* → *regeneration*). 76.5 % of cases where forests have regenerated had both *commitment_FD* and *tree_cutting*. As consistency of the sufficient condition was 0.867, forest regeneration was not confirmed in 13.3 % of the cases which have the sufficient condition.

Similarly with Analysis No.11, combination of relationship with the forest department (*relationship_FD*) and *tree_cutting* was extracted as a sufficient condition with consistency of 0.875 in Analysis No.12 (*tree_cutting * relationship_FD* → *regeneration*). As a result, 82.4% of the cases where forest regeneration was confirmed had both *tree_cutting* and *relationship_FD*.

Regarding Analysis No.13, collaboration with other departments (*collaboration*) was extracted as a sufficient condition in addition to the sufficient condition derived from Analysis 8 (*collaboration* + *~boundary * tree_cutting* → *regeneration*) as same as Analysis No. 9. 23.5 % of cases where forests regenerated had *collaboration* or both *~boundary* and *tree_cutting*, and these sufficient conditions might have been extracted incidentally for the same reason with Analysis No. 8 based on the low coverage of each sufficient condition.

As a result of Analysis No.14, combination of community development works (*community*) and *tree_cutting* was identified as a sufficient condition (*community * tree_cutting* → *regeneration*). It is implied that having both *community* and *tree_cutting* caused forest regeneration. 88.2% of the cases where forests have regenerated had both *community* and *tree_cutting*.

4. Discussion

4.1 Implication of two necessary and sufficient conditions – *relationship_FD* and *community*

The one to one cross tabulation analysis result shows firstly the causal factor, "relationship with forest department" (*relationship_FD*) is identified as a necessary and sufficient condition. The result verifies the presumption set at the beginning of the study; a relationship between Forest Department and VFC would affect activities of JFM which would ultimately influence the condition of forest regeneration; their good relationship will lead to better condition of forest regeneration. However, the result is more meaningful if we understand this result in the context of the historical background of the two parties mentioned in earlier section ("Reasons for selection" in Table 1). It may buttress the effectiveness of joint (not singly party) management initiative for forest regeneration as an approach, namely JFM.

The result also shows that "community development works" (*community*) (as it is mentioned as "entry point activities" in the questionnaire) as a necessary and sufficient condition, which is also insightful for the following reason. It is related to the background the *community* is added as one of the project components in JICA funded forestry projects in India (as mentioned earlier as a reason for selecting this factor as a causal condition to be tested ("Reasons for selection" in Table 1)). Its effectiveness has been discussed and pointed out in earlier reports but has not been scientifically investigated. As the one to one cross tabulation result showed *community* was a necessary and sufficient condition for forest regeneration, it can be said that it forms a part of the first scientific evidence that *community* is effective for forest regeneration.

In view of this result, it is also important to consider why it is so. In fact, the development

community works consist of installation of electric pumps, and construction of wells, meeting halls, and village roads, none of which do not seem to be directly related to forest conservation. This reminds us of one of the results of QCA study on "Integrated Natural Resource Management and Poverty Reduction Project in Haryana" which may bring a hint in considering this reason. Although this study sets the outcome as "changes in villagers' awareness for forest conservation" not as "forest regeneration" per se, the changes in villagers' awareness can be assumed to be on the process to actual forest regeneration. The analyst of this study explains one of the reasons behind the strong correlation between community development works and the outcome can be as follows.

The community development works *which improved the living environment of villagers were jointly planned and facilitated with the external professional resources under the supervision of HFD (Haryana Forest Department) advisors and representatives of VFCs. The strong correlation implies that the planning activities referred to in the villagers' opinions of their autonomous participation with HFD and VFC facilitation may have provided an opportunity to instill the necessity of forest management into villagers' mindset, consequently improving their awareness throughout the discussions in terms of forest conservation along with the development works of stakeholders.*

The similar interpretation may be possible in the case of TAP II.

4.2 Implication of four sufficient conditions – *microplan*, *non_timber*, *commitment_FD* and *collaboration*

As sufficient conditions, causal conditions such as "planning and implementation based on microplan" (*microplan*), "appropriate distribution of non-timber benefits between Forest Department and VFC" (*non_timber*), "commitment of forest department" (*commitment_FD*) and "collaboration with other departments" (*collaboration*) were identified as their consistency values are high (above 0.8). Except *commitment_FD*, within villages where forest regeneration was considered to be achieved, the number of villages where those causal conditions were met was not a lot. However, in all or almost all of the villages where those conditions were met, the forest regeneration was considered to be achieved.

To begin with the causal condition of "commitment of forest department" (*commitment_FD*), strong commitment and support by forest department was observed in 18 villages, and forest regeneration was confirmed in 15 villages out of the 18 villages (83%). Meanwhile out of 17 villages where forest generation was confirmed, commitment of forest department was observed in 15 villages, which means the consistency rate (88%) is high as a necessary condition though it does not reach 90% which is a threshold set for this study. These results may suggest that the commitment of forest department is considered to be an important factor to achieve forest regeneration as assumed in Table 1.

With regard to the microplan, out of 17 villages where forest regeneration was considered to be achieved, in only 9 villages planning and implementation were based on microplan while in all 9 villages forest regeneration was considered to be achieved. Out of 15 villages where planning and implementation were not based on microplan, in 8 villages forest regeneration was considered to be achieved while in the rest 7 villages the forest regeneration was not considered to be achieved, meaning that the answers were split into almost a half. In view of this result, although in 7 villages where planning and implementation based on microplan was not conducted, forest regeneration did not take place, at least in all the 9 villages where planning and implementation are based on microplan, forest regeneration was considered to have taken place, thus it can be induced that it is safer to ensure planning and implementation of microplan rather than disregarding it.

The two other causal conditions such as "appropriate distribution of non-timber benefits between Forest Department and VFC" (*non_timber*) and "collaboration with other departments" (*collaboration*) identified as sufficient conditions require additional interpretation. The number of villages where those causal conditions were met was very small (5 on *non_timber* and 2 on

collaboration). However, in all the 5 villages where appropriate distribution was done and in all of the 2 villages where collaboration with other departments was taking place, forest regeneration was considered to be achieved.

About the result mentioned above, it is somewhat too hasting to conclude that distribution of benefits and collaboration with other departments can be very important factors for forest regeneration. It is for the following reasons:

Firstly, it is in fact unknown whether the forest villagers were practicing the collection of non-timber products in all the villages targeted for this study in the first place. For a certain number of villages where such practices were not present due to the limited accessibility to certain forest species as a product in their planted forest, the question may not be relevant. If the comparative analysis was done among the villages where such practices were surely observable, the result may have been firmer.

Similarly, it is not clear whether all the villages targeted for the study had collaboration with other departments at the outset. For those villages where there was no option of collaborating with other departments, the question whether they had a good relationship in asking support from other departments or not may not have been relevant. At least in two villages where they answered they had a good relationship with other departments, forest generation was considered to have taken place. However, it is difficult to conclude only from this result that the collaboration with other departments aiming at synergy effects (namely "conversion approach" promoted through JFM as mentioned in "*collaboration*" in Table 1) has a lot do with the outcome of forest regeneration.

4.3 Implication of the remaining causal conditions – *boundary*, *livestock*, *tree_cutting* and *micro_credit*

In regard to the following three causal conditions, clear boundaries of the reserved forest areas (*boundary*), awareness of livestock management (*livestock*), control of excessive tree cutting for fuel use (*tree_cutting*), they were identified as neither necessary nor sufficient conditions though their relation with forest regeneration was seen not so weak. On all the causal conditions, within the villages where forest regeneration was considered to be achieved, the number of villages where the conditions were met exceeded those where the conditions were not met, thus it is not appropriate to disregard those conditions. It is still worth paying attentions to them and carefully observing their progress as possible drivers for the forest regeneration.[25]

The reason why the three conditions were not extracted as sufficient condition is that the number of villages where forest regeneration did not take place is more than 20% and it did not exceed threshold for sufficient condition. For example, speaking of *boundary*, 6 villages that match clear boundaries of forest areas (*boundary*), which is 30% of the all cases matching *boundary*, did not confirm forest regeneration. There are 14 villages, quite big number, where *boundary* was confirmed, but *boundary* was not extracted as sufficient condition because of the presence of 6 villages where forest did not regenerate. Likewise, awareness of livestock management (*livestock*) and control of excessive tree cutting for fuel use (*tree_cutting*) were confirmed in many villages, however, the number of villages that matched the condition but did not attain forest regeneration was quite large. The reason why the three conditions were not extracted as necessary condition is also the same reason.

How can we interpret this result? There are several possibilities as reasons: 1) Above mentioned three causal conditions are all basic activities in forestry projects and it is in a way obvious that they have to be implemented but the amount or level of activities was not enough to drive forest regeneration. 2) There are prominent factors causing deforestation such as illegal cutting or other external forces driving against forest regeneration in certain villages; 3) Meeting only one causal condition would not

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[25] It is safer to say so as it can be pointed out that the cross tabulation result may have been affected by the nature of information collected. The questions related to the causal conditions such as *boundary*, *livestock*, *tree_cutting* and *micro_crediting* do not necessarily pertain to the degree of achievement. For example, the question on *livestock* was only about the degree of villagers' awareness of awareness of livestock management not about how far such management is achieved. If the information on the degree of achievement on cbm, *livestock*, *tree_cutting* and *micro_crediting* was collected, the result might have been different.

lead to forest regeneration thus other causal conditions that reinforce or recover the conditions are missing. The reasons can be different depending on villages, but if the conditions of villages are as such, the above mentioned possibilities may be a source of information for practitioners to consider whether any additional or different support is required.

In view of the result of micro-credit benefits (*micro_credit*), the study was not able to show a clear perspective and a further investigation is necessary. The relation between this causal condition and forest regeneration was one of the aspects to be highlighted in this study (as mentioned in Table 1). JICA, through discussion with Forest Department, has added to the basic forestry project the component of micro-credit activities to promote income generation of forest villagers, reduce their dependency on the forest resources and ultimately help regeneration of forests. In this context, effectiveness of causal condition of micro-crediting benefits was something wished to be verified. However, the study was not able to show its clear effectiveness/ineffectiveness as shown in "3. Results." In addition, recently it has been pointed out that credit options more attractive than those provided within the scheme of forest projects by Forest Department are available in the market and the logic of intervention related to microcredit by Forest Department is being questioned. In this context, a more rigorous study on this aspect is awaited.

4.4 Implication of four combinations drawn from QCA

The cross-tabulation analysis has shown overall features of villages where forest regeneration is considered to have taken place. It implies already what causal conditions that deserve attentions in order to facilitate the outcome. However, the reality is that multiple causal conditions are intertwined and the combination or mixtures of those are leading to outcome. It is also important to look at what combinations are leading to forest regeneration.

As it is mentioned in "3. Results," a high solution coverage was found in the following combinations and they were identified as sufficient conditions for forest regeneration:

1) The combination of "Planning and implementation based on microplan (*microplan*) or Appropriate distribution of non-timber benefits between Forest Department and VFC (*non_timber*)"
2) The combination of both "Control of excessive tree cutting for fuel use (*tree_cutting*) and Commitment of forest department (*commitment_FD*)"
3) The combination of both "Control of excessive tree cutting for fuel use (*tree_cutting*) and Relationship with the forest department (*relationship_FD*)"
4) The combination of both "Control of excessive tree cutting for fuel use (*tree_cutting*) and Community development works (*community*)"

(1) Combination of *microplan* or *non_timber*
As regard to the result of 1), both conditions were, as a single causal condition, identified as sufficient conditions. As a result of QCA, it was shown that 76.5 % of cases (villages) where forest regeneration was considered to have taken place had "Planning and implementation based on microplan" or "Appropriate distribution of non-timber benefits between Forest Department and VFC."
Both microplan and distribution of forest resources are something that need to be agreed between Forest Department and VFC. In some of the cases, the way of benefit sharing is stated in microplan. In view of this above, the result may be suggesting that if such agreement on benefit sharing between two parties are arranged properly, forest regeneration tends to take place. If this interpretation is valid, whichever the form it may be, it is important for the project concerned to make sure that agreement on benefit sharing of forest resources between two parties are made during project monitoring.
Furthermore, in the section of cross tabulation analysis, we were not fully convinced about the

causal condition of benefit sharing as the important one due to the lack of cases. However, in combination with QCA result, the importance of causal factor may have become more convincing.

(2) Three combinations with *tree_cutting*

Regarding the results of 2), 3) and 4) mentioned above, it was found that "Control of excessive tree cutting for fuel use (*tree_cutting*)," as a single causal condition, was not identified as neither necessary nor sufficient conditions but it was identified as a condition that forms three sufficient combinations. Earlier in "4.3 Implication of the remaining causal conditions – *boundary*, *livestock*, *tree_cutting* and *micro_credit*," we mentioned three possible reasons why they were identified as neither necessary nor sufficient conditions. One of them was "3) Meeting only one causal condition would not lead to forest regeneration thus other causal conditions that reinforce or recover the conditions are missing." as mentioned in the section 4.3. In view of the result of QCA, "Control of excessive tree cutting for fuel use (*tree_cutting*)" seems to fall in this category.

The first combination of "Control of excessive tree cutting for fuel use (*tree_cutting*)" with "Commitment of forest department (*commitment_FD*)" implies that the causal condition was a reinforcing factor for "Control of excessive tree cutting for fuel use (*tree_cutting*)." It may not be wrong to assume that the commitment of Forest Department was important to realize control of excessive tree cutting for fuel use. Thus, those villages where both causal conditions of commitment of Forest Department and control of excessive tree cutting for fuel use tended to lead to forest regeneration. The same kind of understanding may be possible as regard to the second combination with "Relationship with the forest department (*relationship_FD*)" which can be considered as a reinforcing condition for control of excessive tree cutting for fuel use.

Also about the combination with "Community development works (*community*)," the similar interpretation can be made especially when we recall the interpretation on the cross tabulation analysis on "Community development works (*community*)." The reason why this was identified as a necessary condition was elaborated that community development works worked as a trigger for villagers to think about the forest protection more seriously. In the villages where control of excessive tree cutting for fuel use was achieved, it can be considered that the community development works was forming a basis of villagers' awareness against excessive tree cutting.

A simple message from this finding to the project concerned is that (higher) commitment of forest department, (good) relationship with forest department, and (recognized role of) community development works were identified as important factors, thus it is suggested to make sure those three conditions are met in villages. On the other hand, if they are not met, it is recommended that the project concerned take them as alerts and take actions to change the situation. A further message is that the findings on three combinations mentioned above provide the project concerned with an opportunity to rethink the prominent causal conditions leading to forest regeneration. Control of excessive cutting for fuel use is an important condition to facilitate forest regeneration, but then to make that more effective what other causal conditions should be ready on top is another question to ask. The project concerned can regard this study as an opportunity to consciously consider what other causal conditions may be important for facilitating control of excessive cutting for fuel use.

(3) Particularity of Tamil Nadu

In conducting the study on the case of Tamil Nadu, several points were found that seem to be particular in the case of Tamil Nadu among many forestry projects in India. They need to be considered in interpreting the result and also in designing similar studies in different cases.

First point is that in the case of Tamil Nadu, the Forest Department had a strong grip in decision making in JFM. The form of JFM seems to be established well thus there is not much room for VFC to decide and take actions by itself. Thus it is presumable that the study result showed that commitment of Forest Department and good relationship with them were important conditions. However, in the cases where more room of decision making was allowed for VFC, the result might have been different.

Secondly, when selecting causal conditions for this study, prevalence of the use of LPG as a fuel

may be an important one, thus it was included in the questionnaire. However, it was found later that, in the case of Tamil Nadu, in almost all the villages, the LPG was available and it did not form an explanatory power for comparison. But in different context where the LPG is not prevalent, it may be an influential causal condition.

 4.5 Lessons drawn from the analysis

(1) Implications for the practices of JICA-assisted forest projects

(a) QCA as a role of evidence making
   The study was conducted to provide an opportunity of breakthrough to the current situation that there is a complete lack of systematic analysis on factors and conditions leading to forest regeneration on JICA assisted forestry project in India. Decision on introduction of new project component or reduction of funding on certain components has been made mainly based on experience and knowledge of the project stakeholders including the State Forest Department or JICA practitioners, which is not an evidence-based decision making. Although JICA already assisted over 20 forestry projects in this country, a funding decision has still been made without concrete evidence on what works and why in a scientific manner. This study has provided some evidence by identifying several causal conditions that might have led to forest regeneration as mentioned in earlier sections. It is expected the study be referred by the project concerned in justifying project components or activities at the time of project formulation.

(b) QCA as role of prioritization
    By conducting this study, it was also found that QCA may be helpful in looking back the essence or real intension of each activity under the project. Sometimes practitioners get lost because of too many activities to monitor in front of them and get puzzled why those activities are important. QCA may be able to guide one to find a way out of the maze and focus on the highest priority. For example, as it was shown in the result of QCA analysis on the identified combination of causal conditions: planning and implementation of microplan (*microplan*) and appropriate distribution of non-timber benefits between Forest Department and VFC (*non_timber*) (refer to 4.4 (1)), they were originally considered as different causal conditions and treated as such, however through the process of examining why these conditions were identified, it was found that essence or real intensions of those activities might have been the same, which is "agreement on benefit sharing." In this way, by considering why these conditions are prominent and what is common between those conditions, a more fundamental factor can be found, which can ultimately leading to bundling activities together and reducing redundancy among activities.

(2) Important topics for further study

(a) Causal Conditions leading to two outcomes – forest regeneration and livelihood improvement
    TAP-II had two outcomes: forest regeneration and livelihood improvement. This study focused only on the outcome of forest regeneration due to its limitation of available data. Ideally it should have also included the analysis to identify causal conditions and their combinations which significantly contribute to both forest regeneration and livelihood improvement of VFC members, not those contributing to a single outcome of forest regeneration.
    At the formulation of the project, it was assumed that if activities for forest regeneration reduce the dependency of the villagers on the forest resources, their source of income may also be reduced. By introducing income generating activities through micro-credit scheme, the project intended to achieve forest regeneration without sacrificing villagers' livelihood and even its improvement. Thus it was critical to deal with both outcomes.
    As this study could not meet the need mentioned above, it is suggested that the further study make

sure to set both forest regeneration and livelihood improvement as outcomes and identify the causal conditions and its combinations leading to them at the same time.

(b) Effectiveness of Micro-credit scheme

Unfortunately the study was not able to show its clear effectiveness/ineffectiveness of micro-credit scheme for forest regeneration though it was one of the major additional interventions by JICA to JFM scheme and the project concerned was expecting to see its effectiveness. Meanwhile raison d'être and added value of the micro credit scheme by Forest Department are being questioned in the recent context of increasing available credit options. In view of the situation above, it may be a good opportunity to consider conducting a rigorous study on its effectiveness for forest regeneration and livelihood improvement.

(c) "Sustainability" and "Inclusiveness" factors in outcomes

The outcomes of the TAP- II were set as forest regeneration and livelihood improvement and their achievement was expected to take place two years after the project completion. This study was conducted at this timing. Due to the nature of QCA, its results were limited to a certain point of time, as it is said in Pattyn (2019), "analytical moment is in essence a static moment."[26] However, more vital questions that the project concerned may want to ask would be "what causal conditions and their combinations would lead to 'sustainable' forest regeneration and livelihood?"

If outcomes are set as such, the result would have been different. For example, through this study, community development works was identified as necessary condition for occurrence of forest regeneration. However, if it was playing a role as a booster for JFM to attract villagers to raise their awareness, to what extent this causal condition would be influential as the time passes is unknown. It may not be as influential as it was seen in this study in a different context of a longer term of forest regeneration assumed as an outcome.

Not only "sustainability" but also "inclusiveness" is a factor to be counted. The outcome of livelihood movement whose indicator was set as an average per household income in TAP-II. This does not disclose its difference/diversity in the degree of improvement within each village.

Thus, another QCA analysis by resetting the outcomes that take into consideration the time and disparity factors may be a suggested scope of further study. Such study will facilitate considering project components which are more effective for the SDG (Sustainable Development Goals).

(d) Causal conditions other than JICA intervention – core drivers of afforestation and deforestation

The study was originally aiming at identifying the causal conditions which are not necessarily related to JICA's intervention but also the driving forces of regeneration (or deforestation). However, the study faced the limited information on the survey site to include such aspect and select factors as causal conditions. It is suggested the further study consider the scope of a wider perspective on causal conditions not limited to man-made interventions.

(3) Possible areas for the use of QCA in evaluation

(a) QCA as a tool for drawing lessons

QCA is not a perfect method to show the robust evidence on the project impact to serve for accountability purpose, but it is a method to help one to draw lessons or facilitate trial and error to identify better approach.[27] It provides an opportunity to consider why a certain combination of causal conditions can generate a certain outcome and to propose the most effective interventions. Based on a

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[26] It is a nature of QCA whose "analytical moment is in essence a static moment. Policy interventions, in contrast, always incorporate a dynamic component. The time dimension as such is not directly covered by the technique." (Pattyn: 2019, p68)

[27] "QCA evaluations will be closest to the learning pole rather than the accountability pole. Rather than "an effects-of-causes-stance" (what works question) which is typical for quantitative approaches, QCA follows "a causes-of-effects-stance" ("why does it, or did it not work?"—questions)"(Mahoney & Goertz, 2006; Vis, 2012).

good understanding on the strength of this method, it is vital to consider in what kind of environments/contexts/sectors, this method would be useful. This study on TAP-II dealt with a forestry project which had many factors/interventions involved and which was in the context that the most influential factors/ interventions were wished to be identified; it may have been one of the proper examples. India has been strengthening the biodiversity components in forestry projects these days. This can be another possible area to which QCA might be suggested to be applied. Independent Evaluation Office (IEO) of Global Environment Facility (GEF) has already conducted QCA in its own intervention on ecological protection projects worldwide.[28]

(b) QCA as a method for "limited generalization"

Although we emphasized the role of QCA as drawing lessons rather than ensuring accountability, among evaluation researchers, its use for accountability purpose has also been stressed recently. For example, it has been said that "[t]he method is increasingly considered a valuable alternative or complement to existing evaluation methods. That a widely disseminated study on "broadening the range of designs and methods for impact evaluations." (DFID (2012)).

QCA may not have strong explanatory power to withstand for accountability purpose alone. However, it is certainly broadening the choice of evaluation methods to provide 'limited generalization' as Befani and Sager (2006) states: "'the limited generalization' that QCA allows on twenty or thirty cases, is much 'less limited' than that allowed in a classic case comparison." In the statement of Rihoux and Lobe (2009)[29] and Befani (2013), QCA is "meeting the needs to gather in-depth insight into different cases and to capture their complexity, whilst at the same time attempting to produce some form of generalization."

In the field of evaluation, due to limited available data, there are many cases where a sample size is too small to conduct impact evaluation using econometrics while classic case studies do not provide enough generalization. This study on TAP-II was proposed because of this very constraint. Thus QCA may fill in the gap between quantitative and qualitative study by producing 'limited generalization.' In this sense, QCA, for this purpose, has a high potential in applying to ex-post evaluations.

5. Conclusions

The study has analyzed ten causal conditions that may have led to the forest regeneration by JICA-assisted forestry project in Tamil Nadu, TAP (II) and shown the extent to which those conditions and their combination are associated with the forest regeneration through cross tabulations tables and an application of Qualitative Comparative Analysis (QCA).

As a result of cross tabulation analysis, it was found good relationship with forest department and recognized role of community development works were identified as necessary conditions. It is the result that verifies firstly the importance of joint approach between Forest Department and VFC for forest regeneration and secondly the effectiveness of introduction of community development works. This would justify continuation of direction that JICA is pushing forward in forestry projects in India to a certain extent. In addition, causal conditions identified as sufficient conditions suggest that planning and implementation based on microplan and high commitment of forest department are also important causal conditions for achieving forest regeneration.

It was found from QCA that four combinations were identified as sufficient conditions for forest regeneration. The first combination shows that the forest regeneration was considered to have taken place where planning and implementation based on microplan, or appropriate distribution of non-timber benefits between Forest Department and VFC were conducted. This may imply the importance of agreement of benefit sharing of forest resources.

From the remaining three combinations, it can be suggested that the project concerned make sure

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[28] See IEO BRIEF (2016) "Impact Evaluation of GEF Support to Protected Areas and Protected Area Systems" and Independent Evaluation Office (IEO)(2016) for the reports of the study.
[29] Rihoux and Lobe (2009) (p472)

the reinforcing conditions such as high commitment of forest department, good relationship with the forest department, recognized role of community development are met in villages in order to maintain control of excessive tree cutting ultimately for forest regeneration.

Several lessons were drawn from the study. Firstly the study contributed to the practice of JICA-assisted forest projects by providing some evidence on what works and why or a certain causal condition affected the outcome of forest regeneration and on activities to be prioritized. Secondly, despite its contribution, there are still many important topics that further study is expected to take upon: (a) QCA of causal conditions leading to two outcomes - forest regeneration and livelihood improvement, (b) effectiveness of micro-credit scheme for forest regeneration, (c) QCA in consideration of "sustainability" and "inclusiveness" factors in the concept of outcomes, (d) broadening other causal conditions, for example to include core drivers of afforestation and deforestation. Lastly, based on the study experience, possible areas for the use of QCA in evaluation are also indicated.

6. Methodological Limitations

(1) Limitation in outsourcing data collection

In this study, the site survey and data collection were conducted through outsourcing. Mainly due to this reason, the study had to suffer from the gap between the information required by employers and the questionnaire set for it by consultants. For example, employers thought that the study required the information on the extent to which livestock management was conducted or achieved for forest regeneration at survey sites. However the actual question included in the questionnaire was more about the villagers' consciousness on livestock management. As already mentioned in the section on the result of cross tabulation of the causal conditions, the result may have been different depending on the nature of information collected. Furthermore outsourcing data collection made it also difficult for the analyst/author to compare the result with ground information and to modify QCA to withdraw more useful result. If a similar kind of analysis is conducted in future, it is suggested that employers consider the division of tasks between employers and consultants more carefully to reduce the gap in understanding on the data to be collected and to prepare a better environment for the analyst to adjust QCA more easily.

(2) Challenges on comparability of data

One of the important rules of QCA is considered that "[n]o matter whether data sets are of primary or secondary nature, QCA, as the term itself indicates, requires the data to be comparative."[30] Most of the data sets used in this study were primary data and the maximum efforts were made to collect comparable data sets. However, there were several challenges in this study. Firstly the projects sites, namely the targeted villages are scattered in all over the state of Tamil Nadu which are located a few hours distant each other. Secondly the data on those scattered sites were not available in advance, thus surveyors were not able to assess the comparability until they visited the sites. Thirdly climate or other natural conditions were diverse among projects sites. Due to such circumstances, a selection of cases/villages had to be done within the limited number/choice of villages that the surveyors could visit and where availability of data was ensured. Pattyn (2019) suggests that "[w]hen data are insufficiently comparable, QCA evaluators can consider clustering the cases in groups with comparable data, and analyze these separately." The possible solution that the further study can consider is to cluster villages in groups based on data that tends to be available in advance such as climate or natural conditions to focus only on the villages less distant each other, and then to apply QCA on each group. In this way, on one hand, the probability of visiting comparable villages/cases would get higher. On the other hand, several sets of QCA result will be produced on each different context.

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[30] Pattyn et al. (2019, p63)

(3) Difficulty in selecting causal conditions based on informed theory/evidence

In using QCA in evaluation, it has been emphasized that "[t]he choice of conditions should ... be strongly theoretically informed or be based on prior (evaluation) evidence..."[31] Despite the recognition of the significance, this study had to depend on the assumptions that the project concerned were likely to have (not necessarily scientifically withdrawn assumptions) in selecting causal conditions for comparison. Main reasons were the lack of such evidence backed up by previous study and the insufficient information to make such evidence. This is a problem which can be traced back to the lack of baseline and end-line data on key effect and operation indicators or on possible causal conditions, which is discussed further in (4) as below.

(4) Limited scope of study due to the lack of outcome indicators

Firstly the study faced the lack of data on quantitative outcome indicators, for example, the areas of plantation in each village and average income per household before and after the projects. In fact, because of this lack of data, the study suffered in selecting villages for survey which led even to reducing the study scope. The study originally planned to identify the causal conditions leading to both forest regeneration and livelihood improvement in its scope, thus it needed the villages as cases where the livelihood improvement took place and vice versa with a balanced portion. However, as the basic data on livelihood improvement of the project targeted villages was not available, the collected cases ended up being mostly those villages where livelihood improvement took place after the survey (and very few of those villages where it did not take place). This caused the result of QCA all the causal conditions were extracted as sufficient conditions and did not produce a meaningful result to make practical recommendations.

Secondly, on the indicator of the forest regeneration, the study had to depend on the perception of villagers (not the quantitative data). The study tried to use the quantitative data (satellite images) from GIS or geospatial technologies to grasp the exact change of project targeted area during the project intervention but the data on boundaries of project target areas at village level was not available. More rigorous study could have been done if such data was available.

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Annex

(1) Annex 1: Questionnaire

Survey Sheet of Qualitative Comparative Analysis
For Crisp Set Membership
Version May 2, 2018

_____ D / _____ M /2018

ID	

Target Surveyed Population

	Interviewee or Interviewed Group	Range Officer/Guard/Watcher		□
		VFC Member (Male)		□
		VFC Member (Female)		□
		Female SHG or Group _____ *		□
		Female SHG and Group _____ *		□
		*Specify the attribute		

	Procedure of selection of Interviewee	Interviewee's Background
	_____	_____
	_____	_____

Part I: Information

VFC Village Information		
01	VFC Name	
02	Revenue Village Name	
03	Range Name	
04	Division	
05	District	
06	Locality	Block town _____ away from ____ km
		District town _____ away from ____ km
07	Average Annual Rainfall	_____ Mm
08	Topography of Plantation (Multiple answer)	1.Close to mountain □
		2.Near mountain □
		3.Within mountain □
		4.Micro water-shed area □
		5.Plain land □
		6.Slope area of mountain □
09	Plantation Type	1. upper zone and lower zone □
		2. lower zone only □
10	Information nearby VFC Village	1. Animal destroying field (definition) : yes □no □
		2. Near eucalyptus tree plantation ("Near" means within km from VFC village）: yes □ no □
		3. Near reservoir or dam ("Near" mearns km from VFC village）: yes □no □
11	Survival Rate of Planted Tree	_____ %
12	Number of VFC Members	Male _____ Female _____

	(At present)	Total _____
13	Number of Executive Committee (EC) Members (At present)	Male _____ Female _____ Total _____
14	Number of Active VFC	_____ (At present)
15	Number of Active SHGs	_____ (At present)

Information on Reserved Forest in Planted Area (=A)

16	Reserved Forest in Area A	_____ Ha
17	Administrator（管理者） of Reserved Forest in Area A	1. Planned: FD / VFC/ Others(_____) 2. Current Situation : FD / VFC / Others(_____)
18	Roles of VFC in Reserved Forest of Area A	1. Plantation □ 2. Maintenance □ 3. Monitoring □ 4, Other □ Please specify _____
19	Forest Situation of Reserved Forest in Area A before Plantation	1.Shrub □ 2.Open □ 3.Other □ Please specify _____
20	Current Forest Situation of Reserved Forest in Area A	1.Scrub □ 2.Open □ 3.Other □ Please specify _____
21	If there are forest types other than reserved forest in Forest Area A, specify the types of forest.	

Information on Reserved Forest in Forest Area except A (=B)

22	Reserved Forest Area in Area B which meet the following conditions: 1) Located around Forest Area A 2) Within the area monitored by Forest Department (Forest Range Officer/Guard/Watcher)	Reserved Forest Area _____ ha
23	Administrator （管理者） of Reserved Forest Area in Area B	1. Planned: FD / VFC/ Others(_____) 2. Current Situation : FD / VFC / Others(_____)
24	Roles of VFC in the Reserved Forest in Area B	1. Plantation □ 2. Maintenance □ 3. Monitoring □ 4, Other □ Please specify _____
25	Situation of Reserved Forest in Area B before the Project	1.Shrub □ 2.Open □ 3. Other □ Please specify _____
26	Current Forest Situation of Reserved Forest in Area B before the Project	1.Shrub □ 2.Open □ 3.Other □ Please specify _____
27	If there are forest types other than	

	reserved forest in Forest Area B, specify the types of forest.	

1. Number of VFC Member

VFC Member	Male	Female	Total
At setting up			
As of 2018			

2. Household (At present)
How many households are there in the VFC village? _____ HHs

3. Hamlet (At present)
How many hamlets are there in the VFC village? _____ Hamlets

4. Caste of VFC Member Households

	Caste	No. of HHs	%
1	SC		
2	ST		
3	Other Caste		
	Total		

5. Migration for Income Generation
How many households had member(s) of seasonal migration to a town or city in VFC before the project?
_____ HHs _____ %

How many households have member(s) of seasonal migration to a town or city in VFC now?
_____ HHs _____ %

6. Fuel
6.1 What type of fuel do VFC Households use for cooking in general?

		2018	
	Fuel	Tick Major One	% of HHs
1	Firewood		
2	LPG		
3	Others (Agricultural Residue, etc.)		

Actual Use of Fuel
 (Please describe the percentage of actual use of fuel in the pie chart.
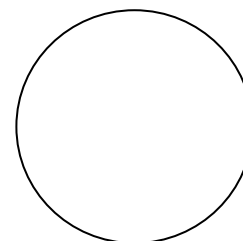
6.2   If VFC Households use or used firewood,
from where is this fuel for cooking obtained?
1. From which forest_____
2. From market or seller_____

6.3 If VFC Households mostly use LPG,
　　how many years have they been using it?

3. Other/s_____

1. ＿＿＿ years

Draw Mapping

・Plantation area (=A)
　-Reserved Forest
　(Its definition: The reserved forest, it is possible for VFC members and others to enter and to pick up shrubs, dried woods etc. without having an ax, or to collect dead branches and wood etc. with agreements or permission with Forest Department or informally)
　-Protected Forest if any
　(Its definition: The protected area is prohibited for people to enter totally.)

・Forest except A (=B)
　-Reserved Forest
　(Its definition: The reserved forest, it is possible for VFC members and others to enter and to pick up shrubs, dried woods etc. without having an ax, or to collect dead branches and wood etc. with agreements or permission with Forest Department or informally.)
　-Protected Forest if any
　(Its definition: The protected area is prohibited for people to enter totally.)

・Buffer Zone
・VFC village area

Within VFC village area, there could be a variety of the following areas.
Draw them in the map if relevant

・VFC Hamlets
・Others

Part Ⅱ : QCA Membership Determination

<Forest Regeneration>

1. Reserved Forest in Area A

    (1) Fairly well regenerated □
    (2) Well regenerated □
    (3) Not well regenerated, rather poorly regenerated □
    (4) Not regenerated, rather decreasing □

    _____
    _____
    _____

_____

2. Reserved forest in Area B
    (1) Fairly well regenerated □
    (2) Well regenerated □
    (3) Not well regenerated, rather poorly regenerated □
    (4) Not regenerated, rather decreasing □

    _____
    _____
    _____

<Cutting Forest Trees>

3. Decrease of Illegal Tree Cutting by Outsiders* (*Unknown people or the neighborhood population, excluding the same villagers).

    (1) Illegal cutting does not occur totally (A. □ B. □)
    (2) Illegal cutting does not occur (A. □ B. □)
    (3) Illegal cutting occur sometime (A. □ B. □)
    (4) Illegal cutting occur often (A. □ B. □)

    _____
    _____
    _____

4. Reporting Illegal Cutting to the Forestry Department
  (1) Report definitely when found (A. □ B. □)
  (2) Report inconsistently, not every time (A. □ B. □)
  (3) Rarely report (A. □ B. □)
  (4) Never report (A. □ B. □)

    _____
    _____
    _____

5. Social Pressure for Illegal Cutting
    (1) There exits strong social pressure. (A. □ B. □)
    (2) There exists slight social pressure. (A. □ B. □)
    (3) There exists loose and unbounding social pressure for preventing illegal cutting. (A. □ B. □)
    (4) There is no social pressure at all. (A. □ B. □)

    _____

<Forest Fires>

6. Incidence of Forest Fires
   (1) Highly decreased (A. □ B. □)
   (2) Decreased (A. □ B. □)
   (3) Not so decreased (A. □ B. □)
   (4) Not decreased (A. □ B. □)

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7. Reporting Forest Fire Incidences to the Forestry Department
   (1) Reporting when fire incidence found (A. □ B. □)
   (2) Attempt to report when fire incidence found (A. □ B. □)
   (3) Not reporting when fire incidence found (A. □ B. □)
   (4) Ignore it and never inform (A. □ B. □)

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8. Agricultural Practice in Agricultural land
   (1) Adopted agricultural practice, and not burning the field nor agricultural remains.   (A. □ B. □)
   (2) Mostly adopted agricultural practice and attempt not to burn the filed or agricultural remains.   (A. □ B. □)
   (3) Still burning in a small area.   (A. □ B. □)
   (4) Burning the field for clearing the field.   (A. □ B. □)

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9. VFC Villagers' Conscientiousness about Fires and Forest Preservation
   (1) VFC villagers well aware the importance of forest preservation in relation to fires.   (A. □ B. □)
   (2) VFC villagers aware the importance of forest preservation in relation to fires.   (A. □ B. □)
   (3) VFC villagers do not well aware the importance of forest preservation in relation to fires. (A. □ B. □)
   (4) VFC villagers do not aware the importance of forest preservation in relation to fires.   (A. □ B. □)

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<Collecting Wood of Forest for Cooking>

10. In comparison with before the project, people do not collect the wood from forest.
   (1) Yes, people do not collect the wood at all.   (A. □ B. □)
   (2) Yes, people do not collect the wood.   (A. □ B. □)
   (3) No, still collecting, but not so much.   (A. □ B. □)
   (4) Collecting wood from forest a lot.   (A. □ B. □)

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   _____

<Prevalence of LPG Use>

11. VFC Villagers use LPG for Cooking
  (1) Yes, they mainly use LPG　□
  (2) Yes, they use LPG if needed□
  (3) Not use LPG so much □
  (4) Not use LPG □

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<Livestock Treatment>

12. Does VFC community tie a neck tether of cattle?
  (1) Yes, always tie a neck tether of cattle. □
  (2) Yes, tie a neck tether of cattle usually. □
  (3) Not always tie a neck tether of cattle. □
  (4) Never tie a neck tether of cattle. □

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13. Do cattle graze in the forest without watcher?
  (1) Never.　(A. □ B. □)
  (2) Rarely.　(A. □ B. □)
  (3) Yes, often.　(A. □ B. □)
  (4) Yes, always. (A. □ B. □)

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14. In case some other households let their cattle go graze in the forest or plantation area without watcher or without any permission by VFC or the Forest Department.
  (1) Fine it (A. □ B. □)
  (2) Warn it. (A. □ B. □)
  (3) Glare at them, but not warn. (A. □ B. □)
  (4) Nothing to do (A. □ B. □)

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<Fencing off reserved forest area from Livestock>

15. For the purpose of protecting forest area from livestock, (=A and B)
  (1) The barbed wire is used or the other fencing is used for preventing livestock entering the plantation area. (A. □ B. □)
  (2) The barbed wire is partially used or the other fencing is partially used for preventing livestock entering the plantation area. (A. □ B. □)

(3) The barbed wire is not used, nor the other fencing is not always used for preventing livestock entering the plantation area. (A. □ B. □)

(4) The barbed wire is not used, nor the other fencing is not used for preventing livestock entering the plantation area. (A. □ B. □)

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\<Intensive Care in reserved forest Area and Boundary Line\>

16. Intensive care was done at each step at initial period, such as watering, measures to protect seedlings.(=A and B)

   (1) Yes, it was carefully done. （A□　B □）

   (2) Yes, it was done. （A □ B □）

   (3) No, it was not carefully done. （A □ B □）

   (4) No, it was not done. （A □ B □）

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17. Boundary lining is clear to identify the location of reserved forest areas.(=A and B)

   (1) It is clear anywhere. （A □ B □）

   (2) It is clear in some places. （A □ B □）

   (3) It is relatively unclear to identify the boundary line. （A □ B □）

   (4) It is difficult to identify the boundary line （A □ B □）

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\< Facilitation of NGO or Forest Department Officer \>

18. At the project's initial stage, a clear mission statement about VFC and forest preservation, was given. (=A and B)

   (1) It was very clear statement for VFC Members to understand the VFC mission (A. □ B. □)

   (2) It was clear statement for VFC Members to understand the VFC mission (A. □ B. □) □

   (3) It was not so clear statement for VFC Members to understand the VFC mission. (A. □ B. □)

   (4) It was not totally clear statement for VFC Members to understand the VFC mission. (A. □ B. □)

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19. Continuous Follow-up by Forest Department Officer. (=A and B)

   (1) After the initial stage, the continuous follow-up has properly been provided by forest department officer (A. □ B. □)

   (2) After the initial stage, the continuous follow-up has been provided by forest department officer (A. □ B. □)

   (3) After the initial stage, the continuous follow-up has not been properly provided by forest department officer (A. □ B. □)

   (4) After the initial stage, the continuous follow-up has not been provided by forest department officer

(A. □ B. □)

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<Selection of Preferred Tree in Plantation area>
20. Have the tree kind been selected which will bring the benefits to VFC? **(= A)**
  (1) Yes, the preferred tree kinds that bring the benefits were selected. □
  (2) Yes, the preferred tree kinds that bring the benefits were mostly selected. □
  (3) No, the preferred tree kinds that bring the benefits were not mostly selected. □
  (4) No, the preferred tree kinds that bring the benefits were not selected. □

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<Periodical Benefits from NTFP >
21. VFC Members' Benefits of Non-Timber Forest Product (NTFP) Benefits
  (NTFP means fruit, herbal medicine, resin, wood fiber and so forth)
  (1) VFC Members has been benefited by NTFP from planted plantation very much. (A. □ B. □)
  (2) VFC Members has been benefited by NTFP from planted plantation. (A. □ B. □)
  (3) VFC Members has not been benefited from NTFP from planted plantation so much. (A. □ B. □)
  (4) VFC Members has not been benefited from NTFP from planted plantation totally. (A. □ B. □)

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<Expectation for Profits from the Trees in plantation area in the Future>
22. VFC members' Expectations for Profits from Trees Grown in the Future. **(=A)**
  (1) VFC members' expect the profits of future grown trees very much. □
  (2) VFC members' expect the profits of future grown trees. □
  (3) VFC members do not (cannot) expect the profits of future grown trees so much. □
  (4) VFC members do not (cannot) expect the profits of future grown trees. □

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<Stable Income from Agriculture or Animal Husbandry>
23. Stable Income from Agriculture or Animal Husbandry
  (1) VFC members' households have stable income. □
  (2) VFC members' households have a certain stable income. □
  (3) VFC members' households do not have a certain stable income. □
  (4) VFC members' households do not have stable income. □

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<Benefits by Micro-crediting >
24. Micro-crediting Benefits.
  (1) Micro-crediting benefited VFC members very much. □
  (2) Micro-crediting benefited VFC members to some extent. □
  (3) Micro-crediting does not benefit VFC members so much. □

(4) Micro-crediting does not benefit VFC members.□

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25. Revolving Fund
   (1) Revolving fund is well revolving.□
   (2) Revolving fund is revolving.□
   (3) Revolving fund is not well revolving.
   (4) Revolving fund lost the fund and defaulted.□

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< Sense of Ownership>
26. Planting seedlings.
   (1) Planting seedlings nurtures a sense of ownership or responsibility of VFC members very much.□
   (2) Planting seedlings nurtures a sense of ownership or responsibility of VFC members. □
   (3) Planting seedlings do not nurtures a sense of ownership or responsibility of VFC members so much
   □
   (4) Planting seedlings never nurture a sense of ownership or responsibility of VFC members □

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27. Labor for the Soil and Moisture Conservation (SMC)
   (1) SMC works highly nurtures a sense of ownership and responsibility of VFC members for plantation.□
   (2) SMC works moderately nurtures a sense of ownership and responsibility of VFC members for plantation.□
   (3) SMC works do not nurture plantation a sense of ownership and responsibility of VFC members for plantation so much □
   (4) SMC works do not nurture and a sense of ownership and responsibility of VFC members for plantation. □

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<Commitment of Forestry Department>
28. Dissemination activities for forest preservation by the Forest Department
   (1) Highly effective to preserve forest. □
   (2) Effective to preserve forest. □
   (3) No so effective to preserve forest. □
   (4) Not totally effective to preserve forest. □

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29. Forestry Department Commitment and Support to the Project Activities*
(*Project activities mean microplan formulation, maintenance planation income-generating activities

including SHG formulation and micro-credit activities.)
   (1) Very Strong. □
   (2) Strong. □
   (3) Not so strong. □
   (4) Not strong.   □

<Relationship with the Forest Department >
30. Relationship with the Forest Department
   (1)VFC has a very good relationship with the Forest Department.□
   (2)VFC has a good relationship with the Forest Department. □
   (3)VFC does not have good relationship with the Forest Department so much.□
   (4)VFC has never have a good relationship with the Forest Department.□

<Relationship with the Other Line Departments >
31. Collaboration with Other Line Departments
   (1) VFC has a good relationship in asking support from the other departments. □
   (2) VFC has a relationship in asking support from the other departments. □
   (3) VFC does not have a good relationship in asking support from the other departments. □
   (4) VFC does not have such relationship in asking support from the other departments. □

< VFC Leader and Member Collaboration>
32. Leadership of VFC President
(1) VFC president leadership has been very effective for management of VFC.□
(2) VFC president leadership has been effective for management of VFC.□
(3) VFC president leadership has not been so effective for management of VFC.□
(4) VFC president leadership has not been effective for management of VFC.□

33. VFC Members' Collaboration for VFC activities*
(* VFC activities include plantation, maintenance, monitoring, income-generating activities.)
(1) VFC members have been very collaborative for VFC activities.□
(2) VFC members have been collaborative for VFC activities.□
(3) VFC members have not been so collaborative for VFC activities.□
(4) VFC members have not been collaborative for VFC activities.□

< Forest Management based on Microplan>
34. Knowledge of Microplan
(1) VFC members understand the contents of microplan of one's own village very much
(2) VFC members　understand the contents of microplan of one's own village □
(3) VFC members do not understand the contents of microplan of one's own village so much □
(4) VFC members do not understand the contents of microplan of one's own village totally□

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35. Management by Microplan
(1) VFC has been managing plantation area based on micro-plan （A □ B □)
(2) VFC has been managing plantation area mostly based on micro-plan （A □ B □)
(3) VFC has not been managing plantation area based on micro-plan very much　（A □ B □)
(4) VFC has not been managing plantation area based on micro-plan at all （A □ B □)

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< VFC's Mission >
（**VFC's mission means purpose of activities**）
36. VFC members' knowledge on VFC mission
(1) VFC members know VFC mission very much □
(2) VFC members know VFC mission.□
(3) VFC members do not know VFC mission so much □
(4) VFC members do not know VFC mission.□

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<VFC Functioning>
(Functioning means having periodical meeting or activities for plantation preservation**)**
37. Current VFC's Functioning for VFC mission
(1) Current VFC is well functioning on behalf of VFC mission.□
(2) Current VFC is functioning on behalf of VFC mission.□
(3) Current VFC is not well functioning on behalf of VFC mission.□
(4) Current VFC is not functioning on behalf of VFC mission.□

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<Change in livelihood>
38. Change in livelihood over the project period
　(1) Livelihood of VFC members' households has improved largely. □
　(2) Livelihood of VFC members' households has improved gradually.□
　(3) Livelihood of VFC members' households has deteriorated gradually.□
　(4) Livelihood of VFC members' households has deteriorated largely.□

<Effect of community development as entry point activities>

39. Effect of community development fund for entry point activities

(1) Community development fund for entry point activities contributed to activation of forest management. largely.□

(2) Community development fund for entry point activities contributed to activation of forest management a little. □

(3) Community development fund for entry point activities did not contributed to activation of forest management so much.□

(4) Community development fund for entry point activities did not contributed to activation of forest management at all.□

<Change in decision making power of VFC >

40. Change in decision making power of VFC

(1) Through plantation and forest management activities with Forest Department, VFC's decision making power on the use of forest resources increased largely. □

(2) Through plantation and forest management activities with Forest Department, VFC's decision making power on the use of forest resources increased a little.□

(3) Through plantation and forest management activities with Forest Department, VFC's decision making power on the use of forest resources decreased a little.□

(4) Through plantation and forest management activities with Forest Department, VFC's decision making power on the use of forest resources decreased largely.□

(2) Annex 2: A list of Surveyed VFC Villages and their Preconditions

ID	Revenue Village	VFC Village	JAXA Cluster	District	Sub-district	Rainfall	Reserved Forest	Agri, Animal Husbandry	One-day Accessibility	No Eucalyptus Tree Plantation	Distance form Block Town	Distance from District Town
1	Rangappanur	Rangappanur	Cluster13	Vilupuram	Kalakuruchi	1072.58	✓	✓	✓	✓	16	115
2	Pillrampattu	Appanandai	Cluster12	Vilupuram	Vilupuram	1137.03	✓	✓	✓	✓	10	45
3	Kundiyanatham	Mattaparai	Cluster13	Vilupuram	Kalakuruchi	1072.58	✓	✓	✓	✓	50	75
4	Esanthai	Fathimapalayam	Cluster13	Vilupuram	Karakuruch	1072.58	✓	✓	✓	✓	8	85
5	Ravanthavadi	Rajapalayam	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	18	48
6	Andipatty	Kliamman Koil Pudur	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	15	52
7	Valayam Pattu	Kumarasany Palayam	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	8	43
8	Andipatti	Thambunaickenpatti	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	22	55
9	Ravandhavadi	Neepathurai	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	24	59
10	Chenna Samudiram	Darbarpalayam	Cluster 4	Tiruvannamalai	Chengam	1073.96	✓	✓	✓	✓	8	43
11	Aravatla	Pasmarpenda	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	8	60
12	Aravatla	Aravatla	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	10	50
13	Kottaiyur	Kottaiyur	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	9	62
14	Gundalapalli	Kudipalli	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	7	59
15	Kankuppam	Moolakankuppam	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	17	48
16	Kothapalli	Onkuppam	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	22	55
17	Killkothur	Gumbalkottai	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	22	54
18	Kallapadi	K.Pudhur	Cluster 4	Vellore	Gudiyattam	839.55	✓	✓	✓	✓	8	39
19	Thattaparai	Velleri	Cluster 4	Vellore	Gudiyattam	839.35	✓	✓	✓	✓	10	41
20	Vellakkal	Vellakkal	Cluster 4	Vellore	Vaniyampadi	936.48	✓	✓	✓	✓	40	65
21	Athimoor	Dhaniar	Cluster 13	Tiruvannamalai	Polur	955.56	✓	✓	✓	✓	12	36
22	Kadampalayam	Ayyappan Nagar	Cluster 13	Tiruvannamalai	Polur	955.56	✓	✓	✓	✓	24	47
23	Kidampalayam	Gandhinagar	Cluster1 3	Tiruvannamalai	Polur	955.56	✓	✓	✓	✓	27	50
24	Nattapriyur	Mattapriyur Krishanapuram	Cluster1 4	Tiruvannamalai	Polur	955.56	✓	✓	✓	✓	12	40

Note) Created by Noriyo Aoki, Alfapremia Co., Ltd.

(3) Annex 3: Final Judgement on Outcome and Causal Conditions of VFC Villages used as Cases

ID	VFC Village	Outcome	Causal Conditions									
		regeneration	Microplan	boundaries	livestock	tree_cutting	non_timber	micro-credit	commitment_FD	relationship_FD	collaboration	community
1	Rangappanur	1	0	1	1	0	1	0	1	1	0	1
2	Appanandai	0	0	1	1	0	0	1	1	1	0	1
3	Mattaparai	0	0	0	1	0	0	0	0	0	0	0
4	Fathimapalayam	0	0	1	1	1	0	0	0	0	0	0
5	Rajapalayam	1	0	1	1	1	1	1	1	1	0	1
6	Kliamman Koil Pudur	1	0	1	1	1	0	0	0	0	0	1
7	Kumarasany Palayam	1	0	1	1	1	1	0	1	1	0	1
8	Thambunaickenpatti	1	0	1	1	0	0	0	1	1	0	1
9	Neepathurai	1	0	1	1	1	1	1	1	1	0	1
10	Darbarpalayam	1	1	1	1	1	0	1	1	1	1	1
11	Pasmarpenda	1	0	1	1	1	0	1	1	1	0	1
12	Aravatla	1	1	0	0	1	0	1	1	1	0	1
13	Kottaiyur	1	1	0	1	1	0	1	1	1	0	1
14	Kudipalli	1	0	1	1	1	0	1	1	1	0	1
15	Moolakankuppam	1	1	1	1	1	0	1	1	1	0	1
16	Onkuppam	1	1	0	0	1	1	1	1	1	1	1
17	Gumbalkottai	1	1	1	1	1	0	0	1	1	0	1
18	K.Pudhur	1	1	1	1	1	0	1	1	1	0	1
19	Velleri	1	1	1	1	1	0	1	1	1	0	1
20	Vellakkal	1	1	1	1	1	0	0	0	1	0	1
21	Dhaniar	0	0	1	1	1	0	1	0	0	0	0
22	Ayyappan Nagar	0	0	1	1	0	0	0	0	0	0	0
23	Gandhinagar	0	0	1	1	1	0	1	1	1	0	0
24	Mattapriyur Krishanapuram	0	0	1	1	1	0	1	1	1	0	0

(4) Annex 4: A list of Tables and Figures