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Analysing Government Decision Making in the South African Biofuels Industry: A Game Theoretic Approach

By

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T Funke[1], P Klein[2]

Abstract

The production of biofuels in many countries is largely driven by the government strategy and incentives that are in place. In South Africa the first round of the development of such a draft strategy took place in 2005 while the official stance on biofuels was finalised in December of 2007. During the policy development process various governmental departments had strategic goals and targets that they all were required to achieve. The achievement of these strategic targets and goals is also risky and the various departments that have some form of involvement in the biofuels industry need to decide on how much risk they are willing to take. This article sketches the game that the various governmental departments played as well as the risks that they were faced with when writing the Industrial Biofuels Strategy. In establishing a Nash Equilibrium and when comparing this to the current state of affairs in the industry an investigation is launched as to what has caused the governmental department to divert so strongly from this position. A variable Z is defined and included in the model in order to explain the current state of affairs. The Z variable is also analysed further in order to bring some form of structure to the debate on the government's stance on the issue.

Keywords: Biofuels, Game Theory, Government Strategy.

1. Introduction

Biofuel production in South Africa seems to be profitable, even without government intervention, if certain innovative approaches are followed. Without such innovations and applications, such as vertical integration in the supply chain and the penetration of a non transport fuel market, it seems that government support will be required if

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the industry is to develop at all. The Department of Minerals and Energy, with its new name the Department of Energy, was tasked to develop and propose a strategy that could assist the government in developing such an industry and in addition achieve a number of other political goals in the process. These goals, amongst others, included rural upliftment and development through better market access and higher prices as well as meeting renewable energy targets as set out in the White Paper on Renewable Energy in 2003. The achievement of these goals proved to be somewhat more complicated as other governmental departments also hold a stake in the agricultural industry and they too have goals to fulfil which are not necessarily in line with those of the other departments. Governments do however also take a risk when they follow a specific set of new policies. On the one hand, the government runs the risk of implementing a too severe policy, which in turn can have a severe impact on the greater economy due to welfare costs to the consumer and higher food prices, while on the other hand the government runs a risk of not achieving anything by implementing a policy that is not significant enough and as a result achieves nothing other than frustration of role players, inefficiency in the market and a lack of rural development. Such a variable needs to be taken into consideration when modelling the game as it has been perceived that such a variable has had a definite impact on the current game played in the South African biofuels industry.

The aim of this chapter is therefore to develop a game theoretic model which explains the reasons as to why the three government departments all with a stake in agriculture, have reacted as they have to the Industrial Biofuels Strategy[3] (IBS) of the Department of Energy (DoE). The game is sequential as the Department of Agriculture, Fisheries and Forestry (DAFF) and the Department of Rural Development and Land Reform (DLA) have only taken a stance of the issues after

[3] The Industrial Biofuels Strategy refers to the governmental action plan that has been released in order to regulate the development of the industry in South Africa. From here on it will be referred to as the IBS as to not create a confusion with the terminology used in game theory.

the IBS was released. A set of policy alternatives are represented thereafter which could assist the industry in achieving the industry in becoming a self sustained enterprise within the agro-processing sector.

2. The Department of Energy

In November 2003, the Department of Minerals and Energy released a document in the Government Gazette, titled the “White Paper on the Renewable Energy Policy of the Republic of South Africa”. The document recognises that it is vital to invest an equitable level of national resources in renewable technologies, given their potential with respect to investments in other energy supply options. The document further recognises the need that a certain percentage of the national energy demand is met in the form of renewable energies and sets the DoE’s goals on 10 000 Gigawatt hours (GWH) of renewable energy contribution to final energy consumption by 2013, which should be produced mainly from biomass, wind, solar and small-scale hydro. It further states that this energy is to be utilised for power generation and non-electric technologies such as solar water heating and biofuels. It further envisaged renewable energies to make up approximately 4% of the projected energy demand for 2013, in other words a total of 1667 megawatt (DME, 2003).

In December of 2007 the DoE released its IBS in which it outlined the road map for biofuel production in South Africa. The goal of this IBS was to steer biofuel production into the right direction, i.e. one of self sustained development. In addition the IBS aimed at creating a policy environment in which the production of biofuels could occur without too much intervention and regulation. It was also hoped that the policy would generate enough investments so that the renewable energy goals, as set out in the white paper on renewable energy, would be met and achieved. Unfortunately many industry role players felt that the IBS did not offer enough

incentive to go ahead with multi billion Rand investments. The sugar industry, for example, is sceptical to consider an ethanol investment even though it might make economic sense when taking the feed in tariff into account. Cutts (2009) commented that the main reason why the sugar industry would not invest in ethanol production is due to the non existent ethanol uptake mandate, which in turn does not secure an off-take market. In addition, a lack of import tariffs also create an insecure environment as there is a strong possibility that cheap ethanol from Brazil might enter the country and take over the market share. Other biofuel investors rated the licence application process as being a main factor of concern. This is especially true for regions where location of the plant is determined by former homeland areas and as a result of ineffective government policies, agriculture within these areas is resembled by uneconomical, subsistent farming practices. This means that farmers in those regions would by no means be able to supply feedstock to the biofuels plant even if prices where at above market levels. The failure of extension policies and their implementation by DAFF and the neglect of infrastructural development have strongly contributed to the failure of mentionable biofuel production developments in the specific areas.

With the White Paper on Renewable Energy in mind together with the 10 000 GWH target to be achieved by 2013, it seems reasonable to assume that the DoE would rather like to see a development in biofuels than none. The resultant payoffs that they receive from pursuing an active biofuels policy is therefore greater than their payoff that they receive from a policy that results in less active developments. The DoE as the first mover in the game therefore, rethinks the current strategy and pursues on that offers greater returns for them, in terms of reaching their targets.

3. Department of Agriculture, Fisheries and Forestry

The Department of Agriculture, Fisheries and Forestry is, in the IBS, quoted as being one of the major stakeholders in the biofuel development initiative. In the IBS the role of DAFF is portrayed as supporting the development of feedstock supplies through its existing support programmes, such as the Comprehensive Agricultural Support Programme (CASP), by increasing local agricultural production (DME, 2007). In addition, agricultural development on underutilised land will be prioritised for feedstock production and CASP will be steered in such a way that this is prioritised.

International developments in 2008 have resulted in the views on biofuels changing somewhat. The surges in international oil prices together with a host of other factors, had resulted in higher farm commodity prices as inputs and the demand for biofuels increased (Westhoff, 2008). This resulted in some countries reacting by restricting exports or reducing import barriers and as a result local prices where slightly reduced while international market prices increased further (Westhoff, 2008). In South Africa, concerns were raised due to the higher food price inflation with the National Agricultural Marketing Council reporting an food price inflation figure of 16.1% in January 2009 and an overall year on year inflation index of 8.1% for 2008 (NAMC, 2009). The hype that biofuels caused food price inflation to spike may have been one of the reasons why DAFF has taken a backward stance on the issue and have tried focussing their policies on the food security aspect, rather than on agricultural development. It is somewhat ironic as both food security and agricultural development go hand in hand and both of these aspects can only be dealt with sufficiently if and only if there is sufficient investment in the sector. Up to now there investment in the sector has been very small and it can be argued that the lack of action as well as the inefficiency of their policy and development programs has put

South Africa's food security more than if they had actively supported the initiative by the DoE on developing an additional off take market for agricultural commodities.

In order for DAFF to achieve its goals on food security and rural agricultural development it is important that the correct policies are in place to achieve this. Basic assumptions made with respect to the stance of agricultural development already indicate that if DAFF plays an active part in the biofuel industry's development process, economic conditions will improve which in turn can help them achieve the rural development and food security goals in the sector.

4. Department of Rural Development and Land Reform

The Department of Rural Development and Land Reform (DLA) focuses on the creation of vibrant, equitable and sustainable rural communities (DRDLF, 2009). The mission of the DLA is to facilitate integrated development and social cohesion through participatory approaches, in partnership with all sectors of society. In other words, the DLA's role is to uplift the rural communities and ensure that they are sustainable and vibrant, ensuring that they can continue their daily lives in an economically sustainable manner.

The process of Land Reform is however not always successful. A 2008 survey by the University of the Western Cape's Institute for Poverty, Land and Agrarian Studies (PLAAS) indicates that the land reform programme in South Africa is suffering from severe difficulties. The survey found that just one project out of the 128 surveyed is producing a sustainable profit. A call to pair the claimants with commercial operators, often the previous land owners, is seen as one of the only ways in which these projects can become commercially viable. The report further indicates that support by government is not adequate and that in most instances "many, if not most" projects

still do not receive the support they need to use the land productively (Lahiff, 2008). This means that the support programmes, such as CASP and the Micro-Agricultural Finance Initiative of South Africa (MAFISA) are not as efficient as what they should be that these projects are showing such a low success rate in terms of profitability and sustainability. It therefore seems that additional support and control is required if the land reform projects are to be successful.

According to the DLA they are not mandated to offer post – settlement support to any of the land redistribution projects but at the current, high rate of project failure it is surprising as to why they would not want to be part of the process. If the DLA took an active role in ensuring success with the projects then surely the process would be viewed as positive and the DLA would be seen as actually succeeding in their role as facilitators and mentors. It is for this reason that the DLA would embrace a biofuels initiative with strong incentives from the DoE, as this would spur on investment in the sector and if managed correctly could benefit many land reform projects, taken into account that the mentorship role is not neglected. Without such additional investments, the current programme continues as it is and fails.

5. The Model

A sequential, stylised game is used to represent the interaction between the different government departments. The reason why the game has been structured in such a way is to capture what has actually occurred in the South African sector and why the various departments find themselves in their current positions. The purpose of the game is to show that the rural development and self sustainability goals can be better attained, by both DAFF and the DLA, resulting in higher payoffs for them, if the DoE engages in a strong incentive driven IBS.

The game features three players, government departments that interact with the prospect of achieving their missions as set out by their respective strategies. If the two players that react on the strategies of the DoE decide to support a strong investment in biofuels, then their individual payoffs are far higher as they just have to play a facilitating role and not spend too many funds on development as the incentives in the market take care of this. If however the DoE decides to pursue a strategy with far lower incentives, it means that the governmental departments shift their focus and become more concerned with other developments, worldwide, as a result neglect their mission that they have in the local economy. Their payoff is thus expected to be lower as their expenses increase and their success rate with projects diminishes.

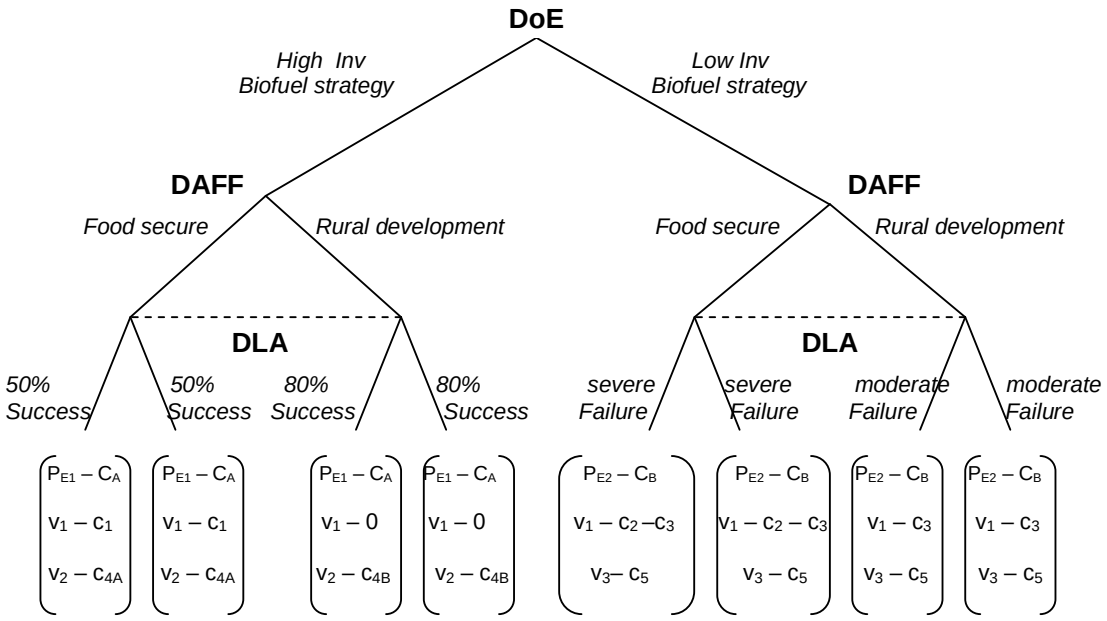

Figure 1: The Structure of the Government Investment Game.

There is a cost involved for the DoE in implementing its BF strategy and this cost is lower in the case of the low impact strategy compared to the high impact strategy. The cost of the low investment strategy is therefore represented by C_B while the cost of the high investment strategy is C_A, where $C_A > C_B > 0$. Even though the cost is

higher in the high investment strategy, the overall benefit and payoff that the DoE receives as a result of achieving its renewable energy targets is far greater than under the low investment strategy. The final payoff that the DoE receives under the high investment strategy is thus P_{E1} which represents the benefit received from national government when achieving its 2013 goals while P_{E2} represents the benefits that are received from not achieving the 2013 goals, where $P_{E1} > P_{E2} \geq 0$. The total payoff is thus represented by $P_{E1} – C_A$ for the high investment strategy and $P_{E2} – C_B$ for the low investment strategy, where $P_{E1} – C_A > P_{E2} – C_B \geq 0$ and $C_A > C_B$.

As the DoE is the first mover in the game, DAFF and the DLA react based on the biofuels investment strategy that the DoE has followed. Under a high investment strategy, DAFF benefits more than under a low investment strategy as the costs of investment are far lower with most of the rural development aspects being taken care of by the market and indirectly by the DoE's investment in biofuels. The payoffs for DAFF are thus as follows, $v_1 – c_1$ for securing food security under a high investment biofuels strategy and $v_1 – 0$ for improving rural development under a high investment biofuel strategy, where $v_1 > 0$. Investments in biofuels result in a far higher cost to DAFF as the department has to finance most of the development costs within the industry. Under the low investment in biofuels strategy, DAFF incurs a few more costs when it attempts to secure food supply in the country as this means protecting borders against cheap imports and improving rural development. As a result their total payoff under a low investment strategy would be $v_1 – c_2 – c_3$ while focussing on rural development alone would be somewhat cheaper with a total payoff of $v_1 – c_3$. The total payoff for the high investment strategy $v_1 – 0$ is larger than the investment under the low investment strategy $v_1 – c_3$ as c_3 is larger than 0. The DLA's strategy with respect to the strategy that is followed by the DoE is slightly different. This follows from the fact that they are at present not at all succeeding with their land reform programme even with large amounts of money that get spent on buying farms

according to the willing buyer / willing seller principle. Their strategy would thus be to support agricultural development in South Africa by any means possible with the hope that mentorship programmes, either through companies or other commercial farmers, will be the order of the day. If this occurs their potential payoffs will be high as the success rates amongst redistributed farms increases dramatically, helping them to prove that land reform can be successful. If there is only a low investment strategy for biofuels then the emphasis on a successful land reform programme falls on the DLA who up to now have struggled to achieve any rate of success with their projects (PLAAS, 2008). The DLA's payoffs under a high investment strategy are thus $v_2 - c_{4A}$ with v_2 being the benefits that they receive from success in the land reform process and c_{4A} the cost that they incur in the land purchasing process, where $v_2 > c_{4A} > 0$. The success rate of reforming farms under a strategy where DAFF focuses on food security is slightly less, 50%, than a strategy where DAFF focuses on rural development, 80%. Therefore, DLA incurs a cost of c_{4B} when the focus is on rural development and under that strategy money is saved, so $c_{4A} > c_{4B}$, as the DAFF funds also support the DLA projects. Under the low investment strategy the benefit that the DLA receives is very low as their success rate is almost 0 and this does not boast too well with DAFF as such a low success rate impacts on the nation's food security status. In addition, the DLA has huge costs to cover as the various farms need to be purchased and with a low success rate it is viewed that these funds are being wasted. The payoff structure is thus $v_3 - c_5 > 0$, where $v_3 < c_5 > 0$.

Given the structure of the benefits that the various governmental departments would receive from investing and supporting a high incentive biofuels strategy it seems a bit confusing as to why they would opt not to take this route. The case for failure of other departmental programmes does seem to rest with the decision by the DoE to follow a low impact strategy, which at the time of writing the strategy, in 2007, was perhaps an over cautious approach. Since then international developments in agricultural

commodity prices have caused concern of food security throughout the world and this together with a concern of the financial viability of biofuels world wide have made a high investment strategy even more unlikely. It is however ironic that with a lack of investment and huge inefficiencies in governmental processes, deserving and desperate farmers face a situation in which it is highly unlikely that they will be the ones who receive the support and as a result they might never be lifted out of this poverty trap.

6. The Game

It becomes clear from the investigations and from the reasoning in section 5 that none of the governmental departments are currently at the Nash Equilibrium in the game. It is the aim of this section to explore where exactly the Nash Equilibrium finds itself and why it would be to the advantage of the different departments to move toward those points.

The game indicates that there is a clear Nash equilibrium[4] and theoretically that should be the point at which all players in the game should not want to deviate from. The actual equilibrium at which all of the government departments would receive maximum payoffs, be it in terms of recognition or measured in success is if they follow this terminal history: (HI BFS, RD, Success). At both endpoints on this terminal the agricultural sector, commercial and small scale will benefit most as an incentive to spur on the development of an additional agricultural processing industry far surpasses any current agricultural development programmes. In addition renewable energy targets are met in a time that South Africa needs to show the world that it is serious about reducing its carbon footprint and that it wants to adhere to the guidelines laid out in Copenhagen in 2009.

[4] a strategy profile from which no player wishes to deviate, given the other players' strategies

The game tree indicates just how crucial the governmental policies are in ensuring stronger economic development in the South African agricultural sector. A low investment strategy for biofuels results in almost no rural development and does also not improve the food security situation as a strain on development and an unsuccessful land reform programme are having negative impacts on agricultural production in South Africa. In addition, the DoE does not meet any of its renewable energy targets and this will result in South Africa being seen as a strong polluter in the developing world.

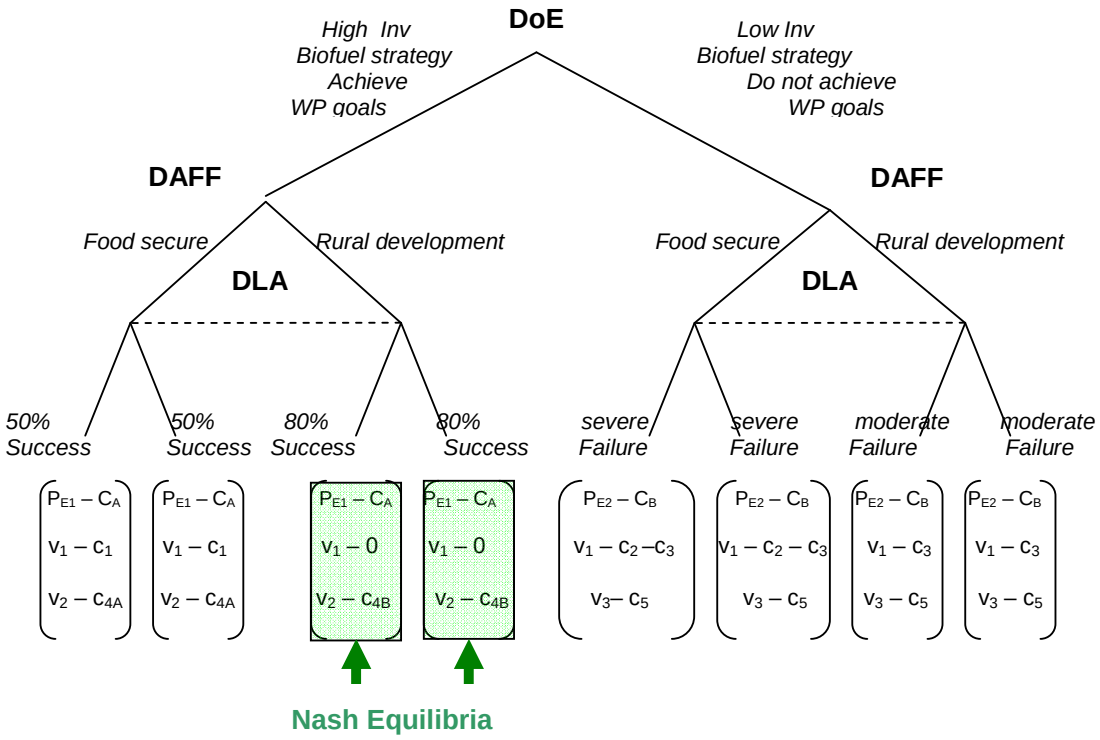

Figure 2: The Government Investment Game, Nash Equilibria.

The Nash Equilibrium situation is a far better option for all of the governmental departments. When following this strategy the DoE achieves part of its renewable

energy goals and even though the investment in the sector is more expensive than under the low investment strategy, its effects are further reaching. DAFF, for example, does not have to invest any money in rural development as the strategy spurs on investment and this in turn develops rural areas while food security is far less of an issue with increased agricultural productivity and better infrastructure. The DLA also benefits tremendously from this situation as an increase in the demand for agricultural commodities improves rural development and with that the new farm owner's rationality with respect to the degree of mentorship that needs to take place so that the farming enterprise becomes economically profitable. With this type of investment there is a strong possibility that the profitability of land reform farms can increase and that the success rate of farms will improve. It is therefore optimal for all of these departments to pursue such a strategy as the developments within the market should take care of most infrastructural adaptations.

This means that if all of the variables mentioned in the game are correct and that if all of the players are taking rational decisions, then they should end the game at the NE. The lack of investment, development and success of the South African biofuels industry has however shown a different picture. At present, circumstances are somewhat different in that the DoE has not followed a high investment strategy, DAFF is largely concerned with Food Security and not acting in terms of rural development and DLA is showing a complete failure in its land reform programmes and has in the past years achieved a less than 1% rate of success (PLAAS, 2008). This suggests that the game theory representation of this situation is lacking in some instances as one would expect the governmental departments to behave differently in order to achieve the outcome represented in the Figure. It seems as if a cost or risk variable is included when the government has chosen the path of a lower investment strategy. This risk variable is perhaps the most important factor affecting the way that the government departments, especially the DoE have responded to the

calls of the industry. The following game represents this clearly and indicating just how large the impact of this variable has been on the policy directions that have been followed.

7. The Game - replayed

The variable *z* has been included in the game to represent a risk that the government has opted not to take in terms of the development and support of the industry. The *z* variable represents a number of aggregated factors including a unclear, confused information flow from various role players, uncertainty, the resultant high costs of attaining a license as well as the uncertainty that they face in promoting a policy which in turn could impact on the consequences that they will face, from both the public and other government departments. In other words it represents a situation in which the government would risk the consequences of making large and important uninformed decisions.

Z is a variable included only under the high investment biofuel plan, meaning that this is the only time that the government really runs the risk of supporting an investment of which it has not had the most reliable and accurate set of information. It is represented as a cost to the government at all levels and as a result has an impact on how they react. What needs to be kept in mind is that the NE changes as their respective payoffs change.

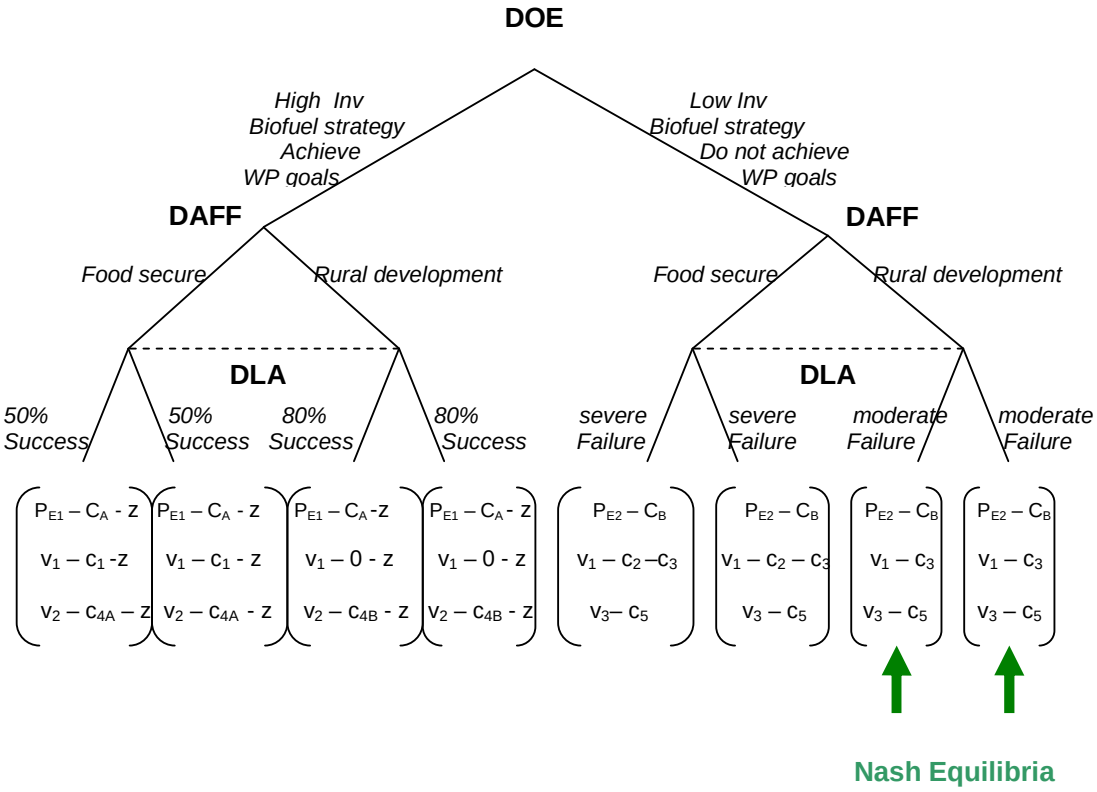

Figure 3: The Government Investment Game, replayed.

The outcome of the new game indicates that the Z variable does indeed play an important role in the final outcome. Adding Z to the equation results in the NE shifting from its previous location at a relatively successful situation with a strong focus on biofuels, rural development and a 80% success rate in land reform to a terminal mode where DoE follows a relatively low investment strategy, DAFF attempts to focus on rural development and DLA sees a moderate failure rate of its land reform projects. The outcome represents the current situation in the industry which in turn means that the variable Z needs to be investigated in closer detail.

8. Conclusion

The success of agricultural and rural development is usually dependent on the governmental policies that are in place. These policies are usually aimed at supporting the sector but there have been various instances where such policies have actually been destructive. In this game an agricultural processing sector is depicted which does have the ability to process agricultural commodities, take up surplus supply and as a result spur on rural development due to higher prices and a larger market. There are however, various inefficiencies within the sector, mostly at government level that hinder expansion and are keeping this new and exiting industry dormant.

The game theoretic approach that has been followed in this chapter indicates that the various governmental departments are indeed finding themselves at an equilibrium in the market due to a risk variable, termed variable Z. Their goals that they have set out to achieve in their strategy and policy papers are far from being realised, their current attempts at achieving their goals are failing and the potential that this will change without them taking a new and reformed approach to the situation, is highly unlikely. The question that remains is to be answered is why this is actually the case and why do these inefficiencies exist within this sector and if the idea of producing biofuels is actually worth pursuing. From the game theoretic model it becomes clear that the production in the biofuels industry could have further reaching effects which could in turn support the agricultural sector and help spur on investment in rural development and infrastructure without costing the government too money. It is just a matter of having the correct policies in place.

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