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A COMPUTATIONAL FRAMEWORK FOR SOCIAL ENTREPRENEURS TO DETERMINE POLICIES FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Many villagers in India suffer from multiple socio-economic challenges, such as, low-income, unemployment, and lack of access to clean water and energy that hinder their overall development. Social entrepreneurs can assist with the design and implementation of policies that help villagers achieve overall sustainability. Previously, a framework to support social entrepreneurs and stakeholders in identifying potential challenges and evaluating the impact of solutions concerning sustainable development was proposed. The framework was anchored in a single perspective (thematic area) Dilemma Triangle Method for identification of challenges and System Dynamics Models for evaluation of impacts. Policies for sustainable development, however, require an understanding of the interactions among multiple possibilities and their associated challenges to be viable, feasible, and equitable. Additionally, one key missing feature in the past framework is the evaluation of the economic impact of the solutions or policies.

In this paper, we add new value to the past framework using the Dilemma Triangle Method to integrate more than one perspective, and the System Dynamics Model integrating the economic indicator to get a holistic view of sustainable development. By the addition of more than one thematic area in the Dilemma Triangle Method, the inter-dependency among thematic areas and their associated parameters is understood, which is necessary for identifying problems in complex systems. We include Gross Value Added (GVA) as an economic indicator for evaluating the economic feasibility of the policies identified by using the framework. To illustrate the efficacy of the framework, we implement it for the Kantashol village (panchayat), Jharkhand, India. Based on the Dilemma Triangle Method, multiple policies are proposed, out of which four policies are evaluated in the Systems Dynamic Model for the sustainable development of the village. The policies are currently being applied in the village and the outcome of this framework will be validated in real-time over the years.

KEYWORDS

System Dynamics; Sustainable Development; Value Proposition; Dilemma Triangle Method; Gross Value Added, Economic Parameters; Policies

GLOSSARY

Sustainable development: Development that meets the needs of the present without compromising the ability to meet future needs. By applying sustainable development, the three spheres of sustainability are satisfied: social, environmental, and economical [1].

Dilemma: A dilemma is a difficult choice between two options, each of which is (or appears) unacceptable or unfavorable. A dilemma represents a zero-one outcome. We attempt in engineering is to convert zero-one outcomes into positive-sum outcomes [2].

Social Entrepreneur: A social entrepreneur is a person who establishes an enterprise to address social problems and thereby effect social change [3].

Value Proposition: A value proposition is a promise or a value to be delivered, communicated, and acknowledged to a customer. In the context of rural development, a value proposition is a promise that is delivered to improve the quality of life of villagers. This is in the form of an asset, product, or service [3].

Gross Value Added (GVA): Gross Value Added is defined as the total value output in a village minus the intermediate cost or consumption. Gross Value Added is the measure of the value of goods and services produced in a village, town, industry, or any small sector. GVA is adopted in many sectors, and hence it is easy to evaluate the economic growth of a village with its help [4].

Agroforestry: Agroforestry is a land-use management system in which trees or shrubs are grown around pastureland. The intentional combination of agriculture and forestry has benefits like increased biodiversity and reduced erosion. An increase in agroforestry contributes to the increase of area under forest [5].

Thematic Area: Thematic areas are defined as an area or category in which all the issues relating to the same subject are collected

Driver: Drivers are the spheres of sustainable development which help in achieving particular phenomenon. The three drivers present in this paper are people, planet, and progress. People in the social sphere in which the progress of villagers is given priority, the planet is the sphere of the planet in which the preservation of nature is given priority, and progress is the economic sphere in which the economy of the village and villagers is given priority.

Issue: Issues are defined as the problems faced by the villagers with respect to the thematic areas and drivers.

Focus: Focus is defined as the aim/goal of the user of the framework while solving an issue.

1. FRAME OF REFERENCE

A large proportion of farmers in India have low income because of market remoteness, low productivity, and lack modern technology in farming [6]. There is a high illiteracy rate in rural Indian because the number of educational institutes in the villages is low [7]. Additionally, Indian villagers suffer from malnutrition because there is a lack of availability of nutritious food [8]. Furthermore, villagers in India face socio-economic challenges, such as low income, illiteracy, unemployment, and lack of clean drinking water.

To improve the standard of living of the villagers, policymakers need to focus on two major aspects. Firstly, the interventions, or, the policies must be anchored in sustainable development [9]. Sustainable development is the process of fulfilling the needs of the present without compromising the needs of the future [10]. The focus is on the financial growth of a rural area which does not impact the environment negatively [11]. To enable sustainable development, three drivers are used: People, Planet, and Profit (Progress) [12]. To achieve sustainable development, key stakeholders such as the government, villagers, social entrepreneurs, etc., need to come together [13]. The villagers' role is to provide information regarding the challenges, government official's role is to provide funding, and approve policies. Whereas a social entrepreneur's role is to identify the challenges and then propose policies to solve the challenges [14]. Overall, the social entrepreneur becomes the connection between stakeholders and is required to have a holistic view of the systems. To support social entrepreneurs, and to identify and solve challenges associated with sustainable development, a framework of Dilemma Triangle Method and System Dynamics Model is developed [15]. In the past framework, the Dilemma Triangle Method is used to identify the zero sum issues (dilemmas) between the different drivers of sustainable development for a single thematic area[15]. Taking the information from the Dilemma Triangle Method, policies are developed that are then evaluated using a village level System Dynamics Model, also anchored in sustainable development. [18].

A holistic understanding of the system is required for attaining sustainable development [2]. For example, forestry, agriculture, and water are the interdependent thematic areas, where the challenges are connected, but the policies for each of these thematic areas are implemented in silos that can negatively affect interdependent thematic areas [16]. For example, the use of chemical fertilizers increases agricultural production, but it deteriorates the quality of the soil. Therefore, a solution for the agricultural perspective creates problems for the water perspective. Different thematic areas are not taken into consideration in the past framework. Additionally, in the previous framework, while evaluating policies in the village level System Dynamics Model the economic growth of a villager is considered, but the economic growth of a village as an indicator of sustainable development is not included [13]. It is sometimes possible that the economic growth of an individual is good, but the economic growth of the village is poor [17]. For example, the villagers may receive income from an occupation that is outside the village. In this case, there is economic growth for the villager, but as the occupation is not done in the village, there is a nominal economic advantage that the village receives. Therefore, it is crucial to calculate the economic growth of the village along with the economic growth of the villagers. In the next section, the framework of the Dilemma Triangle Method and System Dynamics Model is explained in detail.

1.1 Dilemma Triangle Method (DTM)

In this section, the dilemma triangle method used in the previous framework is explained. Solving dilemmas are important as they help Social Entrepreneurs to solve wicked problems. A wicked problem is a problem that is difficult to solve because it is contradictory and transient. To understand the wicked problem, take the example of people whose income is dependent on forestry. If these people stop cutting trees to save the planet, then their income reduces. Hence, this is a dilemma that a social entrepreneur needs to solve for achieving sustainable development. In the Dilemma Triangle Method, we take issues aligned to three drivers which are people, planet, and progress. The driver helps to attain sustainable development. The people driver helps the social entrepreneur to solve issues related to a villager's life, the planet driver helps to solve problems of the environment and planet, and the progress driver helps the social entrepreneur to solve issues that obstruct the sustainable development of the village. The Dilemma Triangle Method is carried out in the Custom-made Excel-VBA software. The Dilemma Triangle Method is used with other methods to solve wicked problems. The two major parts of the Dilemma Triangle Method are the Tension matrix and the Dilemmas with the value proposition.

A) Tension/Issue Matrix

A tension matrix or an issue matrix is a matrix in which the relation between two issues is found. This is a critical step to determine the dilemmas in a system. The issues are written in the first column and the first row of the tension matrix, then the relationship between the issues is written in the table. The different relations in the tension matrix are:

i. Tension

Tension is created when the solution for one issue impacts the problems of another issue.

ii. Dependents

Dependent is a condition in which a solution for one problem solves another problem.

iii. Inter-Tension

This term is similar to tension, but the two issues creating the tension belong to different thematic areas. For example, a solution that impacts an issue positively of one thematic area impacts another issue negatively of another thematic areas.

iv. Inter-dependents

This term is similar to dependent, but the two issues having dependency belong to different thematic areas. This means that a solution impacts both the issue of different thematic areas positively.

An application of the tension matrix is in Section 3.

B) Finding Dilemmas with Value propositions

Dilemmas are created after carefully analyzing the relationships among the issues. A dilemma is created by taking tensions and dependents of the different perspectives together. These tensions and dependents contradict each other if poor solutions are proposed. To solve these dilemmas value propositions are proposed. Many value propositions may be proposed, and 4-5 value propositions may be selected from among them.

1.2 System Dynamics Model (SDM)

In this section, the Systems Dynamics Model which is used in the previous framework is explained. The System Dynamics Model is defined as a model which is used to understand the behavior of complex systems. It is a combination of various stock and flow diagrams. Here, the System Dynamics Model is created with Vensim which evaluates the performance of a model with a systems approach. The two steps which are used to create the System Dynamics Model are:

a) Causal loop diagram

A causal mapping/loop diagram is a powerful tool for representing the structure of a complex system. They are used in visualizing the interconnections of variables in a system; that means how different variables are related to each other. They are used to understand the system conceptually. The Causal loop diagram is a qualitative modeling step of the System Dynamics Model. The plus sign in the causal loop diagram depicts direct relation between two variables, and the minus sign indicates the inverse relationship between two variables.

b) Stock and flow diagram

Stock and flow diagrams help the social entrepreneur to evaluate the policies and the magnitude of the output parameters. It is the quantitative modeling step of the System Dynamics Model. Stocks and Flows are two types of variables used in the System Dynamics Model. A stock is measured at one point in time and represents the accumulation of the existing quantity. A flow is a quantity that is measured according to time. In the next section, the new value-added in the framework is explained.

1.3 Gaps in the Framework

In the previous framework of Dilemma Triangle Method and System Dynamics Model, the desired policies may not be proposed and implemented because it is based on the three assumptions; see [2 and 3].:

1) Dilemma Triangle Method is applied to a single thematic area in the previous papers, hence interactions are made between the issues of the same thematic areas, but real systems are not anchored to the issues of one thematic area. In other words, interactions between the issues of different thematic areas are not considered while proposing policies.
2) In the previous framework, there is an economic indicator that predicts the socio-economic development of an individual, hence, the socio-economic development of the village as a whole system is not evaluated.
3) Data from a real system is not used in the past framework, and the results obtained from the previous framework are not implemented on a real system. In the absence of data, some important parameters are ignored while evaluating policies.

Given the three limitations, we propose adding to the framework of the Dilemma Triangle Method and System Dynamics Model for achieving sustainable and socio-economic development of the village and for the villagers.

1.4 Problem Statement

In this paper, the main focus is on describing a framework that helps social entrepreneurs to propose and evaluate policies for the sustainable development of a village.

The first goal is to use a Dilemma Triangle Method which covers issues from more than one perspective (thematic area). The second goal is to add economic parameters in the System Dynamics Model of the proposed framework. To calculate the overall economic growth of the village, Gross Value Added is used as a parameter in the System Dynamics Model. By implementing these goals social entrepreneurs achieve the long-term sustainable development of the village.

To illustrate the efficacy of the framework we have applied it to a panchayat which comprises 14 villages in the Jharkhand state of India. The 14 villages have a population of 6060 people [18]. The road transport in the village is marginal, but mobile connectivity is normal. The groundwater of that area is overexploited, and limited agriculture is practiced [19]. Most of the population depend on forestry for their livelihood due to which their income is low. The terrain of the village is hilly, and therefore there are high runoff areas [20]. Annual rainfall is 800-1310 mm and it normally rains for 60-65 days a year. The normal temperature in the village is 40-45 degrees Celsius. The data about the Kantashol village is obtained from SunMoksha Power Pvt. Ltd.

In Section 2, the description of the framework based on the gaps identified is presented, In Section 3, to illustrate the efficacy of the framework, it is applied to a village named Kantashol. The results obtained from the framework when applied to the Kantashol village are given in Section 4. In Section 5, closing remarks with future work of this research paper are given.

2 DESCRIPTION OF NEW VALUE-ADDED IN THE FRAMEWORK

2.1 Brief Explanation of the New Value-Added in the Proposed Framework

		People	Planet	Progress
	Food			
Progress				
Planet		Tension 1		
People			Dependant 2	
		People	Planet	Progress
	Water			
Progress				
Planet				
People		Inter -Tension 1		
		People	Planet	Progress
	Energy			
Progress				
Planet				Inter -Dependent 1
People				

FIGURE 1: TENSION MATRIX WITH THREE THEMATIC AREAS

The Dilemma Triangle Method is useful method to identify dilemmas. In this framework with new value-additions, there are three thematic areas, and the relation between different issues is determined from a tension matrix as shown in Figure 1. Three sub-matrix are made as seen in Figure 1, and each matrix represents one thematic area. For attaining sustainable development the issues are classified according to the people, planet, and progress drivers. Dependent-1 and tension-1 show the relationship between the issues of one sub-matrix, and Inter-Dependent 1 and Inter-Tension 1 represent the relationship between issues of two sub-matrices. The relationship between issues is identified, and dilemmas are created. Then value propositions to solve those dilemmas are created. These value propositions are evaluated by using system dynamics. In the System Dynamics Model, to calculate the economic growth of the village and the villagers, we have incorporated Gross Value Added as an economic indicator. The Gross Value Added (GVA) is a good indicator of the progress driver. For progress, the village economy needs to prosper, and the GVA indicates the condition of the village economy. In economics, GVA is the measure of the value of a village in a period. The formula to calculate GVA is,

$$Gross\ Value\ Added\ (GVA) = \sum Economic\ value\ added\ to\ village - Cost\ of\ all\ the\ value\ additions - Miscellineous\ cost \quad (1)$$

In Section 2.2, the steps to implement the revised framework added are illustrated.

2.2 Steps to Implement the Framework of Dilemma Triangle Method, and System Dynamics Model with New Value Added

DTM Step 1. Categorize the issues

In this step, all the issues according to thematic areas and drivers are categorized and this is necessary to create a tension matrix

DTM Step 2. Create the tension matrix

In this step, the relationship between different issues is determined, and it is necessary to identify the Dilemmas in the system

DTM Step 3. Identify dilemma and develop the value proposition

All dependents and issues identified to create dilemmas, this is necessary to develop value proposition

DTM Step 4. Select the best value proposition

In this step, the goal is to select the best value propositions that are feasible for a social entrepreneur to implement, and which has the most significance for village sustainable development.

Steps for creating the System Dynamics Model are,

SDM Step 1. Create the causal loop diagram

Evaluate the relationship between the different parameters of the System Dynamics Model. This yields the qualitative model of the System Dynamics Model.

SDM Step 2. Create the stock and flow diagram

In this step, the model is simulated which is created in the previous step along data. This is the quantitative model of the System Dynamics Model.

SDM Step 3. Evaluate the results

Here the results of the System Dynamics Model are evaluated and then compare the policies to select the best policies for the socio-economical development of the village.

These steps are explained in Figure 2

In the next section, we apply the revised framework for the Kantashol village for its Socio-economic development

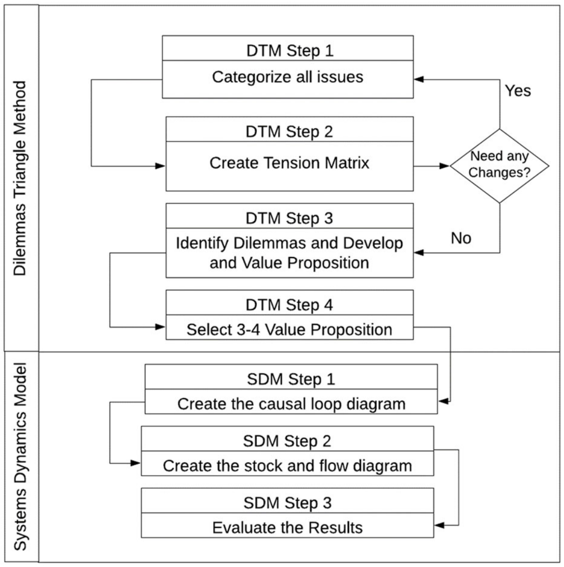

FIGURE 2. FLOW CHART OF THE FRAMEWORK

3. APPLICATION OF THE FRAMEWORK WITH NEW VALUE-ADDED ON THE KANTASHOL VILLAGE

3.1 Application of Dilemma Triangle Method

In this section, the Dilemma Triangle Method is applied stepwise to propose policies for the sustainable development of the Kantashol Village.

3.1.1 DTM Step 1. Categorize the issues

In this section, the issues that the Kantashol village faces are categorized according to their perspectives. This step helps in arranging the issues in the Tension Matrix table. It is carried out on custom-built Excel VBA software. First, the issues are categorized according to the thematic areas, and then according to their respective drivers. The focus is also set to fix the problem boundary. The three thematic areas which are used here in the Dilemma Triangle Method are Forestry, Agriculture, and Water. Forestry is selected as a thematic area because Kantashol is surrounded by forest, and most of the people depend on forestry for their livelihood. Agriculture is selected as a thematic area because the majority of people are farmers, but they produce few products. Water is selected as a thematic area because water is scarce in this hilly area, and it is not stored effectively and usually runs off,

A. Focus and Issues for forestry thematic area

a. People

Focus-The Focus is to make forest products easily accessible to People to promote sustainable agroforestry for the sustainable development of the village.

Issues-

1) The difficulty of traveling in the forest

Some of the shrubs and herbs on which the livelihood of villagers depend are found in the deep forest. Some of these parts are inaccessible to the villagers due to rugged terrain, and dense forest.

2) Fewer policies to promote agroforestry

There are very few policies that are favorable for promoting agroforestry.

3) Strict government policies regarding access to forest

The government does not permit villagers to enter the main forest without special permission.

b. Planet

Focus- The Focus is to preserve the forest and its biodiversity

Issues-

1) High exploitation of forest by villagers

Villagers are very dependent on the products of the forest for their living. This makes deforestation a huge cause of concern for the planet.

2) Excessive grazing

Animals from the villages enter the forest for fodder and they eat the vegetation in the forest area. This leads to soil erosion which creates run-off and a reduction in the groundwater level.

3) No initiative for tree nursery establishment

To promote forestation and agro-forestation, planting trees on barren land is important, but this initiative is not implemented in the Kasntashola village.

c. Progress

Focus- The focus is also to promote agroforestry. Agroforestry creates a source of income for villagers and saves the planet.

Issues-

1) Fewer species of crops that are used for agroforestry

Currently, few species of crops are cultivated for agroforestry. This problem makes villagers less interested in practicing agroforestry.

2) More barren lands

Conventional practices of forestry and agroforestry create barren lands where there is no vegetation.

3) More runoff

Water is wasted and not stored properly because the capacity to hold water is low in barren lands.

B. Focus and Issues for agriculture thematic area

a. People

Focus- The focus is to provide an adequate amount of nutritious food to everyone in the village.

Issues-

1) Lack of agriculture

Villagers are unaware of new techniques and trends in agriculture, and they use old techniques of agriculture due to which their agricultural production per acre is low.

2) High reliance on forestry

The villagers are more dependent on products obtained from forests rather than agriculture for their livelihood.

3) Lack of crop diversification

A reduced variety of crops are grown, due to which villagers are unable to get nutritious food.

b. Planet

Focus- The focus is to conserve the fertility of the agricultural land for the continuous growth of crops.

Issues-

1) Mono-cropping

Growing one type of crop, again and again, decreases the fertility of the soil. Mono-cropping not only reduces the fertility of the soil but also contributes to the erosion of soil.

2) High reliability on forest products

The villages are highly reliant on forest resources which degrades the bio-diversity of the forest.

3) Excessive tillage

Tilling is the process of loosening the soil before planting seeds. High tillage is carried in the Kantashol village for agriculture thus to which the fertility of the soil is reduced.

c. Progress

Focus- The focus is to achieve progress in the villager's income, and to preserve the fertility of the soil.

Issues-

1) Deforestation

Forest areas are cleared to create new lands for agriculture. This leads to deforestation.

2) High reliance on agroforestry

The villagers are more dependent on products obtained from forests rather than on agriculture for their livelihood.

3) Wastage of food

The village has no storage facility. Due to this, a considerable amount of food is thrown away because they spoil before reaching the market.

4) Uneconomical transportation

There are poor transportation facilities in the village and the price of transportation is high. This problem reduces the capability of the farmers to sell their products in the outside market.

C. Focus and Issues for water thematic area

a. People

Focus- The focus in Kantashol is to provide water for drinking, irrigation, and other uses.

Issues-

1) *Fewer facilities to store water*

There are fewer facilities to retain water, like rainwater harvesting, check dams, water absorption tank, canals, and wells in the village to store water.

2) *More runoffs*

Paddy areas are useful to store water but they are low in the Kantashol village because there are more runoff areas.

4) Unstable groundwater

Groundwater available in this area is low and unpredictable because the hilly and barren land does not allow the water to seep into the ground.

5) Shortage of clean drinking water

As water is scarce there is a shortage of drinking water in the village.

6) No rainfall for six months

There is hardly any rainfall for 6 months in the summer and therefore water is scarce.

b. Planet

Focus- The focus is to preserve the available water resources for future use.

TABLE 1. TENSION MATRIX FOR FORESTRY

	Forestry	Strict Government policies	Less financial aid from the government to promote agroforestry	The difficulty of traveling in Forest	High Exploitation of Forest by villagers	Excessive Grazing	No initiative for tree nursery establishment	Fewer species of crops that are used for agroforestry	More Runoffs	More Barren lands
Progress	Fewer species of crops that are used for agroforestry		Dependent 1							
	More Runoffs					Dependent 2				
	More Barren lands	Tension 1					Dependent 3	Inter-Dependent 3		
Planet	High Exploitation of Forest by villagers	Tension 2								
	Excessive Grazing	Tension 3								
	No initiative for tree nursery establishment		Dependent 4	Inter - Tension 1						
People	Strict Government policies			Dependent 5						
	Less financial aid from the government to promote agroforestry									
	The difficulty of traveling in Forest									

Issues-

2) Excessive grazing

The cattle do excessive grazing therefore erosion of topsoil occurs and then water is unable to reach deep in the ground. This prevents the collection of groundwater.

3) Quick Depletion of Water

The villagers use a high amount of water for agriculture as well as for personal use. This creates a shortage of water.

4) Chemical fertilizers deteriorate water quality

Most of the farmers of the village use chemical fertilizers for agriculture. This makes the groundwater poisonous and undrinkable.

c. Progress

Focus- The focus is to provide a reliable water supply for agricultural production, and personal use.

Issues-

1) Limited Access to Water

There are no proper water storage facilities and water supply systems in the village.

2) Lack of Piping Systems

The village has a lack of infrastructure of the piping system which may hinder their attempts to circulate water in the village.

3) Excessive use of water in Agriculture

Due to a lack of knowledge of the quantity of water to be supplied for a given crop and its stage, the farmers supply more water than needed which results in water wastage.

4) Unstable Power supply for pumps

Electricity is also sparse in the village. This creates issues while circulating water on the farm and in the village.

In the next step, the relationship between issues is found by using the tension matrix.

3.1.2 DTM Step 2. Create the tension matrix

In this step, the relationship between the issues is found. More information about the tension matrix is given in Section 2.1

A. Tension matrix for forestry:

Forestry dependent 1 and forestry tension 1 is explained in this section, and the remaining relations are explained in the appendix.

FORESTRY DEPENDENT 1

Less financial aid from the government vs Fewer species of crops that are used for agroforestry

The increase in financial aid by the government increases the number of species of crops that can be grown for agroforestry.

FORESTRY TENSION 1

Strict Government Policies vs More Barren Lands

If government policies are made more lenient then more people will start deforestation and the barren lands will increase.

B. Tension matrix for agriculture:

Agriculture dependent 1 and agriculture tension 1 is explained in this section, and the remaining relations are explained in the appendix.

AGRICULTURE DEPENDENT 1

High Reliability on Forest vs Deforestation

If the people's reliability on forest products is reduced, deforestation will be reduced as fewer people will enter the forest and exploit it.

AGRICULTURE TENSION 1

High reliance on agroforestry vs Deforestation

TABLE 2. TENSION MATRIX OF AGRICULTURE

	Agriculture	Lack of Crop Diversification	High reliance on agroforestry	Lack of Agriculture	Mono-cropping	High Reliability on Forest Products	Excessive Tillage	Deforestation	High reliance on agroforestry	Wastage of food	Uneconomical Transportation
Progress	Deforestation					Dependent 1			Tension 1		
	High reliance on agroforestry	Dependent 2									
	Wastage of food										
	Uneconomical Transportation										
Planet	Mono-cropping	Dependent 3	Tension 2				Tension 3				
	High Reliability on Forest Products										
	Excessive Tillage			Tension 4							
Planet	Lack of Crop Diversification										
	High reliance on agroforestry										
	Lack of Agriculture										

B. Tension matrix for agriculture:

Agriculture dependent 1 and agriculture tension 1 is explained in this section, and the remaining relations are explained in the appendix.

AGRICULTURE DEPENDENT 1

High Reliability on Forest vs Deforestation

If the people's reliability on forest products is reduced, deforestation will be reduced as fewer people will enter the forest and exploit it.

AGRICULTURE TENSION 1

High reliance on agroforestry vs Deforestation

In agroforestry trees are required to be planted along with farming. Hence, if are under agroforestry is increased amount of deforestation will decrease.

C. Tension matrix for water:

Water dependent 1 is explained in this section, and the remaining relations are explained in the appendix.

WATER DEPENDENT 1

Unstable groundwater vs Limited Access of Water

If the groundwater tables are filled with water the problem of limited access to water will reduce.

TABLE 3. TENSION MATRIX FOR WATER

	Water	No rainfall for half a month	Shortage of clean drinking water	Unstable groundwater	more runoffs	Fewer Facilities to store water	Excessive grazing	Quick Depletion of Water	Chemical fertilizers deteriorates water	Limited Access to Water	Lack of Piping Systems	Excessive use of water in Agriculture	Unstable Power supply for pumps
Progress	Limited Access to Water		Inter-Dependent 1	Dependent 1	Dependent 2	Dependent 3		Dependent 4					Dependent 5
	Lack of Piping Systems									Dependent 6			
	Excessive use of water in Agriculture				Dependent 7			Dependent 8					
	Unstable Power supply for pumps												
Planet	Excessive grazing				Dependent 9			Dependent 10					
	Quick Depletion of Water					Dependent 11							
	Chemical fertilizers deteriorates water												
People	No rainfall for half a month												
	Shortage of clean drinking water					Dependent 12							
	Unstable groundwater				Inter-Dependent 2								
	more runoffs												
	Fewer Facilities to store water												

Now by carefully evaluating tensions and dependents between the issues, the dilemmas and their value propositions are created in the next section.

3.1.3 DTM Step 3. Identify dilemma and develop the value proposition

By carefully evaluating the tension matrix four Dilemmas are created and then value propositions are proposed to solve these Dilemmas. Value Propositions are classified according to the type of dilemma.

Dilemma 1. How to Boost Agroforestry and Keep Deforestation Minimum?

The proposed value additions to solve this Dilemma are:

1) Provide financial aid for agroforestry
2) Promote post-harvesting processing technology
3) Provide seeds of good quality for agroforestry
4) Improve market access for the villagers for agroforestry
5) Ease the restrictions for villagers to practice agroforestry
7) Allow only local and tribal people to enter the forest who do not contribute to deforestation
8) Create initiatives such as a tree-nursery plantation to increase the forest cover
9) Keep a watch on the people who are entering the forest
10) Provide financial subsidies to people who take initiatives to reduce deforestations

Dilemma 2. How to improve agricultural production?

The proposed value additions to solve this Dilemma are:

1) Give economic support to the villagers and educate them how to do farming efficiently
2) Test the soil, and then suggest to the social entrepreneur the best crops be grown on that soil
3) Improve the market accessibility for the villagers
4) Use of simple automation and smart irrigation systems for agriculture
5) Provide electricity to the farmers to run pumps and agricultural machines
6) Provide post-agricultural facilities like cold storage, packing machines, refining machines, and cleaning machines
7) Provide up to date meteorological data to the villagers to predict the best types of crops to cultivate

Dilemma 3. How to get water and store it efficiently?
The proposed value additions to solve this Dilemma are:
1) Provide meteorological data like location of the water table and amount of rainfall to the villagers
2) Promote the use of rainwater harvesting
3) Create awareness among the people to save water
4) Provide efficient irrigation facilities for agriculture so that water is not wasted
5) Provide new facilities for villagers to store water like overhead tanks, underwater tanks.
6) Provide filters to provide safe drinking water to the villagers
7) Build canals to bring clean drinking water to Kantashol from nearby areas
8) Plant trees on runoff areas to create marshy lands

From these possible policies, four policies are selected according to the requirements of the Social entrepreneur. The four policies selected are "Provide agricultural and agroforestry essentials," "Promote the use of organic fertilizers." "Promote the use of rainwater harvesting," and "Promote the construction and use of cold storage and transportation." In the next section, the four policies that are selected for the sustainable development of the village are explained.

3.2 Explanation of Each Policy Proposed in this Paper

3.2.1 Explanation of agriculture and agroforestry essentials as a value proposition

Essentials are defined as the facilities and requirements for agriculture and agroforestry for sustainable development. It consists of types of machinery such as packaging machines, cleaning machines, rinsing machines, sealers, harvesting machines, and seeding machines. Initially, the cost is incurred to the villager, but after some time profits will be made by the villager.

3.2.2 Explanation of organic fertilizers as the value proposition

Organic fertilizers are fertilizers derived from animal matter, animal excreta (manure), human excreta, and vegetable matter (e.g., compost and crop residues). Naturally occurring organic fertilizers include animal wastes from meat processing, peat, manure, slurry, and guano. Organic fertilizers do not degrade soil fertility. Additionally, organic fertilizers are available at a low price. By using organic fertilizers villagers reduce the runoff areas and increase fertilized lands for agriculture and agroforestry.

3.2.3 Explanation of rainwater harvesting as the value proposition

Rainwater harvesting (RWH) is the collection and storage of rainwater. Rainwater is collected from a roof-like surface and the water is redirected to a tank for storage. Dew and fog are collected with nets or other tools. This water is used to water gardens and farms. The harvested water is used for storage or groundwater recharge. The Kantshola village receives water for only 6 months. Hence, it is beneficial for storing water on a long-term basis and then using it when rain is not available.

3.2.4 Explanation of Cold storage and transportation as the value proposition

Cold storages are the places where organic matter is stored at a low temperature so that it does not deteriorate. Cold storage in Kantashol village helps the villagers to store their yields for a longer time and hence increases market accessibility. This indeed increases the profit earned. Additionally, increasing transportation increases the profit earned by the villagers as it increases access to the market which makes it easier for villagers to sell their products.

In the next section, the proposed policies are implemented in the System Dynamics Model, and their impact on the development of the village is evaluated.

3.3 Evaluating the Policies through System Dynamics Model

3.3.1 SDM Step 1. Create the causal loop diagram

A) Causal loop diagram for forestry thematic area

Investment is done in the village for agroforestry essentials, transportation, and storage facilities. As shown in Figure 3, an increase in financial aid increases the investment in agroforestry and tree plantation. By investing in agroforestry, the number of trees in the forest increases. It also increases the forest area. Additionally, an increase in investment increases the demand and attractiveness for agroforestry.

The demand for agroforestry increases when market accessibility improves, transportation improves, storage facilities improve, and investment in agroforestry equipment and essentials improves. Agroforestry also contributes to increasing the income of villagers, improves the standard of living of villagers, and increases the GVA of the village. All these processes are illustrated in Figure 3. The arrows which are connecting the variables from outside of the image are the arrows that connect the variables of two thematic areas. The complete causal loop diagram is huge, hence we have added the causal loop diagram in sections.

B) Causal loop diagram for water thematic area

Water is an important parameter for the sustainable development of the village. As shown in Figure 4, groundwater, rainwater, and water from dams increase water available. Additionally, the reduction in runoff areas increases the amount of water available. Filteration of water increases the amount of drinking water available, but the use of chemical fertilizer reduces the amount of drinking water.

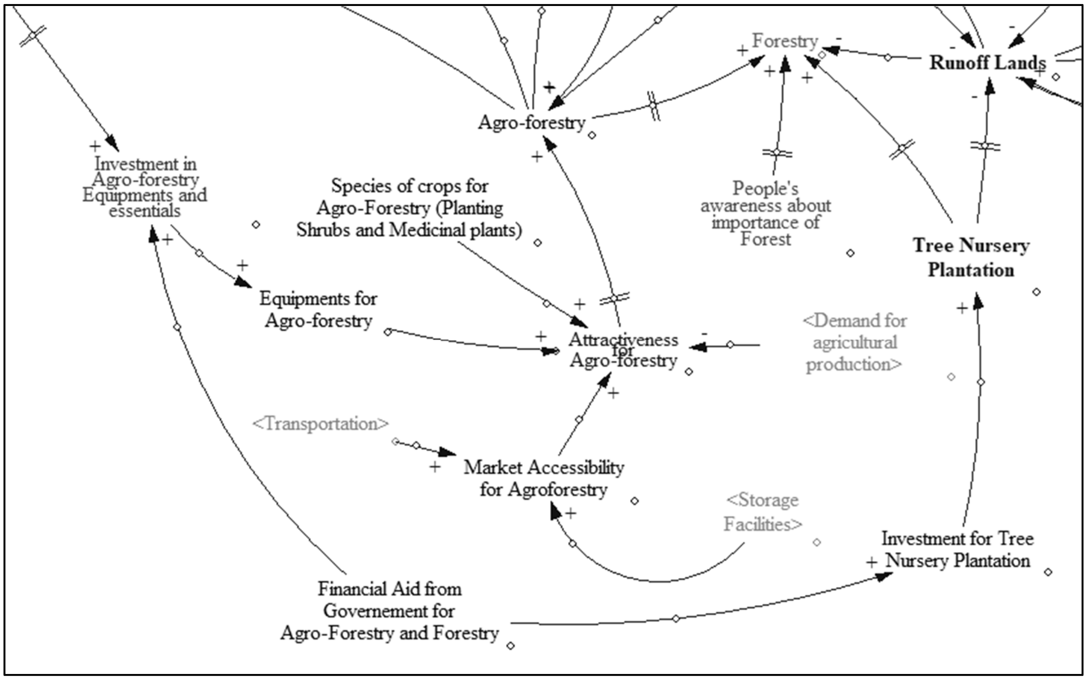

FIGURE 3: CAUSAL LOOP DIAGRAM FOR AGROFORESTRY THEMATIC AREA

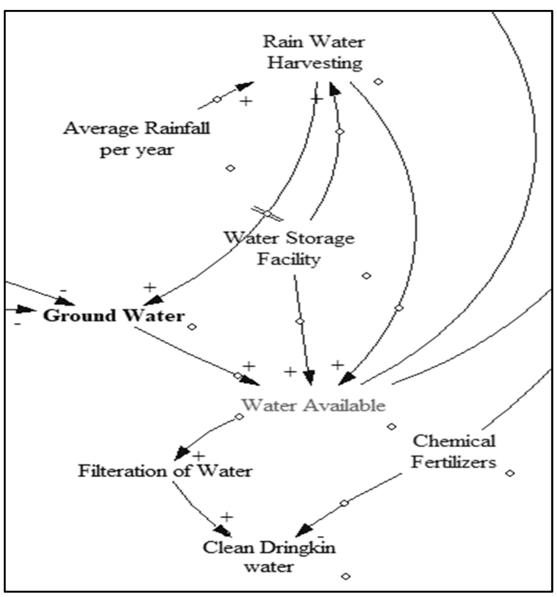

FIGURE 4: CAUSAL LOOP DIAGRAM FOR WATER THEMATIC AREA

C) Causal loop diagram for the agriculture thematic area

The number of storage facilities, the number of transport vehicles, market accessibility, and investment for farming, number of laborers, and quality of soil are the starting points of the causal loop diagram for the agriculture thematic area.

All these points are connected to demand for agricultural production. Demand for agricultural production increases as storage facilities increase, market accessibility increases, transport increases, investment for farming increases, and labor available increases. Agricultural production is impacted by the quality of the soil. Agricultural production is directly proportional to the demand for agricultural products. Agriculture is merely practiced in this village, hence, a social entrepreneur needs to improve agriculture. Agriculture also largely contributes towards the income of the farmers and GVA of the village.

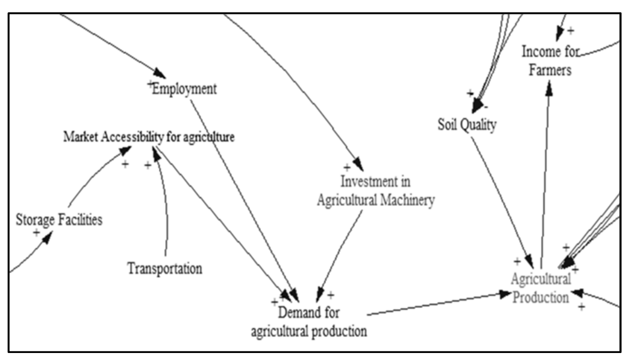

FIGURE 5: CAUSAL LOOP DIAGRAM FOR AGRICULTURE THEMATIC AREA

3.3.2 SDM Step 2. Create the stock and flow diagram

The values of input parameters which are used in the stock and flow diagram are given in Table 4,

TABLE 4. VALUES OF INPUT VARIABLES TO SYSTEM DYNAMICS MODEL[1]

Input parameter	Value
Storage Facilities	6 facilities
Transportation	50 Vehicles
Amount of Tillage	5000 acres
Cost of Chemical Fertilizers	310 rupees per acre
Cost of Organic Fertilers	150 rupees per acre
Multi-cropping	2.5 crops per year
Number of Machinery for Agriculture	50 machines
Number of Post Processing equipements	50 machines
Irrigation cost	5000 rupees per acre
Animal Labour cost	33 rupees per acre
Cost of seeds	2000 rupees per acre
Manure cost	150 rupees per acre
Human labour cost	5000 rupees per acre
Electricity cost	181 rupees per acre
Diesel Cost	520 rupees per acre
Total Area	20000 acres
Number of Machineries for Agro Forestry	50 machines
Number of Canals	5 canals
Amount of rainfall per month	1800 mm per annum
Number of Rain Water Harvesting systems	10 systems

A) Stock and Flow diagram for forestry thematic area

The major input variables for the forestry thematic area are shown in Table 4.

Attractiveness for Agroforestry is defined by the opportunities which are created by implementing modern technology. As shown in Figure 6 an increase in transportation and storage facilities increases the market accessibility which increases the attractiveness for agroforestry. As the interest in pursuing agroforestry increases between the villagers, more area is cultivated and more products of agroforestry are produced. The profit earned by the agroforestry owner is a stock, and two flows which are cost and income are connected to it. The income from agroforestry is defined as a fixed value of money multiplied by the production from agroforestry. The formula for calculating Profit earned by agroforestry is

$$\frac{d(Profit_{\,agroforestry})}{dt} = \frac{\mathrm{d}(\mathrm{Earnings}_{from\ transportation} + \mathrm{Earnings}_{from\ storage\ facilities})}{\mathrm{dt}} + \frac{\mathrm{d}(\mathrm{Earning}_{\mathrm{from\ agroforestry\ machinery}} + \mathrm{Earning}_{from\ products})}{\mathrm{dt}} - \frac{d(Cost_{Transportation\ and\ Storage\ Facility} + Cost_{Agroforestry\ Machinery})}{dt} \frac{d(Cost_{Agroforestry\ essentials})}{dt} \quad (2)$$

[1] Data obtained from SunMoksha Pvt. Ltd.

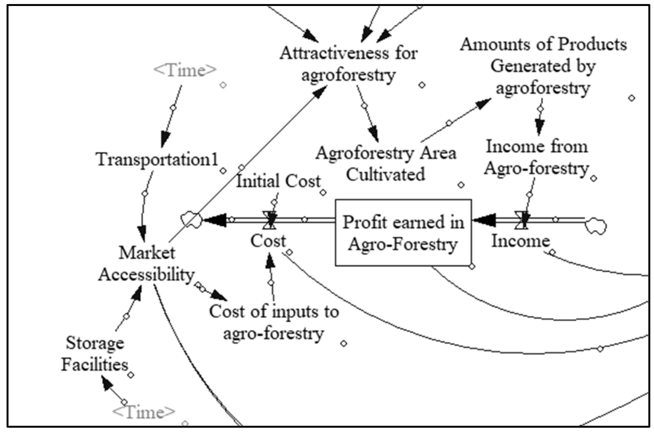

FIGURE 6: STOCK AND FLOW DIAGRAM WITHOUT AGROFORESTRY ESSENTIALS AS A VALUE ADDITION

B) Stock and Flow diagram for agriculture thematic area

The major input variables for the agriculture thematic area are given in Table 4, the starting variables for the stock and flow diagram in Figure 7 is organic fertilizers, multi-cropping, amount of tillage, and chemical fertilizers. Runoff areas create barren land that may reduce agricultural production. To solve this problem, low tillage is performed. Tillage causes loss of fertility of the soil. Organic fertilizers increase and maintain the fertility of the soil for a long time and multi-cropping increases the fertility of the soil because it adds more nutrients to the soil. In this way, the area available for agriculture and profit earned by agriculture increases.

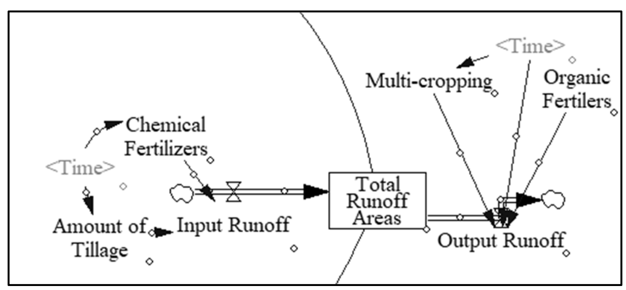

FIGURE 7: STOCK AND FLOW DIAGRAM WITH LOW TILLAGE AND ORGANIC FERTILIZERS AS VALUE ADDITIONS

As shown in Figure 8 Profit Earned in Agriculture is a stock that is defined as the difference between the income and cost of agricultural production. A social entrepreneur wants that the profit earned by the farmer increases with time. The attractiveness of agriculture is directly connected to the number of farmers. As new farmers are added, the area under agriculture increases. Area available for agricultural production is directly connected to income from agricultural production. Agricultural production is connected to the income that a farmer earns, and the income from agricultural production is connected to the stock and flow diagram.

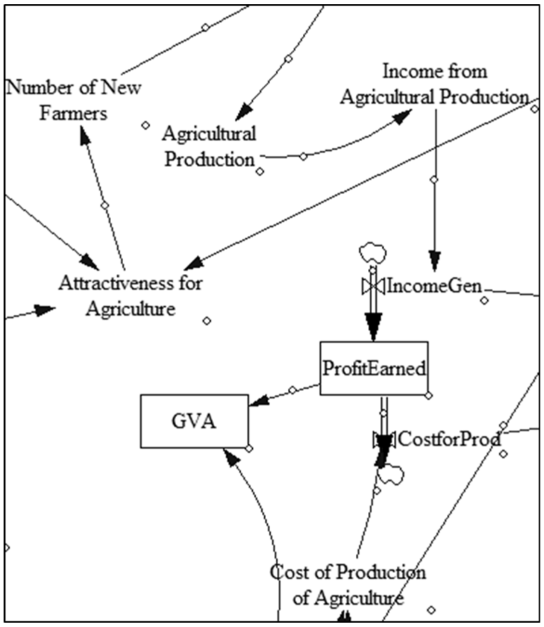

FIGURE 8: STOCK AND FLOW OF AGRICULTURE

The formula for calculating Profit earned by agriculture is

$$\frac{d(Profit_{\,agriculture})}{dt} = \frac{\mathrm{d}(\mathrm{Earnings}_{from\ transportation} + \mathrm{Earnings}_{from\ storage\ facilities})}{\mathrm{dt}} + \frac{\mathrm{d}(\mathrm{Earning}_{\mathrm{from\ agricultural\ machinery}} + \mathrm{Earning}_{from\ products})}{\mathrm{dt}} - \frac{d(Cost_{Transportation\ and\ Storage\ Facility})}{dt} - \frac{d\left(Cost_{agricultural\ essentials+Cost_{agricultural\ Machinery}}\right)}{dt} \quad (3)$$

The formula to calculate Gross Value Added is

$$\frac{d(Gross\ Value\ Added)}{dt} = \frac{d(Profit\ earned\ by\ agroforestry + Profit\ earned\ by\ agriculture)}{dt} \quad (4)$$

B) Stock and Flow diagram for water thematic area

As shown in Figure 9, the amount of rainfall is the starting variable, it changes in different months. The amount of rainfall is connected to rainwater harvesting and the number of canals. From Figure 8 rainwater harvesting, water in canals, and water availability are the stocks. The number of canals increases as a step function. The increase of available water increases agricultural production and agroforestry production. The formula to calculate the total available is

$$\frac{d(Water_{available})}{dt} = \frac{d(Water\ Inflow_{rainwater\ harvesting} + Water\ Inflow_{Canals\ and\ dams})}{dt} + \frac{d(Water\ Inflow_{wells})}{dt} - \frac{d(Water\ Outflow_{agricultue\ and\ agroforestry} + Water\ Outflow_{Villagers})}{dt} \quad (5)$$

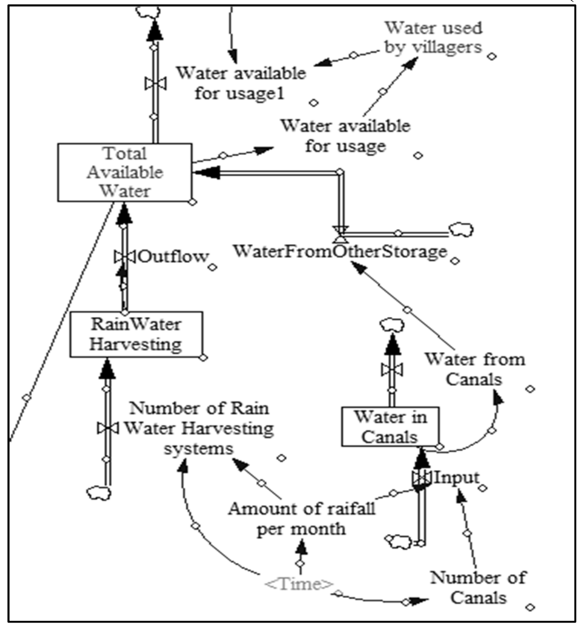

FIGURE 9. WATER AVAILABLE FOR A VILLAGE

In the next section, the results obtained from the System Dynamics Model are explained.

3.3.3 SDM Step 3. Explanation of each scenario for evaluating policies

Scenario 1: Worst case scenario (No policies are implemented)

In this scenario, policies that are proposed for the sustainable development of the Kantashol village are not implemented. The System Dynamics Model predicts the profit earned by agroforestry, agriculture, and the Gross Value Added to the village.

Scenario 2: Medium case scenario, (When one scenario is implemented)

Case 1: The policy of rainwater harvesting is implemented

In this scenario, the policy of rainwater harvesting is implemented. There are three steps while simulating this scenario. In the first step, the rainwater harvesting system is not implemented, and wto canals are built in the System Dynamics Model. In the second step, the rainwater harvesting system with 2 canals is implemented in the System Dynamics Model. In the third step, the rainwater harvesting system is implemented along with 5 canals in the System Dynamics Model. Total water available is the output parameter that is calculated in this scenario.

Case 2: The policy of agroforestry essentials is implemented

Here, in this scenario, the policy of agroforestry essentials is implemented. This scenario is simulated in two steps. In the first step, the policy of agroforestry essentials is not implemented. In the second step, the policy of agroforestry essentials is implemented. Profit earned by agroforestry owners is the output that is calculated in this scenario.

Case 3: The policy of agricultural essentials is implemented
In this scenario, the policy of agricultural essentials is implemented and then the profit earned by farmers is calculated.

Scenario 3: Best case scenario (All policies are implemented)
In this scenario, all the policies mentioned in this paper for the Kantashol village are implemented. The Gross Value Added to the village is calculated, and the results are shown in two steps. In the first step, no policies are implemented, and in the second step, all the policies are implemented in the System Dynamics Model

4. RESULTS AND DISCUSSION
In this section, the results obtained are discussed, along with their ramifications.

4.1 Results of Each Scenario
4.1.1 Scenario 1: Worst case scenario (No policies are implemented)
Policies that are proposed in this paper are not implemented in this Scenario. It is observed that the profit earned by villagers in agriculture is low as compared to the scenario when policies are implemented. Additionally, the Gross Value Added (GVA) of the village is low as compared to the results where the policies are implemented. The profit earned by agroforestry is 0 because no villager practices agroforestry when policies are not implemented.

It is seen in Figure 10 that the profit earned by agroforestry is 0 rupees, profit earned by agriculture is 2 million rupees, and Gross Value Added to the village by a villager is 15 million rupees.

4.1.2 Scenario 2: Medium case scenario, (When one scenario is implemented)
Case 1: The policy of rainwater harvesting is implemented
There is an increase in runoff area in the Kantashol village. These runoff areas make it difficult for villagers to store water. To counter this issue, new canals, rainwater harvesters, and storage plants are constructed. When rainwater harvesting is implemented with 5 canals 1.1 million cubic meters of water is stored, Figure 11. When no rainwater harvesting is implemented and 5 canals are built more than 700 thousand cubic liters of water is stored, and with 2 canals, 300 thousand cubic liters of water is stored.

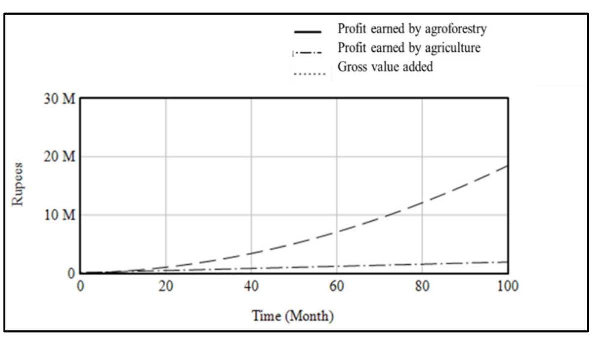

FIGURE 10: PROFIT EARNED WHEN NO POLICIES ARE IMPLEMENTED

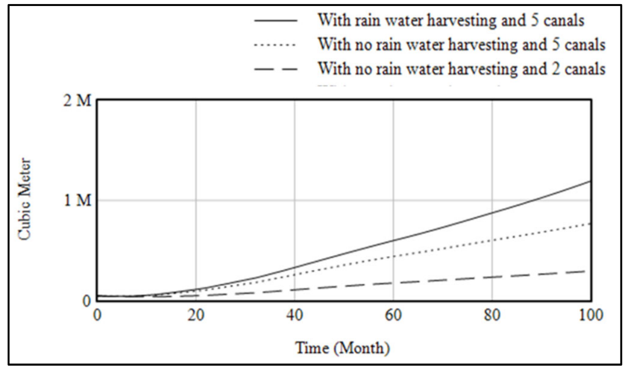

FIGURE 11: TOTAL WATER AVAILABLE IN THE VILLAGE

4.1.2 Scenario 2: Medium case scenario, (When one scenario is implemented)
Case 1: The policy of rainwater harvesting is implemented
There is an increase in runoff area in the Kantashol village. These runoff areas make it difficult for villagers to store water. To counter this issue, new canals, rainwater harvesters, and storage plants are constructed. It is observed from Figure 11 that when rainwater harvesting is implemented with 5 canals 1.1 million cubic meters of water is stored. Also, when no rainwater harvesting is implemented and 5 canals are built then 700 thousand cubic liters of water is stored, and with 2 canals built 300 thousand cubic liters of water is stored. Hence it is observed that by implementing the policy of rainwater harvesting more water is stored.

Case 2: The policy of agroforestry essentials is implemented
Currently, in Kantashol village old conventional forestry activities are carried out. Agroforestry is not practiced in this village, and hence as observed in Figure 12 the profit earned when no agroforestry essentials are implemented is negligible.

After implementing agroforestry essentials it is seen in Figure 12 that after 20 months the villagers start to earn a profit. The rate of earning profit increases due to the addition of agroforestry essential services, better transportation, and storage services. Note that this graph depicts the cumulative profit earned by the farmer in 100 months. It is observed that a single villager earns up to 18 million rupees in 100 months. Earning 18 million rupees per annum is extremely good because it may attract more youth to practice agroforestry. Villagers are not only earning a good profit but also saving the environment by planting trees and increasing forest area.

Case 3: The policy of agricultural essentials is implemented
In this scenario, cumulative profit earned by a farmer in 100 months is calculated. Without implementing the agricultural essentials the profit earned by a farmer in 100 months is 2 million rupees. The rate of profit increases because of the addition of agricultural essentials, increase in farmers, and decrease in run-off areas. It is observed in Figure 13, that an average farmer earns up to 18 million rupees in 100 months. By implementing new policies, and adding essentials, farming becomes a favorable occupation in Kantashol.

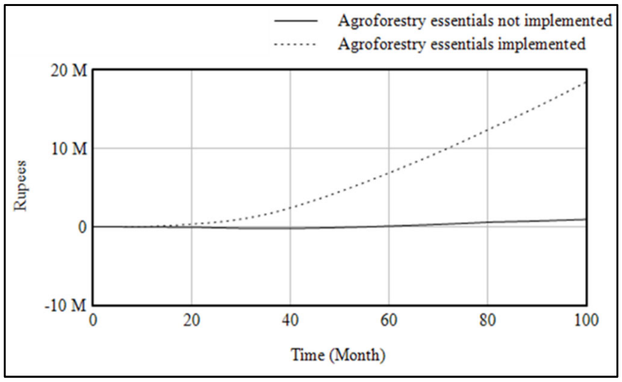

FIGURE 12. PROFIT EARNED BY AGROFORESTRY

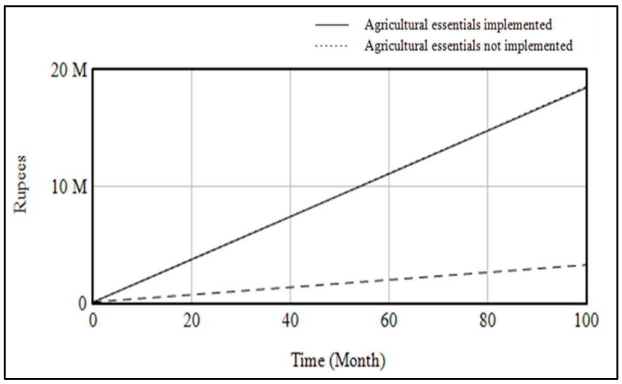

FIGURE 13. PROFIT EARNED BY AGRICULTURE

4.1.3 Scenario 3: Best case scenario (All policies are implemented)

It is observed in Figure 14 that the GVA of the village increases by 15 million Indian rupees when no policies are implemented in the Kantashol village. When all policies are implemented the GVA of the village increases by 25 million Indian rupees in 100 months by each family in the village. The increase in profit in agriculture and agroforestry increases the magnitude of the Gross Value Added to the village. The Kantashol village becomes a wealthy village by implementing the policies proposed here. The total number of families living in the village is approximately 1000, hence, the GVA of the village increases by 5000 million Indian rupees in 100 months.

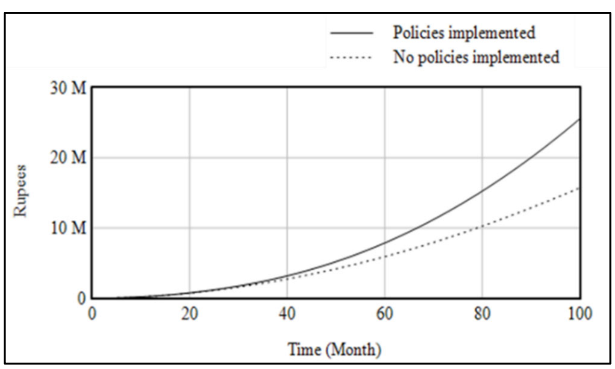

FIGURE 14: GROSS VALUE ADDED

4.2 Ramification of the Results

In this paper, it is found that by increasing the area under agroforestry, the runoff areas decrease, and the land under forest increases. Additionally, it is observed that by implementing the policy of agroforestry and agricultural essentials the profit earned by villagers becomes sufficient to live a sustainable life. The increase in profit in agriculture and agroforestry increases the attractiveness of these types of occupations. Therefore, more villagers take part in these occupations, and the village economy as a whole increases.

It is also observed from the results that the amount of total available water increases when the runoff areas decrease, and rainwater harvesting systems and dams are built. It is inferred from the System Dynamics Model that by implementing rainwater harvesting, both water and electricity are saved. The electricity is saved because fewer pumps are needed to pump the water.

It is observed that by implementing all the policies, the Gross Value Added of the Kantashol village is doubled. The increase in Gross Value Added indicates that the general development of the village is taking place much faster than before implementing the framework with new value-added.

In the next section, the closing remarks along with future work are given.

5. CLOSING REMARKS

In this paper, new value is added to the framework to support social entrepreneurs to identify dilemmas, and then propose policies for a multi-driver, multi-perspective (thematic area) complex system. The framework consists of two aspects that are the Dilemma Triangle Method and the System Dynamic Model. The Dilemma Triangle Method is used to evaluate the issues, and identify dilemmas. Policies are proposed based on the dilemmas identified. Many policies are proposed in the Dilemma Triangle Method, and 3-4 policies are selected for evaluation in the Systems Dynamics Model. The policies are selected by the social entrepreneur according to their feasibility. The proposed policies are then evaluated using the System Dynamics Model. The economy which is an important indicator of growth and sustainable development was missing in the past framework and is added in the current system dynamic model. We use important economic parameters Gross Value Added and profit earned by farmers to evaluate the impact of proposed policies. The Dilemma Triangle Method is implemented using Excel VBA software which is custom made for evaluating the issues from more than three thematic areas. The addition of GVA in the System Dynamics Model can be applied to any village.

To illustrate the efficacy of this framework we propose policies for the sustainable development of the Kantashol village. The issues and dilemmas that are solved in this paper are from three thematic areas namely, forestry, agriculture, and water. The application of this framework for this paper is concentrated towards the development of the villagers, and for the preservation of the forest. Four policies are proposed and evaluated by using this framework, and the validity of these policies proves the potential of the new value-added to the framework; see Section 4.3. The policies are as follows:

i. Provide agroforestry and agriculture essentials; see Section 3.4.1

ii. Encourage farmers to use organic fertilizers; see Section 3.4.2
iii. Encourage villagers to implement rainwater harvesting; see Section 3.4.3
iv. Provide cold storage facilities and increasing the rate of transportation; see Section 3.4.4

Some of these policies are being implemented by the government, together with Kalamandir. Some other policies will be implemented in the cluster by SunMoksha under the CM Smart Village Scheme.

ACKNOWLEDGEMENT

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APPENDIX

REMAINING DEPENDENTS AND TENSIONS OF THE TENSION MATRIX OF FORESTRY

FORESTRY DEPENDENT 2

Excessive Grazing vs More Runoffs

With the reduction in the amount of grazing done by the cattle, the paddy areas increases which decreases the runoff areas.

FORESTRY DEPENDENT 3

No Initiative for Tree Nursery established vs More Barren lands

If tree nurseries are made in barren lands then the area under barren lands will decrease.

FORESTRY DEPENDENT 4

Less Financial aid from government vs No initiative for tree nursery establishment

By getting financial aid from the government the initiatives like planting tree nurseries will increase.

FORESTRY DEPENDENT 5

The difficulty of traveling in Forest vs Strict government policies

If the government policies are relaxed then more people will be able to enter the forest and they will get the motivation to pursue agroforestry.

FORESTRY TENSION 2

Strict Government Policies vs High Exploitation of Forest by villagers

If the government laws are made lenient then more villagers will start to enter the forest and then exploitation of the resources in the forest will take place.

FORESTRY TENSION 3

Strict Government Policies vs Excessive Grazing

By relaxing government policies, villages will take more cattle to the forest and the problem of grazing will increase.

REMAINING DEPENDENTS AND TENSIONS OF THE TENSION MATRIX OF AGRICULTURE

AGRICULTURE DEPENDENT 2

Lack of Crop Diversification vs High reliance on agroforestry

If farmers start growing more variety of crops for agriculture the dependency of the villagers on agroforestry will decrease.

AGRICULTURE DEPENDENT 3

Lack of Crop Diversification vs Mono-cropping

By avoiding mono-cropping practices the farmers will start to plant a variety of crops and hence these two issues are solved

AGRICULTURE TENSION 2

High reliance on Agroforestry vs mono-cropping

If the villagers are more indulged in the practice of Agroforestry then they will not concentrate on agriculture and mono-cropping will increase.

AGRICULTURE TENSION 3

Excessive Tillage vs Mono-cropping

If the problem of mono-cropping is solved the farmers will exercise excessive tillage which will harm the condition of the soil.

AGRICULTURE TENSION 4

Lack of Agriculture vs Excessive Tillage

By solving the problem of lack of agriculture the amount of agriculture will increase and the amount of tillage will increase, which would deteriorate the quality of the soil.

REMAINING DEPENDENTS AND TENSIONS OF THE TENSION MATRIX OF WATER

WATER DEPENDENT 2

More Runoffs vs Limited Access to Water

By reducing the number of runoff, more water will be able to seep into the ground and the groundwater table will increase, and also limited access to water by the villagers will be reduced.

WATER DEPENDENT 3

Fewer Facilities to store water vs Limited Access to water

By increasing the facilities to store water the problem of limited access to water will reduce as ample water will be available to be used for the villagers.

WATER DEPENDENT 4

Quick Depletion of water vs Limited Access to water

If the depletion of water is reduced the water will be saved and the problem of limited access to water will be solved.

WATER DEPENDENT 6

Limited Access to Water vs Lack of Piping System

If we invest in the piping system all the houses will get access to water even if the storage of water is located far away from the user.

WATER DEPENDENT 7

More Runoffs vs Excessive use of water in Agriculture

If the runoffs are reduced then more water will seep into the soil and then the amount of groundwater will increase and excessive water use for agriculture will reduce.

WATER DEPENDENT 8

Quick depletion of water vs Excessive use of water in Agriculture

If excessive use of water in Agriculture is reduced then the quick depletion of water will reduce.

WATER DEPENDENT 9

More Runoffs vs Excessive Grazing

By reducing grazing more plants will grow and then paddy areas will increase and the Runoffs will reduce.

WATER DEPENDENT 10

Quick Depletion of Water vs Excessive grazing

If excessive grazing is stopped, low runoff will be created and then the water will deplete slowly.

WATER DEPENDENT 11

Fewer Facilities to store water vs Quick depletion of water

If the storage of water is increased then quick depletion of water by the villagers will reduce.

WATER DEPENDENT 12

Fewer Facilities to store water vs Shortage of clean drinking water

If the facilities to store water are increased then clean drinking water is stored correctly and villagers will get access to clean drinking water.