DISENTANGLING THE COMPLEXITY OF INDIA'S AGRICULTURAL SECTOR

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Abstract: Agricultural policies in India directly impact the livelihoods of close to two thirds of India's population. Through policies, the government manages food security, urban and rural poverty, energy, and infrastructure, among others. Given the current state of India's governance, the connection between policy making and its results in society becomes a key issue for research. This paper presents a game for use as a research instrument. The game can facilitate research into the policy making process at various levels of the government in India. The design is intended to understand the complexity of the institutional arrangement that defines and implements agricultural policies. The game integrates with other games that simulate other aspects of the agricultural system in India. The paper presents the verification and validation cycles followed, and identifies further steps for field validation.

Keywords: India, supply chain, governance, policy, game

Introduction

The agricultural sector in India is highly dependent on policy makers for regulating tariffs and trade, credit, market access, subsidies and services. The government tries to open markets, establish and run food supply programs for the poor and maintain stocks for draughts and floods. Scandals about food prices that triple over months and tens of thousands farmer suicides because of credit issues, along with the contrasts but prevalence of starving people while food is rotting in other parts of the country dominate the daily national news.

The Indian government works through five year central planning. This period matches the appointment of the central government. Typically the five-year plans constitute numerous schemes to be effectuated through a multitude of institutions at the federal, state and regional level. This system has grown to a size and complexity that is unmanageable, with high transaction costs and results that are hard to predict. Following New Institutional Economics frameworks [*Williamson*, 2000; *Menard and Shirley*, 2003] there must be reasons for this complex system to exist. In the literature, studies can be found on the institutional structures of India and some explorative work on the relation between scheme effectiveness and policy making [*Kapur and Mehta*, 2005], however the reasoning and expectations of policy makers are largely uncharted territory in this country.

This paper will present a new approach to disentangle the complexity of agricultural policy making and its complex effects on the agricultural sector using a gaming simulation approach. In an earlier paper [*Meijer et al*, 2010] the authors explored why the successful Western games do not fit the Indian context. In this paper we present a new module aimed at the ministry and secretary level with a focus on waste, credit and production factors. The paper contains results obtained from test groups validating the module.

1. The Indian agricultural sector

Central role and major problems

Agriculture remains one of India's primary occupations, employing close to two-thirds of India's population. Despite employing a large majority of the population, agriculture contributes only one fifth of India's GDP, creating a situation where large numbers of people earn very low incomes and work at low productivity levels. Efforts to improve rural conditions on a sustainable basis hinge to a large extent on increasing agricultural income. These efforts will have to come in the form of policies improving the production, marketing, and distribution of agricultural products.

Increasing population and urbanization has led to concerns about adequate food supplies worldwide and in India. The recent price fluctuations in world markets have led to spikes in commodity food prices like onions and tomatoes. While a 50 to 100 percent increase in prices may not be a problem to consumers in the sections of the society with higher resources, it is a problem for about 2/3 of India's population of 1.15 billion people. The Green Revolution of the 1960s increased yields in the North of India applying scientific knowledge [*Arunachalam and King*, 2004], and

now new approaches are being applied to provide additional insight. The attention is not only geared towards production techniques, but also on the institutional arrangements and economic incentive system, as India has faced scandals with rotting food and hunger existing simultaneously. Recent studies show that waste in agricultural production in India reaches as high as 20 percent while the perception reflected in government pronouncements and the media often extends to 40% [*Mattoo et.al.*, 2007; *India Today*, 2009). The Asian Development Bank also notes the problems with getting produce in acceptable conditions in a timely fashion to consumers, and the need to upgrade transport, irrigation, marketing and financial sector infrastructure to address them [*ADB*, 2009].

Governance

The national agricultural policy stated in the year 2007 [National Policy for Farmers] has 12 major goals, which cover land reforms for farmers, improving economic viability and productivity, developing support services, food and water security and providing non-farm employment among others. This policy is implemented by the Ministry of Agriculture, and one its primary departments, the Department of Agriculture and Co-operation.

The Department of Agriculture and Cooperation is one of the three constituent departments of the Ministry of Agriculture. The other two Departments of the Ministry are the Department of Animal Husbandry, Dairying and Fisheries and the Department of Agricultural Research and Education. The Agriculture Minister, who is assisted by a Minister of State, heads the Department of Agriculture and Cooperation. The Secretary (Agriculture and Cooperation) is the administrative head of the Department and Principal Adviser to the Minister on all matters of policy and administration within the Department. The Secretary (Agriculture and Cooperation) is assisted by a Principal Advisor, four Additional Secretaries, one Financial Adviser, the Agriculture Commissioner, nine Joint Secretaries, one Horticulture Commissioner, one Agricultural Marketing Adviser and one Economic Advisor.

The Department is organized into 24 divisions and a Technology Mission on Oilseeds, Pulses and Maize. In addition, it has 4 attached offices and 21 subordinate offices spread all over India for coordination with state-level agencies and implementation of central sector schemes in their respective fields. There are in all 2 Public Sector Units (PSU)s, 7 autonomous bodies and 11 national-level cooperative organizations under the administrative control of the Department. In addition, two authorities, namely, the Protection of Plant Varieties and Farmers' Rights Authority and the National Rain-fed Area Authority (NRAA) have been set up [*AGRICOOP*].

The organizational structure of the Department of Agriculture and Cooperation (AGRICOOP) is shown in Figure 1[1]. This excludes the Public Sector Units, autonomous bodies, co-operatives and other authorities that come under its purview. This department is only one of three that the Ministry of Agriculture operates, and functions at the National level.

2. Gaming simulation for research in supply chain policy

The late 1990's and start of the 21th century showed an increasing popularity of supply chain gaming simulations in the domain of supply chains and networks. Gaming simulations (games, in short) in this domain are becoming a standard component of business school curricula [*Corsi et al*, 2006], and researchers use them as a research method for both quantitative and qualitative research [*Meijer*, 2009]. Supply chains and networks are considered complex adaptive systems, as they meet all the aspects in the definition by Holland (1995). Bekebrede and Meijer (2009) demonstrated that complex adaptive systems could be simulated in a gaming simulation. The latest development in gaming simulation is the integration of more and better simulators as technical backbone and more detailed representation of the aspect system under study in the game.

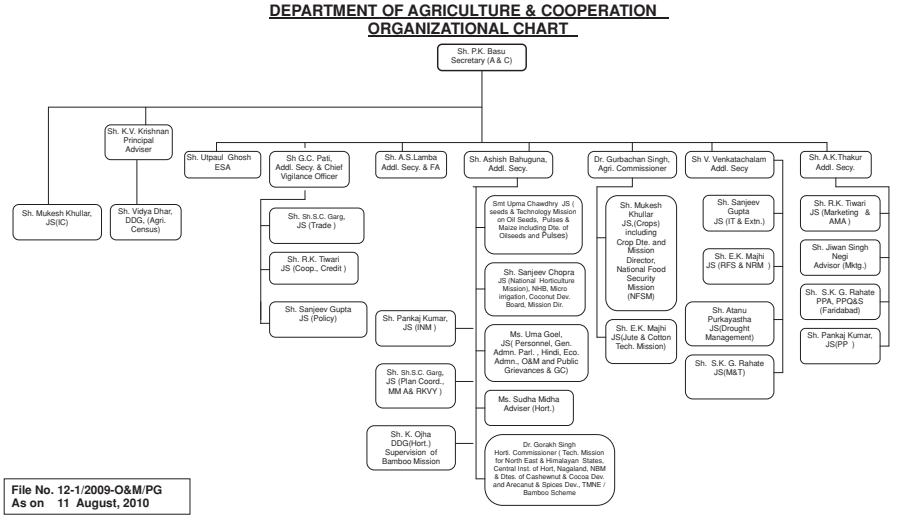

Figure 1: AGRICOOP Organizational Structure (Source: Department of Agriculture and Cooperation)

[1]The image has been modified to exclude the names of officials. The original can be accessed from the source, available on the departments website: http://agricoop.nic.in/orgchart11810.pdf

Using gaming for policy development and testing is certainly not new, and well documented in the work of for instance Duke (1974), Duke and Geurts (2004) and others. Mayer (2009) provides an overview of the development of this field and proves that gaming for policy issues is widely accepted and matured. The use of gaming as a more experimental surrogate environment is less common [*Peters et al*, 1998] and provides methodological challenges [*Klabbers*, 2008]. Recent activities however have shown that it can be done successfully [*Meijer*, 2009; *Zuniga et al*, 2007].

3. A suite for Indian supply chain games

In a previous publication [*Meijer et al*, 2010], the authors showed that no existing gaming simulation currently addresses the specific Indian issues, mainly because most work done has been on Western contexts where seven constraining variables the authors identified do not apply. The seven key elements of the Indian supply chains that must be addressed are:

1. heterogeneous producers, especially small-scale;
2. heterogeneous production methods;
3. segmented markets across geography, time, cultivar, and quality;
4. severe credit constraints, with informal credit often provided by middlemen;
5. inadequate transportation support services;
6. inadequate cold storage and warehouse facilities; and
7. incomplete information across the supply chain, worsening the closer one gets to the farmer/producer.

Not all of these issues can be tackled in one game. Therefore CSTEP works on an integrated suite of supply chain games fitted to the Indian context. The games and game modules developed should all connect to each other to gradually include more aspects in the scope of a playable gaming simulation. In an earlier paper [*Meijer et al*, 2010] we have described the design of a gaming simulation that attempts to track the problems in mango supply chains in India, focusing on wastage, credit and infrastructural/institutional issues. The so-called Mango Mandi Simulation Game (MMGS) models the various roles that exist in the supply networks. Human players can 'take over' each of the roles that are in the model. The simulation part of the MMGS can be isolated and run as a stand-alone supply chain simulation, with software agents playing the roles that exist in the network. The MMGS operates at the level of the markets, which are regulated by a complex machinery of legislations and institutions.

We have chosen to study the agricultural policy making process by using a gaming simulation called the Agricultural Policy Game, as a research tool. The design models the various policy-making roles that exist in the Ministry of Agriculture and its associated departments in the Indian government. Players take on various roles and try to implement an agricultural policy, and the various implements of the policy are fed into the MMGS, which gives the players some feedback on the efficacy of their actions in the game.

4. Agricultural Policy Game

The design of the game is based on the four level framework proposed by Williamson (2000) (Figure 2). Each of the levels changes about ten times as fast as the level above. The top level lists customs, traditions, norms and informal institutions and is usually called 'culture'. Culture is acquired in the early years of a person's life and changes over centuries. Culture influences the institutional environment, which is at the second level. The rules of the "game" or the formal rules governing a community appear, and is often formalized as the legislative environment of the country. This level changes in terms of tens or hundreds of years.

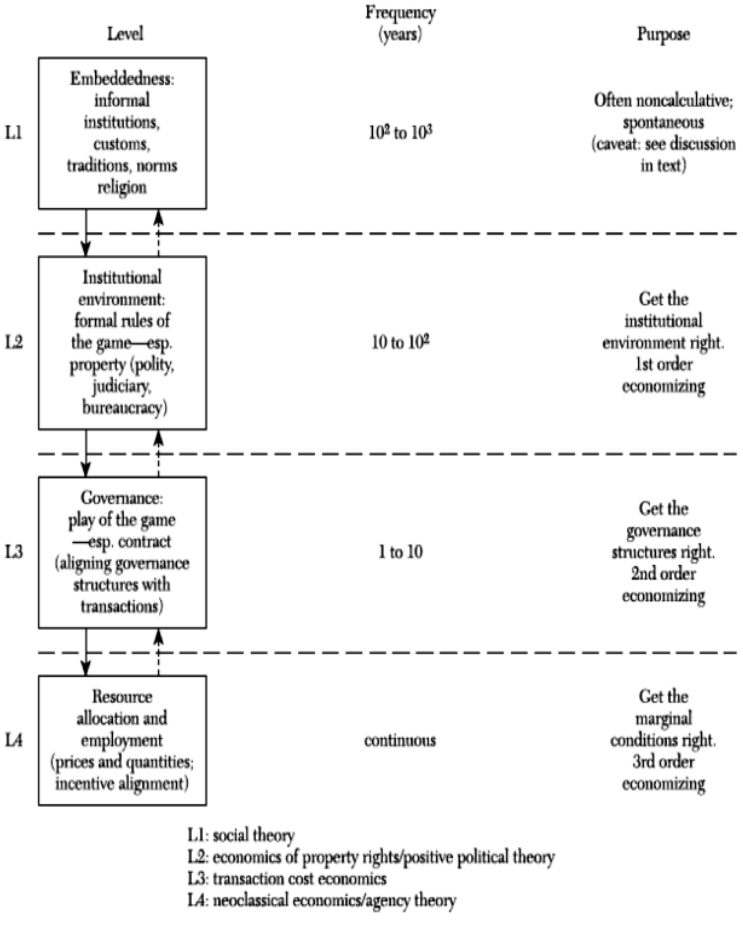

Figure 2: Four-level model of Williamson (2000)

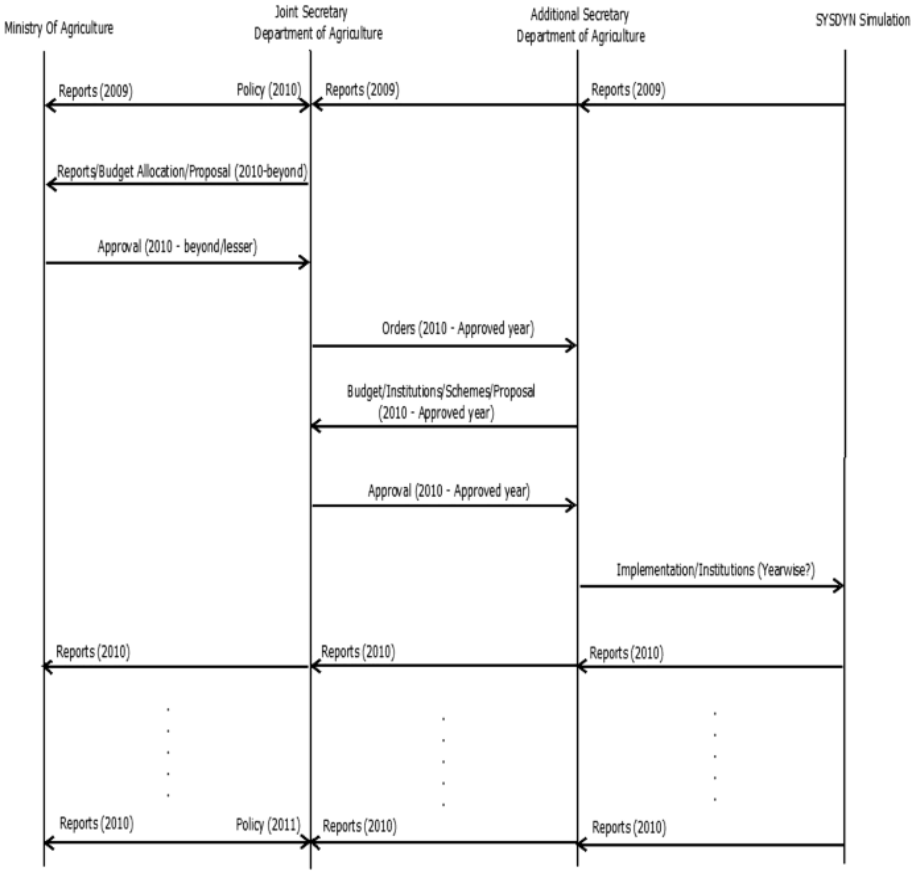

Figure 3: Game Flow

Level 3 consists of the governance structure. Governance structures are ways to implement the rules of the game, and means to resolve conflicts. Level 4 is where the actual business happens, the contracting, negotiations and transactions. The actual transaction costs occur here, as constant negotiations for contracts, both medium and long term happen at this level. For the purposes of this game, this level is currently simulated by a systems dynamics model, but can be replaced by any simulation as relevant to the problem.

The game tries to understand the processes and structures that exist at Level 1 of the four level model, as related to the field of agriculture. All the roles of the game are at levels 2 and 3, and are picked among the roles mentioned in the institutional structure above. The game tries to understand the negotiation processes at the policy making levels (2,3), and on the influence of these policies on the fourth level.

5. Game Description

The APG is a game for 10 to 20 people, and runs in one main room, with optional break-out rooms. The intended play-time is between 2 and 4 hours, depending on the complexity that the game leader wants to put in. The game leader can influence the complexity through interventions.

The game flow is shown in Figure 2. As shown in the figure, there are four roles in the game, three of which can be played by one or more players. The fourth role is simulated, and can be interchanged with alternative simulations based on the context. The game flow shown in the figure is for one round of the game, which represents one year in real time and is repeatable for multiple rounds. The reports at the beginning of every round are generated by the game facilitator, and serve initially as background information on agriculture in India, and as reports on the performance of the players in later rounds.

The game includes a set of roles that players play, and various artifacts that the players use to play the game. These are:

Minister of Agriculture

The minister of agriculture is responsible for defining the agricultural policy, and using the apparatus given to him to implement the policy. At the beginning of every round, he is given a national policy to implement. He can change this policy. He is also given a list of schemes that his Ministry is operating currently. This list contains associated information such as the Department/person in charge, budget, timelines and so on. The minister is also given a list of institutions that the ministry can use to implement various programs; he can also create new institutions as and when necessary. Additional constraints such as a yearly budget are given to the minister. The minister is expected to approve/ disapprove/modify proposals for schemes presented to him, including the ones currently in operation. The approved proposals will become schemes in operation and implemented by officials of the ministry. At the end of every round, the minister receives a report by the officials.

Joint Secretary

The Joint Secretary is one of the senior officials of the Ministry of Agriculture. At the beginning of every round, the Joint Secretary is given a national policy to implement by the Minister. He is also given a list of schemes the ministry is currently operating, along with associated information such as budget, timelines and so on. He is also given a list of institutions that the ministry can use to implement various programs. For every year, the Joint Secretary must propose new schemes, all of which put together will implement the national policy. If approved, the Additional Secretary will implement these schemes. The Joint Secretary must also seek

approval for the continuation of schemes already in operation. At the end of every round, the Additional Secretary gives him a report on the round.

Additional Secretary

The Additional Secretary is also one of the senior officers in the Ministry of Agriculture. There are four Additional Secretaries, each of whom is in-charge of one field. The four fields are Marketing and Trade; Crops and Education; Mechanization and Technology; Credit and Insurance. This classification is based on the programs currently run by the Govt of India, each of which broadly falls under one of these categories. At the beginning of the game each Additional Secretary is given four schemes to manage, two of which he is solely responsible for and two for which he shares responsibility with two other secretaries. Each Additional Secretary is given a list of institutions that they may use to manage one of their schemes, and a budget within which they should operate.

At the beginning of every round, each additional secretary should propose either a new scheme, or seek continuation of schemes he is already operating. The scheme may be run completely by him, or shared with another. Once approved, they are responsible for detailing the scheme and running it. They run the scheme by feeding it into a simulation, which currently is a Systems Dynamics model.

Schemes

Each scheme is detailed by filling out a form given to all the players. The form has the following fields:

- Name of the Scheme
- Implementing Agency (which can be one of the many institutions from a list given to all players, or a new one)
- Type (which is one of the four areas for which the additional secretaries are in-charge, or another type which needs to be specified)
- Year of Commencement
- Duration (number of years for which it will be operational)
- Area of Operation (Geographical area, players can specify that this scheme will be operational only certain select states)
- Funding (Method of funding. For example, whether this scheme will be shared between central, state governments or privately funded and so on)
- Objectives
- Structure
- Budget

The schemes that are already in operation are based on the programs currently being run by the Ministry of Agriculture [*Compendium of Schemes*, 20XX]. Uncertainties and unforeseen events such as droughts, floods and technological advancements and so on can be introduced in the game in the form of messages given to certain players. Apart from the negotiations about the schemes, this adds an extra dimension of complexity as the players can choose to use the messages to their advantage.

Systems Dynamics Model

The players in the game make decisions on the implementation of agricultural policies. We propose to feed their decisions into the Mango Mandi Gaming Simulation, where their decisions will influence a dynamic environment of software agents and/or human players interacting in a market for agricultural goods. For ease of testing the Agricultural Policy Module though, we have chosen to replace the MMGS with a systems dynamics model, illustrated in Figure 3.

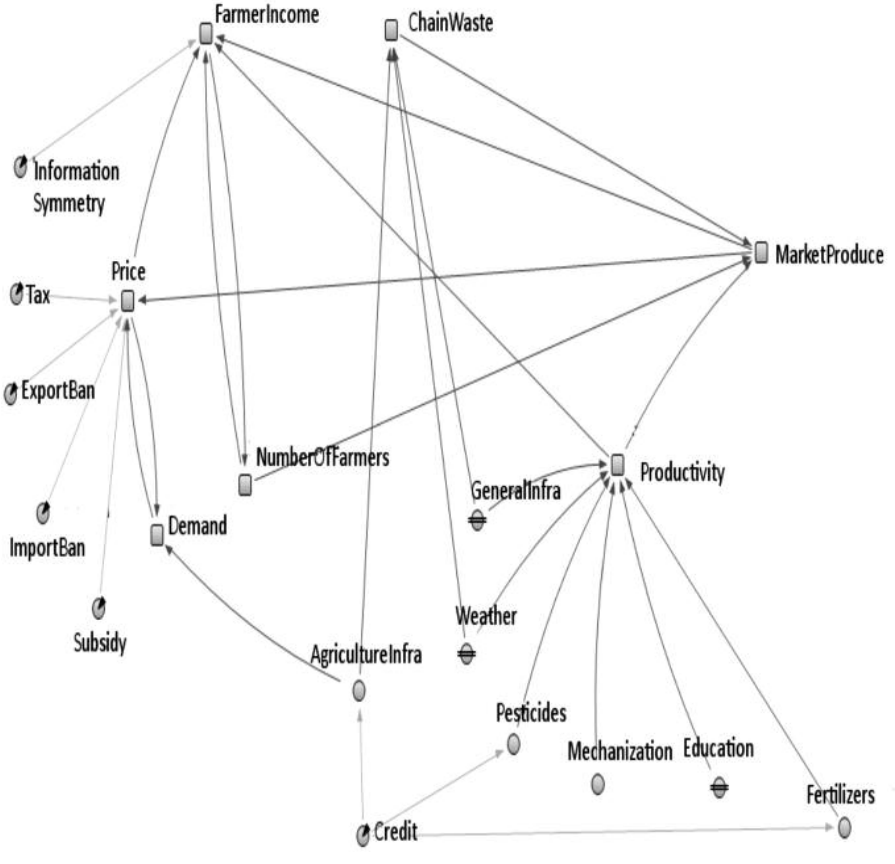

Figure 4: Systems Dynamics Model

The systems dynamics model is simple, intended mainly to illustrate the relationships between various elements in the system and to provide feedback to the players on their policies. A directional arrow between two entities indicates a direct relation between them, either positive or negative. The weight of the relationship is configurable, and the value of the element may be a function of the value of several other elements. The model is configured with initial settings that match the initial report that all players are given. The model can be run as many times as necessary. The value of an element (after a particular run) relative to its earlier values gives the participants an indication of how their policies are influencing the system.

At the end of every round, all the players give their policy measures to the game facilitator. The facilitator then goes through all the schemes and tries to map the schemes to the elements in the model. The values of the elements are changed to suit the new policies that have been implemented, and the model run. Comparisons of results from various models will give participants and indication of the efficacy of their decisions.

6. Verification, Validation and Test Results

In line with the test approach of Duke and Geurts (2004), and the iterative agile design method of Triadic Game Design [*Harteveld*, 2011], we followed a sequence of test sessions. The projected research methodology is analogous to the one used by Meijer et al (2008) in Figure 5.

For the current paper we focus on the left side of Figure 5, where iterative cycles lead to a gaming simulation prototype, later to be used as research tool in the empirical cycle, as well as induced hypotheses from test sessions with projected participants in the later empirical cycles.

We tested the AGP in five cycles of which the last two were fully playable sessions. Both sessions included participants from within CSTEP, so the maximum level obtainable was a working prototype, but no induced hypotheses, as these should come from play-testing with policy officers.

The cycles followed the traditional sequence of testing a simulation:

1. Verification whether all the built-in mechanisms work. In terms of a game this means whether everything is clear to the participants, and understood in the way meant by the designers, whether the Game Flow (Figure 3) really happens, and does not leave people sitting idle for a while, or short on essential information. This took 3 cycles to get everything working as described above in the paper.
2. Validation. We needed one cycle (the 4th) to improve the design here. The last cycle (game session) is described below in more detail. In addition to the 7 key elements of Indian supply chains mentioned earlier, we formulated four patterns that were not directly built into the design of the game, but needed to emerge from the game play. The patterns could not be obtained from literature directly, as little has been written on how the individual officers have their place in the Indian system, but were obtained from interviews with some ex-government officials and from tendencies observed over several years of newspaper reports. They can be used as hypotheses to check in the empirical cycle later in the process. For now the patterns are:
   a) A dominant behavior of the Minister who has a pull to centralize
   b) Joint secretaries will have trouble managing the overview of schemes between the Minister and the Additional Secretaries.
   c) A tendency to invent new schemes instead of changing existing ones
   d) A tendency to bring in funds from central budgets only, and not involving the local or domain agencies in the budget.

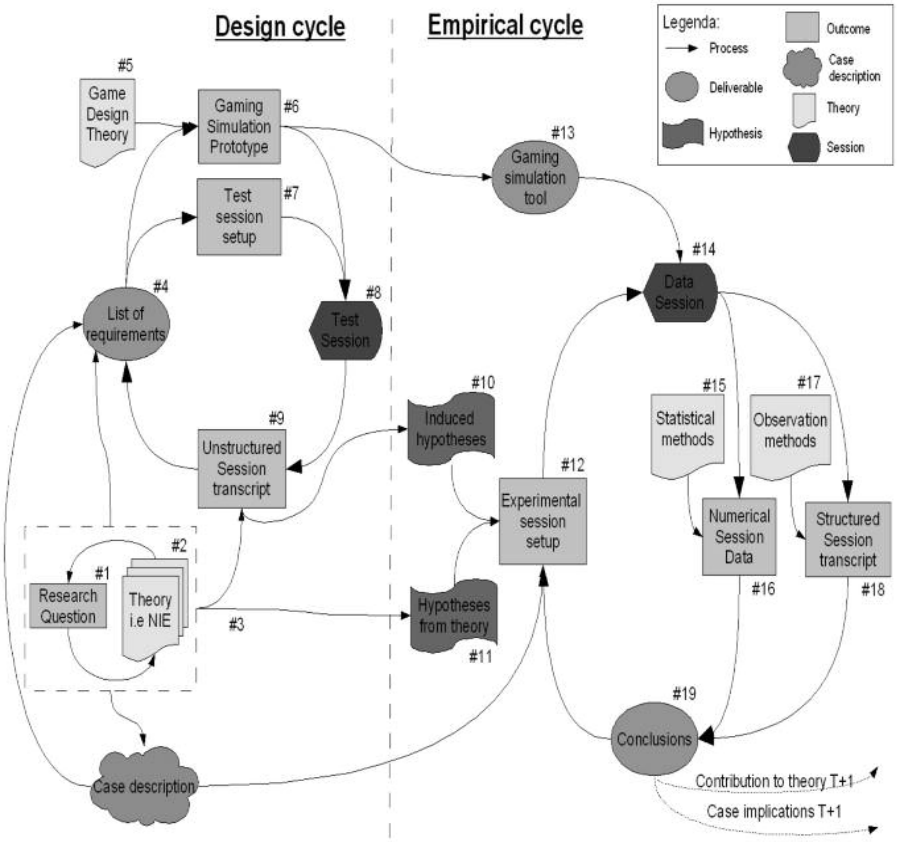

Figure 5: Research methodology for supply chain game [Meijer et al, 2008]

Out of the seven key elements, six could be brought into the game through the information provided on the current state of agribusiness. And through the existing schemes at the game start. This information was based on real numbers, abstract from the latest official online source made public. Only the segmented markets could not be represented, as this is not really apparent on levels 2 and 3 of the Williamson framework used.

The fifth cycle session lasted approximately three hours, including briefing, game play and debriefing. The session included a total of eight participants, one playing the role of the Minister, three playing the role of Joint Secretary, and four playing the role of Additional Secretary. As mentioned earlier, the Additional Secretaries were given two schemes to manage individually, and two schemes to jointly manage with two other Additional Secretaries.

The session was played for two rounds, each of which lasted for approximately thirty minutes and represented a year. In the first round, the participants added 8 new schemes to the existing 12. The original twelve were all renewed, bringing the total number of schemes managed by the participants to 20. In the second round, the participants added 6 new schemes to the now existing 20, making the total 26. None of the schemes started earlier were stopped. The overhead of continuing existing schemes could potentially account for the fall in the number of schemes created in each additional round.

Since every scheme must be approved at the beginning of every round, participants had the freedom to revise existing schemes. Very few schemes were modified, with only three out of twelve modified in the first round and four out of twenty in the second round. In all these schemes, only the budget was modified, while other attributes of the scheme were left intact. The participants were given twelve pre-existing schemes, which they also had to manage. Of these, 50% (6) of the schemes were shared. At the end of the first round, this had reduced slightly to 45% (9 of 20 schemes were shared). At the second round, this percentage had reduced to approximately 42% (11 out of 16 were shared). This proves emergent pattern 3.

While defining a scheme, the participants had to decide on the funding structure as well, i.e they had to decide whether the scheme would be funded completely by the central government, shared between central and state governments, private investment or other sources. A majority of the schemes created were all funded completely by the central government. Only one scheme was funded without any central government funding, and four other schemes were shared between the central government and other agencies. This proves emergent pattern 4.

Over the game play the Minister became more dominant as he got fed-up with the Joint Secretaries. The latter were having major trouble coordinating amongst them and keeping an overview of what the Additional Secretaries were doing. In the hierarchical Indian culture (large power distance in terms of the Hofstede culture dimensions), they could not think of delegating to the additional secretaries, while they had the actual information on their schemes and on what happens in their field. This is very analog to the real situation according to our information. The Minister taking over the control and effectively bypassing the joint secretaries was a matter of time. This proves emergent patterns 1 and 2.

Now that the game has been verified and validated with a test group from outside the governmental institutes, now it is time to plan on the last cycles in the design, being test sessions with policy makers. This last validation part is planned for summer / fall 2011, after which the Agricultural Policy Game can be used as a research instrument in the Indian agricultural sector.

7. Conclusions and Discussion

This paper introduced a gaming simulation for research into the agricultural policy making process in India. The game is intended to be part of a larger stack of games, and parts of the game can be replaced with parts from other games in the stack. The design is faithful to the structure and processes of the official Indian agriculture governance. While the game can be very broad in its scope, special attention is paid to six out of seven key elements of Indian supply chains identified earlier. This makes the game different from other supply chain games, as are popular in the Western world. Verification and validation have been completed insofar can be done without involving real policy makers. Further validation using the targeted participants of later empirical sessions need to be done before the game can be used as a research instrument.

The game can be used to better understand the decision making process at various levels of the government. It is useful in articulating the tradeoffs and concerns of actors in the agricultural governance sector, their power relationships and so on. Coupled with a simulation, it can also be used to help policy makers understand the consequences of their decisions. Depending on the simulation model used, the game brings together actors from both the regulatory institutions and the markets, allowing for feedback and dialogue between the various actors.

The complexities and the scope of the agricultural sector make development of the game challenging. Given the sensitive nature of the sector in India, and the societal issues surrounding it, approaches like the Agricultural Policy Game have potential in disentangling the complexities in regulating this vast sector.

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