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Alleviating poverty with new technology?

A field study of the implications of a new agriculture production method in Zambia and the factors affecting its adoption

Bachelor of Economics Thesis

Almina Kalkan

Johanna Wiss

Supervisor

Juan-Carlos Estibill

University of Linköping

581 83 LINKÖPING

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Almina Kalkan & Johanna Wiss

Abstract

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New technology and new innovations have for long been considered as a spring for growth. Conservation farming (CF) is a new production method introduced in rural Zambia and previous research shows that it increases yields and improves soil fertility. Even though the method is proven more efficient than conventional agriculture, only approximately 10 % of Zambia's farmers have adopted the method. The purpose of this study is to discuss the implications of the introduction of CF on the capabilities of farmers and on economic growth. Furthermore, the study aims to explore why CF, which is proven to be more economically efficient than the conventional method, is not adopted to a larger extent in Zambia.

A qualitative study of 25 farmers, farming with either CF or conventional methods, was performed in the region of Mumbwa, Zambia. The results were divided depending on whether the farmers were using the new method or not. To analyze the selected material theories were chosen that regard economic growth and technological change, the adoption process of new innovations, incentive creation and the expansion of capabilities.

The two groups showed differences in age, the size of their land, how many crops they grew and to what extent they were working for others or hiring labor. The conclusion from the small sample of farmers is that the farmers using CF had been able to expand their capabilities in different ways. They had food for all the year, the new method allowed them to plan their time better and it was more environmentally sustainable than the old method. The negative aspect of CF is that it is not compatible with the old method in terms of social norms. CF leads to a more efficient use of capital and labor and therefore it can increase the economic growth. In terms of a new innovation, CF seems to have a relative advantage over the old method but it must be spread to a larger group of farmers to reach a breakthrough. To create a higher adoption rate of the method the farmers' perception must be taken into account.

Acronyms

ADP Animal Draft Power

CFU Conservation Farming Unit

CLUSA Cooperative League of the United States of America

FAO Food and Agriculture Organization of the United Nations

FRA Food Reserve Agency

FSP Fertilizer Support Program/Food Security Pack

HDI Human Development Index

HPI Human Poverty Index

LDC Least Developed Countries

NGO Non Government Organization

PROFIT Production, Finance and Improved Technologies

Sida Swedish International Development Cooperation Agency

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1. Introduction

Zambia is counted as one of the Least Developed Countries (LDCs) in the world according to the UN and approximately 87 % of the population lives below the poverty line of 2 dollars a day.[1] The majority of Zambia's poor earns their livelihood from small-scale agriculture, which is often short-term-oriented and brings little income, affecting the capabilities of farmers.[2] Moreover, the agricultural sector in Zambia is struggling with problems concerning unsustainable cultivation of land, such as deforestation and burning of residues, leading to losses of soil fertility and land degradation.[3]

To meet the demands for food security and a more sustainable way of cultivation, new methods of agriculture production, promoted by the Zambian government and Non Governmental Organizations (NGOs), have been introduced. One of these methods is conservation farming[4] (CF), a method that implies a reduction of excessive tilling and mixing of the soil. This is done by digging planting basins established before the rain, early planting of all crops, early weeding, soil cover by residues and a rotation of the crops. The work burden is spread out over the year in contrast to the conventional farming method where the work is concentrated to the rain season, when the ploughing, planting and weeding is done, and to the harvesting period.

CF is relatively new to the region of Southern Africa, but it is and has been practiced by farmers in South America, by commercial farmers in the United States and Australia and in some places in Asia. The method was developed by farmers in Brazil, as a response to the erosion problems they were facing.[5]

Earlier studies have investigated the impact of CF in Zambia. One study, performed by Haggblade and Tembo in 2003, suggests that although CF involves additional costs for farmers, particularly when it comes to labor and weeding time, it is more profitable than conventional farming. This is especially the case when the farmer has no adequate animal draft power (ADP), the profits are lower with adequate ADP but still positive. The advantage of CF is also pointed out by a study by J. Rockström et al. in 2008 showing a consistent yield increase for CF practices over conventional farming over time where yields increased with 20- 120% for maize in Zambia.

[1] Human Development Report. (2007).
[2] Sida. (2004). p.11.
[3] Sida. (2004). p.10.
[4] Only farmers having completely adopted CF are called CF-farmers and conservation farming will be referred to as CF throughout this report. See Appendix 1 for adoption definitions.
[5] FAO. [Electronic resource]

Since CF implies a more efficient utilization of resources, an increase in its adoption rate should imply higher economic growth in the region and have an impact on the capabilities of the farmers using it. According to economic theory producers and consumers always try to maximize their profit and consumption and one would therefore expect CF to be well spread in Zambia. Despite its higher profit, CF had only been spread to approximately 10 % of the Zambian farmers in 2003.[6] The adoption rates vary between different groups and determining factors of adoption could include gender, what crops are grown and previous experience of CF. Haggblade and Tembo mention four different factors that could influence the adoption of CF: agro-ecological region, extension support, cattle ownership and personal characteristics.

A study by Knowler and Bradshaw in 2007 investigated how and why adoption of CF occurs. The primary findings of their synthesis is that there are few if any universal variables that will explain the adoption of CF in previous analyses. Regional and personal variables have to be sought in the trial to explain the adoption decision and to create incentives for the adoption of this method.

1.1 Objective

This study aims to discuss the implications of the introduction of CF on the capabilities of farmers and on economic growth. Furthermore, the study aims to explore why CF, which is proven to be more economically efficient than the conventional method, is not adopted to a larger extent in Zambia.

1.2 Problem statement

To fulfill the purpose, the following questions will be investigated:

- *How has the adoption of CF affected the capabilities of the farmers using it and hence the possibilities for poverty reduction?*
- *Can CF be an efficient tool for economic growth?*
- *How come CF, which is proven to be a more efficient production method, is not adopted to a larger extent in Zambia?*

[6] Baudron, Frédéric., et al. (2007). p. 1.

1.3 Realization

The data was collected during eight weeks in Zambia. Due to limited time and resources, the investigation was kept geographically to villages surrounding Mumbwa in the central region and to 25 interviewed farmers. Ten of these were using conventional farming and fifteen had implemented CF. Contact with the farmers was established through Conservation Farming Unit (CFU), an NGO working for the spread of CF practices. Data has also been collected from interviews with NGOs and international organizations linked to agriculture.[7]

The interviews with farmers were based on a semi-structured approach where an interview guide was used.[8] To prepare for our field study and to achieve a better understanding of the subject, we started our investigation by reading previous research available on the topic. After learning about the method and deciding upon our objective, the questions were selected and then discussed with the CFU staff in Lusaka and Mumbwa before the field study. At Forum Syd in Lusaka we conferred with Mwenda Mumbuna, who has an insight in agriculture, to improve the questionnaire further.

Some of the interviewed farmers were chosen by the field officers and others were selected randomly. In some cases the field officer had specific CF farmers in mind that he wanted us to meet and while in the region we then randomly met other farmers as well. The interviews were made as informal as possible, so the farmers would feel at ease with the situation. If possible, the farmer was asked to show her/his fields. Questions concerning general information and labor, capital and land requirements in the two methods were asked. The farmers were also asked to draw a map of their field and to make a schedule over labor requirements in both methods to see the perception of the farmer and to see how they coped with abstractions. Notes were taken during the interviews and the responses were discussed to discover information discrepancies. When having doubts about our understanding in a question, we discussed with the field staff familiar with the reality of farmers. English was used as primary language when possible. Some farmers were not fluent in English and in these cases the field officer also served as interpreter.

In the reference frame, we looked into theories considering economic growth, more precisely how growth occurs and the impact of new technologies on economic growth in a country. Since our objective was to try to understand why a production method proved to be more economically efficient is not adopted to a larger extent, theories about factors affecting adoption of innovations were studied. We also looked into the role of incentives and lastly different aspects of poverty reduction to get a deeper understanding of

[7]Conservation Farming Unit (CFU), Cooperative League of the United States of America (CLUSA), Food and Agriculture Organization of the United Nations and Production (FAO), Finance and Technology Project (PROFIT).
[8] The interview guide can be found in Appendix 2 with commentaries on specific questions.

our subject. We chose to focus on the neoclassical or exogenous growth model of Robert Solow, the endogenous growth model of Paul M. Romer, the attributions of innovations and the adoption process described by Everett M. Rogers, the incentive creation mainly discussed by William Easterly and Amartya Sen's work about capability expansion.

1.4 Limitations and criticism of sources

During our work with the field study as well as with this report we become aware of several aspects that might have affected our results. The most flagrant of these are presented below.

In Zambia, more than 70 different languages and dialects are spoken which made us use an interpreter, usually employees of CFU, on several occasions. There was a risk for the interpreter putting in their own values or those of CFU in the response and also the risk of the farmer slightly modifying the answers depending on what he or she thought the interpreter wanted to hear. We tried to be clear with the fact that we were just there as students, and that we did not work for any organization, so that farmers less likely would adjust their answers to please us or to receive benefits.

Our collaboration with CFU might have affected our perception of CF. At the beginning of the study, our intention was to interview the same number of farmers in both of the methods, but when meeting CFU field officers they were more enthusiastic to introduce us to "their" farmers. Sometimes we had to insist to get interviews with farmers in the conventional method, and in retrospect we could have pushed more or been clearer with our intentions. Further, we never got the opportunity to meet a farmer that was really successful in conventional farming, or some other method of farming. The conventional farmers we interviewed were randomly chosen; often being neighbors to the CF-farmers we visited, indicating that our picture is quite representative for conventional farmers in Mumbwa.

We intended to have an equal gender distribution among the farmers being interviewed. Since women stand for the majority of small-holder farmers in Zambia as in the world[9], we wanted to get the women's point of view on the two methods. This turned out to be more difficult than we thought, and just one third of our interviewees were women.

The theories we use in our reference frame describe fields where much research has been made and being on a time constraint we had to limit our research for alternative theories.

[9] Human Development Report. (2007).

1.5 Disposition

The report is divided into five chapters. The introductory chapter gives a brief description of our topic, objective and method. The second chapter presents the theoretic framework of the report. Chapter three of the report exposes our empirics where the results from the interviews are presented. The results are treated as indicators for our analysis and conclusion presented in the last two chapters. Lastly, a list of ideas for further research is presented. In the appendixes a further description of the principles of CF and the interview guide used for the data collection can be found.

2. Theory

This chapter starts with a presentation of the neoclassical growth model of Robert Solow and the endogenous growth model of Paul M. Romer. The adoption process of innovations and the characteristics of adopters are described according to Everett M. Rogers and further the incentives for adopting new technologies are discussed. The last section addresses poverty and its definitions, taking a closer look at Amartya Sen's capability approach.

2.1 Economic growth: Solow's exogenous growth model[10]

Economic growth is commonly measured by the change in GDP, the relative change in the worth of the total production of goods and services in a country. GDP, Y(t), the total output in time t takes the form:

$$Y(t) = F(K(t), L(t), A(t))$$

Where K denotes capital stock, L labor and A "knowledge" or "technological progress". Output changes over time only if the inputs to production change. In particular, the amount of output obtained from given quantities of capital and labor rises over time only if the amount of knowledge increases.

Robert Solow's neoclassical model of economic growth shows how capital accumulation occurs and the importance of technological progress for growth. In the model households and producers are the economic agents, and there are three commodities on the market: output, capital and labor. The production function can be expressed in the Cobb-Douglas form as follows:

$$Y_t = K_t^{\alpha} \, (A_t L_t)^{1-\alpha}$$

Where α and 1 - α describe the output elasticity of capital and labor and $A_t L_t$ is the exogenously given technological progress, showing labor productivity. For the prosperity of a nation it is GDP per effective worker that is important, and we are interested in knowing the capital per effective labor, k, obtained by dividing the Cobb Douglas function with AL:

$$\tilde{y_t} = \frac{K_t^{\alpha}}{(AL)_t^{\alpha}} = \tilde{k}_t^{\alpha}$$

[10] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005). p. 130- 137.

The evolution of labor and knowledge is exogenous. Therefore the Solow model describes how GDP reaches a steady state by looking at the dynamics of capital. In the economy, the consumers of the households need to decide how much to consume of their income and how much to save. The saving of the household sector per effective labor, S, is shown by the average propensity to save, s, times GDP per effective worker, expressed as follows:

$$S_t = s\tilde{y}_t^{\alpha} = s\tilde{k}_t^{\alpha}$$

The saving can also be seen as actual investment per effective labor, I/AL, adding to capital per effective labor. The capital per effective labor in each period is lowered by capital depreciation (δ), population growth (n) and technological progress (g and ng). In each period an investment equaling these reductions, a break-even investment, needs to be made to maintain k at its existing level. The break-even investment equals:

$$(n + g + \delta + ng)\tilde{k}_t$$

The change in the stock of capital per effective worker depends on the difference between actual investment and break-even investment. When actual investment per effective worker exceeds the investment needed to break even, k is rising. When actual investment is lower than break-even investment, k is falling and when the two are equal, k is constant and GDP reaches a steady state in the economy[11]:

$$\tilde{k}_{t+1} - \tilde{k}_t = \frac{1}{(1 + n)(1 + g)} (sk_t^{\alpha} - (n + g + \delta + ng)\tilde{k}_t)$$

The graphs of the equation can be seen in Figure 1.

[11] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005). p. 134.

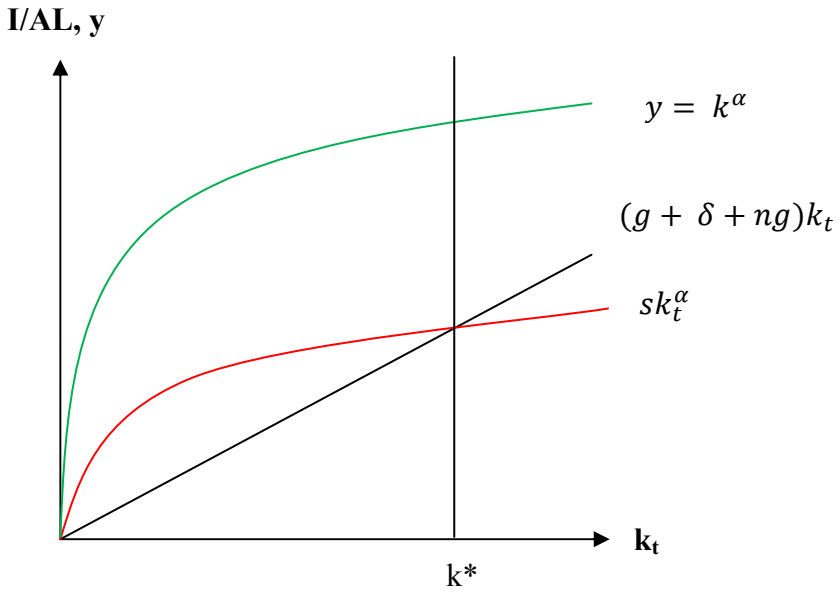

Figure 1. Steady state in the Solow diagram.[12]

An increase in the saving rate will make the curve sk_t^{α} shift upwards and implies a new steady state level of capital per effective worker (k*). Structural policies which increase the saving rate or reduce the population growth rate will gradually take the economy to a higher steady state growth path characterized by a higher level of steady state income and consumption. Nevertheless, a permanent rise in the economy's growth rate can only be achieved via a policy that permanently raises the growth rate of factor productivity.

The Solow model has been criticized for being silent about the factors determining technological progress and therefore the endogenous growth theory, with technological progress as an endogenous variable in the model, has been developed.

2.2 Economic growth: Romer's model of endogenous technological change

Characteristics of knowledge

In the previous section we saw that technological progress, growth in A, is what permanently raises the economy's growth rate. Technological progress originally results from *ideas.* The production of new and

[12] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005).

better ideas is what ultimately will bring better technologies, which will lead to increases in the stock of technology and knowledge (A_t). The potential for ideas to change things is enormous. Romer illustrates this with the example of a child's chemistry set. If one has 100 different chemicals in the set, there are more than 10^{30} possible combinations of 2 or more chemicals one can make (ignoring the opportunities for varying the proportions of the ingredients). The possible number of combinations is overwhelming. By Romer's calculation, if everyone on the planet has tried one combination per second for the last 20 billion years, which is the age of the universe, we still would have tested less than one percent of the possible combinations.[13]

When looking at ideas as economic goods, they can be analyzed as public goods – meaning that their characteristics are *non-rival* and *non-excludable/ imperfectly excludable*. The non-rival aspect to ideas means that once a new idea has been invented, its use in one activity does not limit the use of it in other activities. The marginal cost of production of a non-rival good is assumed being (close) to zero which implies that firms will need to have monopoly on the market to make a profit on new ideas. This can be created by offering patent rights and other legal ways of protecting intellectual property rights. A problem of giving monopoly in the use of ideas to the creators is that it probably will be used too little as compared to what is optimal for the society. But it cannot be ignored that the profit motive is one effective engine for technological development. It has been shown that the most useful part of research and development (R&D) has been done most effectively in private enterprises that are governed by market signals and the profit motive.[14]

The excludability of a good can occupy different degrees. Ideas are seen as being imperfectly excludable varying from being absolutely non-excludable, meaning that no person can be prohibited from using the idea (for example the use of calculus), to partly excludable, implying that people can be excluded from using, for instance, a spreadsheet they have not paid for (using the spreadsheet anyway would be a violation of the law). Furthermore, a competitor in the same business could probably, by analyzing an invention, figure out its components and codes. This is another reason that makes an idea not perfectly excludable. To protect the profit motive it can be of interest to increase the excludability of an idea, and this can to some extent be ensured by law and/or by technology. The improvement of legal protection will also improve the incentives for a private production of ideas. [15]

[13] Romer M. Paul. (1993). p. 215.
[14] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005). p. 277.
[15] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005). p. 281.

Production of knowledge[16, 17]

Ideas are the intended output of R&D. To further understand economic growth the production of ideas and the growth of A needs to be modeled rather than taken as given.

An explicit R&D sector focusing on production of new technologies is introduced and then this production is modeled. The allocation of resources between conventional goods production and R&D is also modeled. Fraction a_L of the labor force is used in the R&D sector and fraction 1 - a_L in the goods-producing sector. Similarly, fraction a_K of the capital stock is used in R&D and the rest in goods production. Because the use of an idea or a piece of knowledge in one place does not prevent it from being used elsewhere, both sectors use the full stock of knowledge, A. The quantity of output produced at time t is then:

$$Y(t) = [(1 - a_K)K(t)]^{\alpha}[A(t)(1 - a_L)L(t)]^{1-\alpha} \qquad 0 < \alpha < 1$$

This equation implies constant return to capital and labor.

In the production function of A, labor, capital and existing technology are combined in a deterministic way to produce improvements in technology. The production function for new technology is:

$$A_{t+1} - A_t = B[a_K K(t)]^{\beta}[a_L L(t)]^{\gamma} A(t)^{\theta} \qquad B > 0, \quad \beta \geq 0, \quad \gamma \geq 0$$

The production function captures that, everything else equal, devoting more resources to research yields more discoveries. A shift parameter, B, incorporates the consequences of changes in other determinants of the success of R&D. The change in A_t depends positively on K_t and the key phrase here is *learning by doing*. The use of (additional) capital in an individual firm will have a direct effect on production but in addition it will have a positive effect on the capabilities of workers who gain new knowledge by working with new capital. The benefit from this effect does not only accumulate to the firm which increases its capital stock, because other firms can gain from "looking over their shoulders", and because in the longer run employees may move between firms and thus bring their acquired capabilities with them to new employers.

[16] Sørensen, B. Peter., & Whitta-Jacobsen, J. Hans. (2005). p. 251- 255.
[17] Romer, David. (2006). Chapter 3.

The production function for knowledge is not assumed to have constant returns to scale to capital and labor. Replicating what the existing inputs were doing would cause the same set of discoveries to be made twice, thereby leaving $A_{t+1} - A_t$ unchanged. Thus, it is possible that there are diminishing returns in R&D. At the same time, interactions among researchers, fixed setup costs, and so on may be important enough in R&D that doubling capital and labor more than doubles output. Hence, there are also possibilities of increasing returns.

The effect of the existing stock of knowledge on the success of R&D is reflected by the parameter θ. This effect can operate in either direction. On the one hand, past discoveries may provide ideas and tools that make future discoveries easier, making θ positive and higher than 1. In this case the production of new technology rises more than proportionally with the existing stock. On the other hand, the easiest discoveries may be made first, making it harder to make new inventions when the stock of knowledge is greater, giving θ less than 1. This will imply that a constant factor input in research will imply that the absolute production of technology, $A_{t+1} - A_t$, increases and goes to infinity over time, but that the growth rate, $(A_{t+1} - A_t)/A_t$, goes to 0. When θ is less than 1, a constant growth rate of the labor input into the research sector is required to maintain a positive, constant growth rate of technology.

In a similar way the effect of the capital input on the success of R&D, reflected by parameter β, and the effect of the labor input, reflected by parameter γ, affect the growth rate and the production of knowledge. Since the importance of technology and innovation for economic growth is emphasized, we will look at what characterizes innovations and how they spread.

2.3 The adoption process of new innovations

The attributes of innovations[18]

To understand how innovations spread it is important to recognize their attributes. Rogers identifies five characteristics of innovations: (1) relative advantage; (2) compatibility; (3) complexity; (4) trialability, and (5) observability. These characteristics affect the rate of adoption of innovation.

The relative advantage is the extent of which an innovation is perceived as being better than the idea it supersedes when it comes to economic profitability. The economic factors that affect the rate of adoption of an innovation may be its initial cost, or the reduced cost of production that is offered by its technological advance. There are also status aspects involved that give a new innovation a relative

[18] Everett M. Rogers. (2003). p. 222.

advantage, often more interesting to early-adopters. *Compatibility* is the extent of which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters. The decision of adoption can depend on socio-cultural values and beliefs, previously introduced ideas and/or the client needs for the innovation. *Complexity* is the extent of which an innovation is perceived as relatively difficult to understand and use. *Trialability* is the extent of which an innovation may be experimented with on a limited basis. *Observability* is the extent of which the results of an innovation are visible to others.

The adopter categories and Rogers' rate of adoption curve[19]

Individuals are not likely to adopt a new innovation all at the same time, consequently different adopter categories can be used. Rogers divides individuals into five different groups: (1) the innovators; (2) the early adopters; (3) the early majority; (4) the late majority and; (5) the laggards.

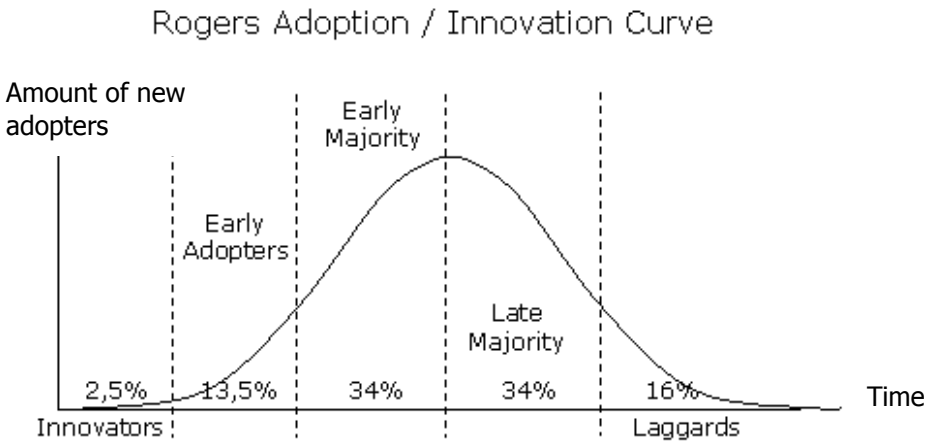

Figure 2.1 Rogers' Adoption / Innovation Curve.[20]

The innovators almost have an obsession with finding the latest trends etc. There are some basics needed being an innovator: the individual will need to have control over considerable financial resources (which will help her/him in case of losses from an unprofitable innovation), it is important to be able to understand and apply complex technical knowledge, the innovator must also be able to cope with a high degree of uncertainty about an innovation when he/she adopts. The innovator plays an important role in launching a new idea in the system.

[19] Everett M. Rogers. (2003). p. 281.
[20] Everett M. Rogers. (2003).

The early adopters are the most influential ones in a society and other potential adopters look at them to seek advice and information about the innovation. When the early adopters decide to try a new innovation it is almost as if they put their stamp of approval on the new idea.

The early majority tend to adopt the new ideas just before the average member of a system. This group is an important link in the diffusion process since they find themselves between the very early and the relatively late adopters. What separates this group from the two precedent ones is that they tend to deliberate for some time before completely adopting to an idea and their innovation-decision period is relatively longer.

The late majority adopt new ideas just after the average member of a system. What affects their adoption decision can be an economic necessity or the pressure from other members of the society. Most of the uncertainty of an idea must be removed before the late majority feel safe to adopt a new idea.

Laggards tend to be suspicious on new innovations and the innovation-decision process is usually long. Their resistance for adopting new innovations is sometimes due to limited resources and there is a need for certainty about the success of the new idea before adopting it.

Characteristics of adopter categories[21]

A lot of research has been made about different variables that are related to innovativeness. These can basically be summarized under three categories: (1) *socioeconomic status*, (2) *personality values* and (3) *communication behavior.*

Socioeconomic characters affecting adoption of new innovations seem to be independent of age; there is no evidence that early adopters are younger or older than late adopters. What is more likely to affect if a person is an early adopter is that people in this category have more years of formal education, are more likely to be literate, have higher social status, have a greater degree of upward social mobility and they have larger-sized units (for example farms, etc.) than late adopters.

According to Rogers early adopters have certain *personality variables* that are typical for them. An early adopter can to a greater extent project himself or herself into the role of another person, can more easily deal with abstractions, has greater rationality, has a more favorable attitude towards change, can better cope with uncertainty and risk, has a more favorable attitude toward science, and has higher aspirations.

[21] Everett M. Rogers. (2003). p. 287-295.

Lastly, the *communication behavior* of an early adopter seem to be that he/she has more social participation, has more contact with change agents, has greater exposure to mass media communication channels, has greater exposure to inter-personal communication channels, seeks information about innovations more actively, has a greater knowledge about innovations and has a higher degree of opinion leadership.

2.4 Incentives

Definition of incentives

After seeing how internal factors affect adoption of innovations this section will take a look at external such. The focus will lie on creation of incentives. The incentives for individuals to behave in a certain way can be divided into three different motivations[22]:

- *Extrinsic motivations:* refers to motivation that comes from external factors affecting an individual. Individuals may for example be motivated by material rewards such as money or grades. These rewards provide satisfaction and pleasure that the behavior or task itself may not provide. Incentives of this kind can also be coercive, where the agent can expect some kind of punishment against her/him or a family member or close friend. Finally, there could also be legal incentives that can be both of awarding or punishing character; for example a tax reduction for environmental friendly cars or a tax augmentation for cars not following a limit of pollution.

- *Intrinsic motivations:* refers to motivation that comes from within an individual such as the pleasure one gets from the task itself or from the sense of satisfaction in completing or working on a task. It could also be viewed as incentives that motivate an individual through their tastes, desires, pride or personal drives.

- *Signaling motivation:* refers to the motivation stemming from individuals' care about how they are perceived by others i.e. if others think highly of us we simply feel good and on the contrary when others think less of us we simply feel bad. Acting in a certain way could also be considered the right thing to do. Through her/his actions the agent can therefore receive admiration by other members of the community or regain self-esteem.

[22] Bénabou, R., Tirole, J. (2005). p. 3-4.

Creation of incentives

Economic growth occurs when people have the incentive to increase their human capital, to adopt new ideas and technologies, being willing to sacrifice current consumption while they are installing the new technology for future payoff. This leads to a steady rise over time in the economy's productive potential and people's average income.[23] Incentives are important to make this happen. Government policies need to encourage investment in the future through innovation, creating a good attitude for technological progress.[24]

However, there are a few complications about incentives for technological progress. Some technological advancement destroys the market for older technologies and goods. People who were producing the old good may well lose their jobs even though new jobs are created, since these are often for people with knowledge about the new technology.[25]

This attribute of ideas and innovations, being public goods, cause disincentives that can be very strong - so strong that there is no innovation and thus no growth in a market economy. The way out would be to create strong incentives for innovation and new technologies by subsidizing private research and development, subsidizing adoption of best-practices foreign technology, encouraging foreign direct investment from high-tech places, having the government itself do some research and development, and having strong intellectual property rights that allow inventors to keep the profits from their invention. Another way would be to raise the incentive to invest in people which would not only benefit skill increases but which would also release some pressure from the problem of population growth in poor countries.[26] This previous section highlighted the importance of incentives for technological progress and hence for economic growth. Incentives and motivation also have a central role in the discussion of increased capabilities and poverty reduction, which follows next.

2.5 Poverty

There are several different definitions of poverty. Some of them consider consumption, for example the minimum amount needed to get by each day or the daily intake of calories that a person needs to function well. But poverty seen as a lack of income is just one aspect of it. If one, for example, cannot go to school or cannot get access to healthcare it can result in individuals not being able to participate in the society they live in, which can also be considered as poverty. Amartya Sen argues that poverty needs to

[23] Easterly, William. (2001). p. 177.
[24] Ibid.
[25] Ibid.
[26] Ibid.

be looked at more broadly than just a measurement of income. He suggests that poverty is the absence of one or several basic capabilities to function well in the society that a person lives in.[27]

The capability approach[28]

The measure of a person's interests, in economic theory, is often referred to as utility. This term can have different meanings. Traditional utilitarian economists have defined it as desire-fulfillment, happiness, or satisfaction and for modern economists it has also been used as a term for whatever the individual maximizes. The problem with these formal economic measurements of an individual's utility is that they have not been focused on the many dimensions of how a person's states and interests can be judged. Sen's capability approach argues that the main goal of poverty reduction should be to expand the capability for individuals for them to be able to enjoy 'beings and doings' seen as valuable for that person. The expansion of human capabilities has both direct and indirect importance in the achievement of development. The indirect role works through the contribution of capability expansion in enhancing productivity, raising economic growth, broadening development priorities, and bringing demographic changes more within reasoned control. The direct importance of human capability expansion lies in its inherent value and its constitutive role in human freedom, well-being and quality of life.[29]

Sen's capability approach principally uses four different notions[30]:

- Goods/Commodities
- Characteristics
- Functionings
- Utility

Sen argues that goods not only give utility through consumption, but they can also provide nutrition, satisfy hunger, meet social conventions, etc. The characteristics of a good are separate from what Sen calls capabilities, because the characteristics are features of a good, whereas capabilities are features of a person in relation to goods. Functionings specify what a person can or cannot do, or can or cannot be. The utility stands for the pleasure or the desire-fulfillment from the functionings that are related to a certain good.[31]

[27] Banerjee, et al. (2006).
[28] Sen, A. (1999). p. 18-21.
[29] Sen, A. (1985). p. 155.
[30] Sen, A. (1984). p. 333-340.
[31] Ibid.

A focus that lies only on functionings and/or utility is incomplete. The reason is that it does not incorporate what Sen refers to as freedom. Capabilities include a person's or a group's freedom to support or achieve functioning's seen as valuable for that particular person or group. Freedom does not always increase with the number of choices nor is it always something that leads to increase in an individual's own well-being. However, capabilities increase when individuals can live a life where they can make genuine choices, whether it leads to a richer material life or spiritual life.

2.6 Summary

To summarize the theoretical section, new ideas and technology are at the core of economic growth. For a permanent rise in an economy's growth rate an increase in factor productivity is needed. Any producer, from big industrial enterprises to a small-scale farmer, benefits from augmenting the productivity of its inputs to production. Increased factor productivity can be obtained by new technology or ideas, such as a new production method. Seen as economic goods, ideas are special in the sense that they are non-rival and non-excludable. These characteristics of ideas have the implication that different farmers can benefit from the same idea at almost no cost without the idea loosing importance to additional farmers. More resources added to the production of new technology and ideas lead to more ideas being produced, partly through the process of learning by doing, which is very valuable to the spread of ideas and innovations. At what rate innovations are adopted depends on its features as well as on the characteristics of the potential users and to speed up the rate of adoption the creation of incentives can play a major role. If the right incentives are created for the adoption of a new, more efficient technology and this leads to increased labor productivity and economic growth, a lowering of poverty and an increase of capabilities and wellbeing of people might be achieved.

3. Empirics

This third chapter presents a background of Zambia and the economic situation in the country as well as the microenvironment of a Zambian farmer and the indications that we found in our study of the differences between conventional and CF-farmers.

3.1 Background

Zambia is situated in southern Africa and has a population of approximately 12.3 million inhabitants. It is considered as one of the LDCs in the world and is ranked as number 164 out of 182 countries on the Human Development Index-list, and as number 110 out of 135 on the Human Poverty Index-list.[32] When it comes to corruption the country is ranked 115 of 180 countries, and the single institution or sector perceived to be the most affected by corruption is that of public officials.[33]

The sectors contributing the most to Zambia's economy are mining, construction, agriculture and manufacturing.[34] In 2006 services contributed 45% to GDP, industry 33% and agriculture 22%. The mining industry has for a long time been the most important sector and the country has access to many natural resources with copper being the most important export good.[35] Even though the country has experienced positive economic growth since 1999[36] (with an average growth rate of 4,808 % per year between 1999-2008), the country still experiences high levels of poverty.[37] This is explained by the fact that economic growth to a large extent has taken place in the mining- and construction sector, without large trickle-down effects.[38] Efforts have been made from the Zambian government to diversify the country's economy to achieve poverty reduction and to make Zambia less vulnerable to the prices of copper.[39]

[32] UNDP, (2009). *Statistical annex.*
[33] Transparency international. (2009). p. 29.
[34] Utrikespolitiska institutet (2007). Section: *Ekonomi*.
[35] Utrikespolitiska institutet (2007). Section: *Geografi* and *Sociala förhållanden*.
[36] IMF. *World Outlook Database.* [Electronic resource].
[37] UNDP. (2009). p. 178.
[38] Government of Zambia. (2006) p. 14.
[39] IMF. (2009). p. 8.

To diversify the economy and target the poor many governmental priorities have focused on agricultural development.[40] Agriculture is one of the primary resources of the poor and 70 % of the population works in this sector.[41] Zambia has a good climate for agriculture that allows cultivation of many different types of crops, yet the land is not used optimally. Fluctuations in output are big, the agricultural sector has shown poor results and the average growth is low.[42] In 2005, the agricultural sector counted for about one fifth of the GDP in Zambia[43]. Table 3.1 presents some selected indicators showing Zambia's development between 1987 and 2007.

Indicators/Year	**1987**	**1998**	**2005**	**2007**
GDP/capita, PPP in USD	717	719	1 023	1 358
Life expectancy at birth, years	54	40.5	40.5	44.5
Adult literacy, percentage	76 %	76.3 %	68 %	70.6 %
HDI-value[44]	0.481	0.420	0.434	0.481
HPI-value[45]	-	37.9 %	40.8 %	35.5 %
Share of population under the extreme poverty line (< 1 USD/day)	-	72.6 %	63.8 %	64.3 % *
Share of population under the poverty line (< 2 USD/day)	-	-	87.2 %	81.5 %

Table 3.1[46] Evolution of indicators for standard of living in Zambia.
*Population under 1,25 USD per day
- Information not available

The incomes in Zambia are unevenly distributed. The poorest 50 % of the Zambian population claim 15% of the resources, whilst the top 10 % claims about 48 % of the total income. The income disparities are less flagrant in the rural areas, but they are still large.[47] Most poor in Zambia live in the rural areas, 78 % of the rural population lived under the poverty line set by the Zambian Government in 2004, compared to 53 % in the urban areas.[48] The Zambian small scale farmers are among the poorest in the country, followed by rural medium-scale farmers in terms of poverty.[49]

[40] Government of Zambia. (2006). p. ii.
[41] UNDP. (2007).
[42] Government of Zambia. (2006). p. 14.
[43] Utrikespolitiska institutet (2007). Section: *Jordbruk och fiske*.
[44] Summary composite index that measures a country's average *achievements* in three basic aspects of human development: health, knowledge, and a decent standard of living. Developed countries have a HDI close to 1.
[45] Summary composite measure that shows a country's average *deprivations* in health, knowledge and standard of living. Developed countries have a HPI close to 0%.
[46] UNDP. (1990, 2000, 2007 and 2009). *Statistical annex.*
[47] Government of Zambia. (2006). p. 16.
[48] Government of Zambia. (2006). p. 12.
[49] Ibid.

The poverty levels are highest among the female-headed households and households headed by elders. Households with seven or more members also show higher levels of poverty.[50] When looking at the education levels related to poverty, it has shown that households where the head has no education are poor in 80 % of the cases, whereas if the head of the household has tertiary education the level is at 24%. The rural population is benefiting less from education since there is an uneven distribution and the urban population is favored.[51]

The urban population in Zambia has decreased from 39.4 % in 1990 to an estimated 35.7 % in 2010.[52] The collapse of the mining sector in the 1990s caused a big migration from the Copperbelt region, where many of the cities are to be found, to other parts of the country.[53] This implies that the most Zambians still live in rural areas where agriculture is the main source of livelihood. The poverty in rural and urban areas must be considered separately since their characteristics are different. In rural areas the economic activity is mainly based on the land and other natural resources, the population is more scattered and the infrastructure is often of low quality, furthermore the rural population is more affected by weakening natural resources. The urban population on the other hand is mostly involved in manufacturing, trade and services, and the population is concentrated and mostly growing. The challenges of the rural population are mostly to reduce income risk and diversify income sources, to create food security, ameliorate the infrastructure and increase the security in land tenure. For the urban population there are other challenges: decrease the reliance of the cash economy, the exposure to environmental risks such as pollution and the lack of social security.[54]

Other difficulties affecting the poor in Zambia have been the poor infrastructure and reduced health. In rural areas of Zambia, the road network is bad which complicates driving. Local transport is kept between towns, vehicle ownership is kept to a small minority and those wanting to move from one village to another usually use transportation by foot, bicycle or hitchhiking. Access to water is restricted and a lot of time is spent collecting water from the wells for the family consumption. Houses in rural Zambia generally do not have electricity.[55] HIV and AIDS are twice as high in the urban areas as in the rural areas.[56] A consequence of diseases such as HIV and malaria is that it weakens the labor force and causes early deaths, affecting the production. Deaths caused by malaria have declined[57], but still remain a problem

[50] Government of Zambia. (2006). p. 15.
[51] Government of Zambia. (2006). p. 17.
[52] UNDP. (2009). p. 191.
[53] Government of Zambia. (2006). p. 14.
[54] World Bank. [Electronic resource].
[55] Government of Zambia. (2006). p. 23.
[56] Government of Zambia. (2006). p. 17.
[57] World Health Organization. [Electronic resource].

and the number of HIV-infected reaches a level of 17% of the population.[58] Zambia also suffers from high level of alcoholism compared to other countries in the region.[59] A good indicator for the well-being of a household is the nutritional status of a child which also reflects the status of the surrounding communities' health statuses and is important for future development. The percent of children underweight or undernourished in Zambia has increased, from 0.5% in 1991 to 20% in 2006.[60] Some progress has been made when it comes to access to safe drinking water but still 47 % still does not have access to safe water. This is especially high in the rural areas.

3.2 The agriculture sector

The following information about the inputs to and outputs from production has been obtained through discussions with the farmers and with CFU in the region of Mumbwa. This is the general picture as we perceived it in Mumbwa and the description could be different in other parts of Zambia.

Inputs to production

Inputs used in small-scale agriculture, such as seeds, fertilizer, herbicides and tools to produce are acquired with economic resources that the farmer has obtained from the previous period of farming. Long-term saving is not common among the farmers in Zambia and credits are generally given only to those with titled deeds[61] or to those who can show other proof of material security. External effects, such as drought, lower the output of farming and the income of the farmers.

Machines are only affordable for medium- and big-scale farmers and machines demanded by small-scale farmers, such as cultivators, are difficult to find on the market. Fertilizer and seeds are commonly distributed through the national Fertilizer Support Program (FSP), selling subsidized inputs and giving out loans. Many farmers point at the flaws of this approach when it comes to the repayment of loans, the distribution among farmers and the time of delivery. Farmers also report complications in the distribution of herbicides, mostly because they are expensive, but also because of insufficient supply. The use of herbicides is also limited by previous misuse due to which some farmers now view it as something unbeneficial.[62]

[58] Human Development Report. (2007). p. 260.
[59] The Norwegian council for Africa. [Electronic resource].
[60] Human Development Report. (1993 and 2007). *Statistical annex*.
[61] Most land in Zambia is traditional, meaning that the farmer does not have legal possession over his or her land. Titled deeds is a proof of legal possession and a long process is required to get it.
[62] Gaffney, Meredith. CFU. [Interview]

Labor is an important input to production. Among the farmers we interviewed, labor is mainly done by the closest family, school-going children included. Sometimes farmers work for others or hire labor. When labor is hired, it is mostly by farmers with good access to land but few family members or farmers without ADP. The people hiring labor say that this delays their planting since the hired worker has to finish her/his own field first and therefore often comes late in the year. A delay in planting the seeds has negative effects on the yields; normally the planting should be done in mid-November when the first rains come. Working for others is mostly done by farmers not yielding enough for their own consumption and therefore they work for acquiring food. Other farmers, with access to ADP work by ploughing other farmers' fields after finishing their own.

The farmers learn the production process from parents, neighbors or relatives. Additional knowledge is acquired from organizations that teach different methods of production, such as CF. The most active organization working for the spread of CF practices in Zambia is CFU. Field meetings where farmers are introduced to this method are organized four times per year. Those who are interested in trying CF get further assistance from the field officers. CFU does not provide any inputs apart from knowledge.[63]

Output from production

The staple crop for Zambian farmers is maize. This is the crop that is most easily stored, the only crop the national Food Reserve Agency (FRA) buys and the main ingredient in the national plate *nshima*[64]. The farmers start their harvest in April and the harvesting continues until June. The price of the maize is set by the Zambian government who usually sets the price in May or June which is often later than the farmers wish to sell.

FRA only starts buying crop after the government has set the price. Many farmers report they would like to sell before the price is settled and this has given rise to so called "briefcase buyers"; businessmen coming to the villages to buy maize with cash, before the price is settled, allowing them to buy at a lower price. The briefcase buyers buy the crop in buckets, not in 50kg bags as is usually used, giving them more crops per paid amount. If the farmer chooses to sell to FRA it often takes several months before the payments arrive. Some farmers also sell on the local market.

[63] More information about the work of CFU can be found in Appendix 1.
[64] Nshima is the traditional maize porridge accompanying most meals in Zambia.

3.3 Farming in the region of Mumbwa

This part begins with a short description of the farmers in Mumbwa, separating the answers from CF-farmers and conventional farmers in the following sections. The information in this section has been obtained through interviews.

The majority of the interviewed farmers have access to an area of 6 hectares or less. Maize, cotton, soya and groundnuts are the main crops but cassava, cowpeas, sugarcanes, beans and sweet potatoes are also cultivated. Most farmers grow three different crops or more, and all farmers grow at least maize. The crop is used for own consumption and/or sold in a non-standardized way, in contrast to big-scale farmers that sell their crop systematically to commercial retailers.

The farmers interviewed are between 32 and 83 years old with the average age of 51 for the total group. All of the farmers have gone to school; 15 of the farmers have gone to some degree of primary school (grade 9 or less), 8 of the farmers have gone to some degree of high school (grade 12 or less) and one has gone to university. All but one (the farmer with university degree) have farming as a fulltime job. Approximately half of the farmers in both groups have previously done other types of jobs before committing to farming on a fulltime basis.

Differences in farming between CF and conventional farmers

Among the CF-farmers, on average 4,2 different crops were grown on 6,9 hectares of land. 60% of the CF-farmers had access to ADP and 13% worked for others while 26% hired labor. 80 % of the CF-farmers grew enough crops to feed themselves and their family and 100% had food all the year, acquiring it by selling things, such as animals.

Among the conventional farmers on average 3 different crops were grown on 5,7 hectares of land. 40% of the conventional farmers had access to ADP and 50% worked for others while 40% hired labor. 30 % of the conventional farmers grew enough crops to feed themselves and their family and 40% had food all the year, mostly acquiring it by working for others.

General differences between CF and conventional farmers

The average age among the interviewed CF-farmers is 49,4 years with 8,4 years of schooling. 73% of the CF-farmers are male. Previous occupations dominating among this group of farmers are pastor,

headman, policeman and teacher and 60% of the CF-farmers had previously stayed in urban areas. CF-farmers have 7,8 children on average.

The average age among the interviewed conventional farmers is 54,4 years with 7,6 years of schooling. 60% of the conventional farmers are male. Previous occupations dominating among this group of farmers are government-related occupation and 60% of the conventional farmers have previously stayed in urban areas. Conventional farmers have 5,7 children on average.

The process of adopting CF

Most of the CF-farmers have heard about the method from CFU but some were also introduced to it by another NGO, Cooperative League of the United States of America (CLUSA). Four farmers have practiced CF more than 10 years but the average time with the CF method is 6 years. The main reason for trying CF is to get better yields since many of the CF-farmers did not get enough food with the conventional method. Other reasons are curiosity, a will to be self sustained, early planting, reduced fuel cost, reduced soil erosion, tiredness of migrating and tiredness of waiting for people to come and plough.

The adoption of CF practices has in most cases happened gradually. Most farmers start with a small plot of land, for example one lima[65], and after seeing the results go over to more and more CF until 100% adoption is reached. Some CF-farmers could describe the increase in yields from one year to another from when they converted from conventional farming to CF. The majority of the farmers interviewed, even conventional farmers familiar with the method, say that a lima grown with CF practices yields more than a lima grown with conventional farming. Most farmers in CF could very precisely describe the changes in output from year to year. Farmers farming with CF for several years stated that soil erosion had decreased and that the quality of the soil was improved.

Several farmers say that the adoption is difficult at the beginning; it is hard to dig basins and to get the technique right. On the other hand, farmers having used CF for a longer period state that after using the technique for a while the method was not difficult and did not demand more labor than the conventional one. When it comes to weeding the farmers do not agree on the outcome. Some claim that the weeding is more labor demanding since the adoption of CF, others say that they could see a decrease in weeds after a couple of years with the method. The outcome also depends on the use of herbicides. Those not having money for herbicides claim that the weeding increases with CF.

[65] One lima = 25 m x 25m

The farmers using CF for less than 10 years state that they, since starting with CF, have been able to do at least one of the following things: put their children in school, open a bank account and purchase animals or pigs, goats and chicken, housing utensils, ploughs, iron sheets for roof, bicycles and one of the farmers had bought a vehicle. The farmers having used CF for more than 10 years have apart from some of the above mentioned things also invested in solar panels and electronic devices such as a telephone, radio or TV and one person has built a house of bricks (the most common housing is made out of mud).

Some farmers mention that CF allows them to plan their time in a better way. They divide the work over the whole year, instead of putting all the effort during a couple of intense months. CF-farmers also mention the sensation of finally succeeding with their farming as being one of the positive aspects of this new method. Some conventional farmers had previously tried CF during shorter periods. The reasons why they had not continued was that they perceived the labor inputs to be too demanding, some of them were old and could not manage the hard work demanded for basin digging. Some farmers said that basin digging is seen only as something for poor people.

Why do farmers choose not to adopt CF?

Farmers were asked to give reasons for why they thought other farmers had not yet converted to CF. We divided the factors into responses from CF-farmers and conventional farmers. Box 3.1 lists the factors given by CF-farmers for why some farmers have not yet converted to CF.

Reasons for non-adoption given by CF-farmers

- age
- lack of education
- habitude
- tradition
- fear more weeding
- lack of money or labor to start
- not convinced of the overall benefit
- misconceptions about CF
- lack of persistence and long-term view
- stubbornness
- fear of rejection by the community
- would need inputs other than knowledge (fertilizer, seeds)
- demean importance of change
- laziness
- pride
- lack of vision

Box 3.1: Reasons for non-adoption given by CF-farmers, ranked with the most frequent first.

According to several farmers age is a limit to the adoption of CF since the technique of digging basins can be physically demanding. The education of the farmer is also given as a factor affecting adoption/non-adoption; people with lower education can have more difficulties learning the method since they are not used to learning new things and since CF requires quite precise technique, for example exact size of the basins and distance between them.

Further factors of non-adoption given by CF-farmers are economic reasons such as lack of money and inputs. As we have previously seen, farmers in both methods say they have difficulties in acquiring the necessary inputs for farming and some farmers in CF think this might prevent other farmers from trying the method. The CF-farmers also talk about factors such as fear of taking risks, not knowing how much labor the new method will demand and what the benefit of it will be. They say that conventional farmers may not yet have seen enough proof of CF being more efficient to adopt the method. Some CF-farmers mention lack of persistence and long-term thinking as reasons for non-adoption. They say that it takes time to understand the ideas of the new method and to see the profit from it and that some farmers

might not take the time that is needed to do this. Others might try it but not be persistent enough to clearly experience the benefit of it.

Another reason that CF-farmers mention is tradition; farmers are reluctant to the new method precisely because it is new with the attitude "the old method has been in use by my grandmother and by her grandmother, who am I to change?". They mention the fear of the reaction of other farmers, especially if neighbors are reluctant to the method. Several farmers mention that some people are afraid of being looked down upon and laughed at by their community if they try the method. Some farmers using CF say their neighbors laughed at them when they started using the method because they needed to work in July and August when nobody else works but they persisted using it and now those laughing in the beginning are coming to work on their field. They think that some farmers might be prevented from trying CF by the community pressure.

Some farmers mention factors such as stubbornness, pride, laziness or an unwillingness to change referring to the fact that people are used to working with their farming during the rain period and the harvesting period but not in the months in between. Since CF demands continuous work throughout the whole year some conventional farmers refuse to try it, preferring to socialize or to do other things than farming when it is not necessary even if it is on the expense of their yield. One farmer thought that lack of vision was an important reason, and claimed that "some people enjoy being poor"[66], meaning that people do what they are used to do and they know that if they fail in their farming they can get food support.

Finally, CF-farmers thought that general misconceptions, especially fear of weeding, had a big impact on those not adopting and also that some people perceive basin-digging as something only used by poor people.

In box 3.2 the factors of non-adoption brought up by conventional farmers are presented.

[66] Mr. Nambwa. [Interview].

Reasons for non-adoption given by conventional farmers

- cannot afford fertilizer and without fertilizer the farmer gets similar yields with CF as with the conventional method
- lack of knowledge about CF
- age
- hard to dig basins
- health
- too few in the family to work in the field
- would need to hire labor
- lack of education
- not convinced of the overall benefit
- arrogance
- misconceptions
- price of seeds and fertilizer
- fear of weeds
- tried CF but basins got filled up with water
- used to animals - therefore tiresome to dig basins

Box 3.2: Reasons for non-adoption given by conventional farmers, ranked with the most frequent first.

Conventional farmers give among other reasons age, education, lack of money and inputs to farming as reasons for non-adoption. They say that lack of knowledge about the method prevents them from trying it. Some farmers say that they have not come in contact with the method and others, already familiar with the method, say that they do not know enough to dare to try it. Some conventional farmers think that CF is more challenging to use since the basins are harder to dig than to plough or ridge the planting areas. Others mention that they or other conventional farmers have too few family members and cannot afford to hire labor force to help out in the field and since CF is a labor intense method this keeps them from trying it.

Some conventional farmers state that the problem of acquiring fertilizer is a reason for not adopting CF. They claim that they would get the same yield in the two methods if they do not use fertilizer, and therefore there would be no use converting to CF. People working at CFU say that the method is superior even without fertilizer but that the effect is much more evident with the use of fertilizer.

Some conventional farmers had tried CF but stopped after the basins got filled up with water and the yields were destroyed, others had previously had oxen/cattle and were not used to the work of digging basins. Only a few conventional farmers mentioned mindset factors as the reason for farmers not adopting CF. As with the CF-farmers, misconceptions, not seeing the difference between the methods and fear of weeds came up as reasons for farmers not to adopt, but also arrogance was mentioned.

These factors, given by both CF-farmers and conventional farmers will be categorized and analyzed further in chapter 4.

Apart from the responses from the farmers, interviews were carried out with CFU and other organizations linked to agriculture and CF[67]. In all of the interviews the importance of the mindset of the farmer was stressed and was perceived as the most difficult thing to change to improve adoption rates. Mark Woods at the organization PROFIT explained the non-adoption as being "*a natural process*"[68] – farmers are risk averse because they have limited resources and because they do not know the outcome of a change of method of farming. He exemplified with farmers putting increased income on new clothing instead of investing in a more efficient farming method that would give them an even higher output. They do this since they know what they will get out of the purchase while an investment in a new method is perceived to be risky. According to Mark Woods, to adopt CF to a larger extent the farmers would need more confidence. He emphasized the perception of farmers; what farmers see as risk is more important than the risk seen from the outside because it shows the reality facing the individual farmer. To increase the confidence of farmers, he continues, the most important things surrounding them need to work and to be integrated, such as infrastructure, the market for inputs and outputs, as well as the possibilities to acquire knowledge, skills and attitude. There is a lot of responsibility on the individual. If you give a farmer a box of tools, the farmer must have the knowledge, the skills and the attitude to be able to use it, otherwise the box of tools will be useless.

[67] Interviews were made with Mark Woods (Profit), Mike Mailloux (CLUSA), Sina Luchen (FAO), Meredith Gaffney (CFU) and Yvonne Nakacinda (CFU).
[68] Woods, Mark. [Interview].

4. Analysis

The questions presented at the beginning of this report will now be discussed, with guidance from the theoretical framework and the indications from our results. One question at a time is treated.

4.1 How has the adoption of CF affected the capabilities of the farmers using it and hence the possibilities of poverty reduction?

When meeting the farmers we got several indications of expansion of their capabilities, an increased ability to enjoy "beings and doings" as seen valuable to them, after the start of CF. Naturally, since preferences vary, these "beings and doings" differ between different farmers. Generally, an increase in farmers' utility can be seen by a use of CF since CF increases the yield and therefore the income that the farmer gets which makes it possible to acquire more goods and commodities. The characteristics of these goods will help the farmer to meet needs that might not have been satisfied before, for example the nutrition in food will satisfy hunger. With increased income a farmer can also put more resources to health and education that increases her/ his functionings.

Looking at the basic need of nourishment, all of the CF-farmers had food for the whole year and 80% had grown this food on their own. In the group of conventional farmers that we interviewed only 40% had enough food for the whole year and 30% of them had grown their food on their own. The lack of food was one of the main reasons for trying CF. Before adopting CF, many of the CF-farmers did not have enough food throughout the year. With this new method the yields had increased which gave them enough food and also the possibility to sell more of their output on the market. Selling on the market gave the farmers means to invest in other commodities than food; some made investments in new equipment for farming, others made improvements in their housing, some bought bicycles, and overall they had bought more animals than farmers in conventional farming. Investments were not only made in material commodities, some CF-farmers reported being able to start sending their children to school after starting with CF and therefore invested in the future of their children.

When it comes to the labor input of the two methods, the difference is that CF implies an early start and a bit of work each day instead of all the work during a couple of months. This demands an ability to plan from the farmers but gives on the other hand a more stable work pace. Some farmers stated that farming with CF had given them more free time. The problematic aspect is that CF might not be compatible with the norms of the surrounding society, where most people still work intensely during a couple of months and the rest of the year there is more time for socializing or working with other projects. CF can therefore imply that the farmers' capabilities in the social aspect will diminish in the

beginning before CF is more accepted as a new kind of farming method. Although, as some CF-farmers stated, they could plan their time better. The fact that the work is spread out during the year imply that socializing is possible even with the new method, but it requires some planning which can be hard in the beginning before knowing the method well.

The problems with the unsustainable cultivation of the land, such as deforestation and the burning of residues seemed to diminish with the use of CF. For the farmers in CF many stated that the soil erosion was reduced and they did not have to move as much as before. Many farmers experienced a sensation of security since droughts affected them less than with the old method.

One flagrant difference between the farmers in both groups concerned the hiring of labor and working for others. CF-farmers did not work for other farmers or hire labor force as much as conventional farmers did, 13 % of the CF-farmers worked on other farmers' fields and 26 % hired labor. The group of conventional farmers on the other hand had 50 % working for others and 40 % hiring labor for their fields. The difference lies not just in the share of farmers working for others or hiring labor, but in the way this is done.

There are different ways of working for others. Farmers with ADP can offer to plough other farmers' fields with their oxen and those without ADP can offer to work on the field with their own manpower, the latter giving a lower remuneration. When CF-farmers work for others they most often offer to plough other farmers' fields with ADP. Conventional farmers on the other hand most often offered to work on others fields when they were lacking of food. This can be seen as a vicious circle for the conventional farmers. When not having enough yields they will work on other farmers' fields which gives them a lower remuneration and they are often just paid with food. If the farmer would have spent the same time on their own field they would most likely earn more if their field was used in an efficient way. The low earnings and the fact that time is spent on developing someone else's field prevents them from devoting themselves to their own which continues the inefficient use of their field and makes them even more dependent on other people. The fact that they are mostly paid with food instead of money also hinders investments in input material which further limits the use of their proper field.

The hiring of labor contains the same problematic aspect as working for others. The CF-farmers tend to hire labor when they need an extra hand on their fields, usually for more intense periods of yielding or weeding the fields. Since the work in the CF method is spread out over the year the farmer is less dependent on when the hired labor can work for them. The conventional farmers on the other hand usually hire labor to plough their field. The timing of the ploughing and the planting of seeds is crucial in the conventional method, to get the biggest yield possible the planting should be done just after the first

rains in November. There are two main problems for these farmers. Firstly, the hired labor force has to be remunerated from the farmers' already limited resources. Secondly, the farmers that will plough the field often have to finish their own field first before coming to other farmers' fields. The fact that conventional farmers employ labor to a larger extent probably delays their planting and reduces their yields even more. The fact that conventional farmers hire labor to a larger extent accentuates that the standard of living is lower in this group.

Tendencies of capability expansion for the farmers in CF could be seen but both these farmers and the conventional farmers had difficulties with the surrounding environment limiting the expansion of capabilities and the incentives for production. Farmers in both groups stated that they met difficulties acquiring inputs for production. One of the main problems was finding fertilizer on time, but also seeds, tools and herbicides. Late deliveries of fertilizers created disincentives since farming without fertilizers will yield much less output or even nothing. Since fertilizers arrive late and therefore cannot be used to their full benefit and since farmers have scarce resources they might choose other priorities on something where the benefit is given, rather than invest in their farming.

When it came to the output from production, most CF-farmers and some of the conventional farmers managed to produce enough to sell their output on the market. The output sector has, as the input side of farming, limitations. The farmers have several options of how to market the output. They can sell output to FRA, to "brief-case buyers" or on the local market. The highest price is offered by the FRA but FRA both announces their prices late and gives out late payments. Farmers in need of money will therefore sell their output cheaper on the market or to "brief-case buyers" which will lead to a loss since they could get a higher price for the crop if they chose to wait. On the other hand, time also has a value and waiting to get paid by the FRA apparently costs the farmers more then the loss they occur by selling to a lower price. With other words, the farmers discount the future value at a high rate and prefer to have the money today. This creates a market for the "brief-case buyers" because the farmers have a need of selling as soon as possible. If the farmers have to wait for the money, investments in inputs such as fertilizer and seeds for the next season will be delayed and it could affect the outcome of the next season.

Whether or not the increased yields and higher independence with CF is translated into capability expansion is not certain. We have seen indications of increased consumption and more independence but also that the new method has social implications and that it is limited when it comes to inputs and outputs in the same way as the conventional method. The increase in yields for the CF farmers is although important. The satisfaction of basic needs such as hunger is crucial for developing other aspects of life. The lack of hunger can give the farmer more energy to focus more on for example developing

their farming and on increasing their knowledge in different areas. The fact that CF farmers, compared to the conventional farmers, tend to have more crops, ADP and more land on average could be a sign of this.

CF could play an important role for the rural population since most of the poor live here. It could also affect to what extent people decide to move to the urban areas where their access to own production possibilities is lower. Therefore CF could be an important method since it has the possibility to increase yields and therefore farmers are more likely to stay in the rural areas and if they decide to leave for the urban areas they will have more means to create a decent life in the city.

From the discussion above we have seen some signs of capability expansion for the farmers in CF. We can never be certain that these improvements are only due to the adoption of CF but the difference was there and according to the farmers it had started with the change of production method. How do these changes in the farmers' capabilities affect economic growth? This will be discussed in the next section.

4.2 Can CF be an efficient tool for economic growth?

We have seen that an increase in the capabilities of farmers possibly have occurred, but what does this imply on a macro level and especially when looking at economic growth?

In the Solow model we saw that economic growth can be measured by the change in GDP, the total output of goods and services in a country at a point in time. Even though the economic growth in Zambia has been positive, with an average of 4.8% per year the last ten years, the levels of poverty are still high. This has probably been due to the fact that most of the growth has been concentrated to the mining and construction sector with small trickle-down effects while the large majority, 70% of the population, works in agriculture. Zambia has a good climate for agriculture that allows cultivation of many different types of crops, yet the land is not used optimally. The work in agriculture is often done on a small-scale basis and for own consumption. To reduce poverty in Zambia and increase the economic growth agriculture production needs to be done in a more efficient way, how is this achieved?

Total output depends on the inputs of capital, labor and knowledge. A large majority of the Zambian small-scale farmers live in poverty or extreme poverty and their assets are limited. They have given amounts of capital that they can put into their production and due to lack of savings this capital largely depends on their production the preceding year. If it is a bad year the yield can be insufficient even for nutrition, resulting in low or non existing investments in the production the next year. If the yield is

enough for nutrition the farmer can sell some of it and invest the earnings in fertilizer, herbicides or tools for production. The earnings can also be invested on other things such as clothes or housing and sometimes a preference to this kind of consumption was observed. Perhaps this is due to the risk associated with investments in production. The farmer can never be certain that the investments will pay off while the investments in concrete things, such as food or clothing are tangible and their benefit is direct.

Most farmers that we met put all of their labor on their farming, indicating that this factor of production cannot be increased either. On the other hand the labor is concentrated to a period of four to five months of the year which means that a redistribution of the labor throughout the year is possible. A redistribution would enable more planning and an earlier start of preparations for the rain season, which could possibly enable a more efficient use of the inputs to production. In fact this is one of the things that happens with a change of production method to CF. The labor is spread out more evenly throughout the year, lowering the pressure on the rain season and allowing more time for planning. On the other hand, preferences differ for how free time is organized. Some farmers probably prefer to have all the free time concentrated to one period of rest than to work the whole year with a bit of free time every day.

What about the third factor of production, knowledge? According to the Solow growth model the amount of output obtained from given quantities of capital and labor rises over time only if the amount of knowledge increases. In Zambia the level of adult illiteracy is high, being on a level of 30% in 2007. On the other hand the production process in agriculture is learned from parents or other people in the surrounding and does not demand a high level of formal education. Further improvements, such as the technique used in CF, can also be learned in a similar way. When farmers learn improvements in the production method, hence when their level of knowledge about the production process increases, the production can be done in a more efficient way. In other words, the inputs of capital and labor are used in a more profitable way, that is to say their factor productivity increases. This results in a higher output from given levels of capital and labor. If many farmers in a region improve their method of production and increase the productivity of their inputs, the economic growth in this region is raised. CF is using capital and labor in a more efficient way than the method conventionally used in Zambia. It is proven to give sustainably higher yields over time compared to the conventional method used in Zambia, which was also confirmed by our field study. Hence, a change of production method, from the conventional method to CF, can contribute to a permanent rise in the economy's growth rate.

CF can be seen as a new idea (for the region) of how to farm more efficiently. The practices of CF are non-rival since the knowledge is accessible to each and every farmer that has an interest in the new method and since the CF practices are spread from farmer to farmer and through NGOs with no profit

motive. The problem with non-rivalry is that it can take away the profit motive which usually encourages further developments of new ideas. Easterly points out that innovations occur and spread mainly as a consequence of the economical maximization of profits. Romer, on the other hand says that there exists an inner creativity in innovators and people who want to spread innovations that leads to the development of new ideas. CF is a mix of these two theories. As we have seen, it is developed and spread by organizations with no profit motive, but farmers using the method have such a low income that every increase in output is highly valued. They want to develop the method to maximize their own profits. This makes the incentives to improve the method high since it is directly linked to the farmers standard of living. CF also has the characteristics of being non-excludable/ partly excludable, since every farmer with access to land and the right tools can use CF with the knowledge about the method.

Since CF is a method that has been in use for a while, discoveries in CF could make new improvements easier and maybe even facilitate the development of other more efficient methods. Another way to create ideas is actively devoting resources to R&D. According to Romer, more resources to research would yield more discoveries. This implies that an improvement in the method of CF could happen if more resources were devoted to research in the method, for example resources from the government and/or from private enterprises with an interest in farmers yielding more crops. On the other hand, a natural development of the method is happening due to creativity, as we saw in the previous paragraph.

The empirical material collected and previous research shows the potential of CF when it comes to increasing output and therefore contribute to a higher income for the farmers. Higher income can result in new investments and an improved standard of living. Thus CF has the potential of contributing to growth, but to be a real tool for economic growth there must be an increased rate of adoption. The following section will discuss CF's characteristics as a new innovation and what affects the adoption of it.

4.3 How come CF, which is proven to be a more efficient production method, is not adopted to a larger extent in Zambia?

Differences between CF and conventional farming

CF can be analyzed as a new innovation by looking at the attributes described by Rogers in chapter 2.3. When looking at the *relative advantage* of CF it is proved to give a higher output which enlarges the security of the farmers, but the farmers perceive other things that affect their choice of adoption. Farmers state that there is more labor initially; they need to learn the new method and the basin digging can be challenging if the farmer is not familiar with the technique. Some farmers claim that they put

more time into weeding than with the conventional method. According to CFU and the field officers the weeds are there with the conventional method but with the ploughing of the soil the farmer cannot see them. On the other hand when the farmer decides what to do it is based on her/his perception. Another relative advantage of the CF method is that the work starts early which gives the farmers more control of their time and hence more free time per day. However, the farmers that prefer not to work the whole year can perceive this as a disadvantage.

There is also a social aspect of the use of CF. Since some farmers have a disapproving attitude towards the method they can laugh at neighbors that use it since they dig basins and have to work the whole year. On the other hand, if the farmer that has adopted CF succeeds with her/his farming this can turn into an advantage. As one farmer stated: "*In the beginning they laughed at us, but now they see the results, now they come to ask us for help*". [69]

Conventional farmers need a method that increases yields for food security and improvements of the soil. Therefore there is a need for the most part of Zambian farmers for a new method of farming. Farmers successful in CF had seen increases in soil fertility over the years, and they have not been forced to move. Though, the new CF method is not completely *compatible* with the old farming method since the old method allows more free time, hence more socializing during the dry seasons. The farmers trying CF are risking being left out since they have to work all year. Thus, a convertion to CF can be difficult for farmers that wish to socialize as before and this is important to take into account in the spread of CF since cultural patterns are difficult to change. It can also be perceived by some farmers that there is an increased time in weeding and high initial labor. Some farmers also perceived that the labor time in weeding would increase with CF and therefore would give them less free time.

When it comes to the *complexity* of the method most farmers using CF admitted that they struggled with the method the first one or two years. The method requires quite precise depth of the basins and the distance between them as well as planning. No one considered it as being difficult after learning the technique. It is possible that the perception of CF being difficult might prevent people from trying it.

The *trialability and observability* of CF are high since the method can be used on a limited amount of land the first year to see the difference. All CF-farmers started with a small amount of land, for example with one lima the first year, and then expanded when they saw an increase in yields. This lowers the risk that can be experienced with trying a new production method since farmers can still continue to use the conventional method. The results of CF cannot be seen immediately, but those not using CF can see the

[69] Mr. Jackson. [Interview].

fields of farmers already applying CF techniques on their field and see the difference. This implies that someone has to start to inspire others.

To conclude, although CF can be perceived as a more complex way of production and not completely compatible with the old method, its relative advantage, the fact that it is easy to try and observe the differences can motivate the spread to a larger group of farmers. This will be discussed further in the following section where the adoption and non-adoption is discussed more profoundly.

Who adopts CF?

As of today, approximately 10 % of farmers in Zambia have adopted CF. Following Rogers' "Adoption of new innovation"-curve, CF-adopters would therefore be in the categories of innovators or early adopters. The organizations working for the spread of CF would need to reach the early majority to get a breakthrough. Rogers described the early majority as similar to the innovators and early adopters, but that they need a longer period to reach a decision of whether or not to adopt. We will look at the behavior of the early adopters to see where the focus should lie to reach the early majority.

When it comes to the characteristics of the early adopters of CF it is hard to draw general conclusions with such a small sample of farmers, but it is possible to see tendencies. We divide the discussion around the three categories given by Rogers; the socioeconomic characters, personality variables and communication behavior.

When looking at *the socioeconomic characters* we could, from the sample of farmers, see that age, according to Rogers' predictions, did not seem to be of great importance over the choice of adoption. Neither education, that normally is a characteristic of early adopters, seemed to matter. But from the interviews made we got the perception that CF-farmers were more engaged in their farming. This can be a sign that the informal education level is higher and that many of the CF-farmers are autodidact. One farmer revealed that since he started with CF he had read almost everything on the subject, and that he is always up to date with new developments in the method. Another remark was that basically all the farmers in CF were fluent in English, but with many of the conventional farmers an interpreter was needed, which can also be an indicator of informal education level. The CF-farmers that previously had other occupations had usually been employed in high status sectors and some farmers had also been/were at present headmen of their village. Others had been selected by CFU as lead farmers or farmer coordinators as a result of their success in CF-farming and their engagement for the new method.
Rogers suggests that innovators have larger production units, which was confirmed by our results. CF-farmers had on average 6,9 hectares compared to 5,7 hectares farmed by conventional farmers. This can

be seen as another sign of higher income of CF-farmers. The difference is not large, but the method does not require large units of land. It can even be difficult to handle big plots of land considering the constraints in inputs such as fertilizer, seeds and labor.

In Rogers' theory of diffusion of innovations different *personality characteristics* that are typical for early adopters are described. We find it difficult to find tendencies with just a sample of 25 interviews but the slight indications we could see are presented below.

Rogers mention that early adopters usually are more emphatic, less dogmatic and that they can deal with abstractions. CF-farmers were more active during the interviews, seemed more curious and were willing to share their experiences. They also seemed to have a good sense of how to plan their work to achieve the good results in CF, since CF requires more planning than the conventional method. The farmers in CF also seemed to have high aspirations, not just in farming but in everyday life. As one CF-farmer put it: "*the secret is ambition*"[70]! It is difficult to say if these tendencies are a natural characteristic of the individual or if they are a result of their increased capabilities from CF.

According to Rogers, innovators are more willing to change and face risks more easily. Most rural farmers are facing risks, and the stake is crucial, a failure could lead to starvation. Since the use of CF does not exclude the continuation of a use of the conventional method, the risk associated with trying CF does not have to be high. Although, a favorable attitude towards change is probably needed.

When it came to the *communication behavior* of the CF-farmers, the social participation seemed to be higher; they were sometimes hosts for CF-meetings and field days and they seemed to have good relations with their farming neighbors, even the conventional ones. They had more contact with change agents – one CF-farmer was the test farmer for newly developed maize grains and showed his fields for future clients. As a test farmer he could quickly adapt to the most successful grains and therefore receive even higher yields. They were up to date about CF and the latest news.

Reasons not to adopt CF

In chapter 3 we listed reasons for not adopting CF, separating the responses from the farmers already using CF and those in conventional farming. In this section we have roughly divided the factors mentioned into concrete and mindset factors for non-adoption.

[70] Mr. Nambwa. [Interview].

Factors for non-adoption, as perceived by the CF-farmers are shown in table 4.1:

Concrete factors	Mindset factors
- age - lack of education - lack of money or labor to start - would need inputs other than knowledge (fertilizer, seeds) - tradition	- demean importance of change - not convinced of the overall benefit - fear of rejection by community - lack of persistence and long-term view - habitude - stubbornness - pride - laziness - lack of vision ; "*some people enjoy being poor*"[71] - misconceptions about CF - fear more weeding

Table. 4.1: CF-farmers' opinions about factors affecting non-adoption of CF.

When it came to farmers in conventional farming, the answers were slightly different if looking at the division between concrete and mindset factors. The factors perceived as most influential on the decision of non-adoption are seen in table 4.2.

[71] Mr. Nambwa. [Interview].

Concrete factors	Mindset factors
- age - lack of education - health - would need to hire labor - price of seeds and fertilizer - lack of knowledge about CF - hard to dig basins - too few in the family to work in the field - cannot afford fertilizer and without fertilizer the farmer gets similar yields with CF as with the conventional method - basins got filled up with water - used to animals - therefore tiresome to dig basins	- arrogance - fear of weeds - misconceptions - not convinced of the overall benefit

Table 4.2: Conventional farmers' opinions about factors affecting non-adoption of CF

When comparing the two tables we see that the conventional farmers put the emphasis on concrete factors affecting their non-adoption of CF, whereas the CF-farmers mostly stress the mindset factors. The farmers already using CF have seen the benefits from it and explain the non-adoption of CF due to mindset factors. They claim that non-adopters are afraid of change, have a tendency to stay with old habits, stubborn, lazy or are too proud to try it. The conventional farmers tend to give reasons such as age, lack of education, health, lack or labor force or knowledge for not adopting CF. Sometimes they already tried the method but failed, sometimes they perceive CF as more difficult to use or more demanding in terms of inputs. Many of the concrete reasons given for non-adoption reflect the conventional farmers' perception of the method that it might be difficult or more labor intense. These factors could also be seen as mindset factors since they often concern their attitude towards change and how the method is perceived by the farmers. Even though the employees of organizations such as CFU consider these concrete factors as misconceptions, they should be taken seriously. It is the farmers' perception that in the end will decide whether or not the farmer will adopt the new method, because the reality for the farmer is his/her perception. It should therefore be of concern for the organizations to understand the reality of the farmer when spreading the method to be able to present the method in a way that speaks to the farmers needs.

5. Concluding thoughts

As a reminder, the study aims to explore the implications of CF on economic growth and why CF, which is proven to be more economically efficient than the method most commonly used, is not adopted to a larger extent in Zambia.

The adoption of CF has been shown to give higher yields over time compared to the conventional method used in Zambia which was confirmed by our study. Indications of increases of the capabilities of farmers that we have interviewed have been seen. Hence CF could play a major role in the development of the rural areas of Zambia. An increased use of CF leads to a higher productivity of the inputs to production, it can therefore increase the economic growth in the region. For this to happen on a larger scale an increase in the adoption rate is needed. CF as a new idea is non-rival and non-excludable which should facilitate its spread. It can be used by all farmers with access to the knowledge and the work by organizations such as CFU makes the knowledge available to a large number of people.

CF might not be completely compatible with the old method since it demands a different pattern of labor input and it can be perceived as a more complex way of production but it is easy to try and observe the differences and it has a relative advantage in the high yield increase which should matter for farmers. The perception of the complexity and the relative advantage of CF would need to change among farmers for it to achieve a higher spread. The mindset of the farmer and his attitude towards risk seemed to affect the adoption to a large extent. Therefore it would be interesting with a future study of the effect of farmer's attitude towards risk on adoption behavior.

The adopters of CF did not differ remarkably from the conventional farmers. Only minor differences between two groups were perceived; adopters were slightly younger, seemed to have a higher informal education level and during interviews they appeared to be more open and curious. In CF, the ability to plan time in a good way is important and numerous of the adopters seemed to possess this quality. They also seemed to have a better connection with the surrounding community.

Both CF-farmers and conventional farmers are limited in their production due to market inefficiencies and other factors in their environment. It would be interesting with a study focusing on the limitations facing small scale Zambian farmers as a result of the existing market failures, both on the input side as well as on the output side. For example, would the supply of fertilizer be better with a private supplier? How is and how can the private sector get more involved in the spread of CF? Could this lead to higher incentives for adoption?

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Appendix 1: Conservation Farming principles

According to United Nation's Food and Agriculture Organization (FAO) CF is defined as a method for resource-saving agricultural production that strives to achieve profits from agriculture as a result of higher production levels and conservation of the environment. Mechanical soil tillage and other interventions are reduced to a minimum, and external inputs such as fertilizers and herbicides are used at an optimal level to avoid interference with the biological process.[72]

The methods used in CF seek to reduce unnecessary tilling and mixing of the soil. There are three main principles of CF[73]:

(1) *Direct planting of crop seeds;* growing crops without using mechanical seedbed preparation, such as ploughing, and minimizing the soil disturbance after harvesting the previous crop.

(2) *Permanent soil cover* is important to protect the soil from the exposure to rain and sun, to provide the micro- and macro organisms with nutrition and to alter the microclimate in the soil to obtain optimal growth.

(3) *Crop rotation* is necessary to offer diversity in nutrition to the microorganisms that operate in the soil. Different crops also use different layers of the soil and can therefore maximize the nutrients in the soil. The crop rotation leads to a diverse soil flora and fauna which plays an important role in transforming plant nutrients in the soil; it will furthermore prevent the spread of plant specific diseases and pests from one crop to another.

It is sometimes difficult to decide whether a farmer is a true adopter of CF. A farmer may use some of the methods described above, but all of the criteria's above need to be adopted for a farmer to be considered as a CF-farmer.[74]

The most active organization working for the spread of CF in Zambia is Conservation Farming Unit (CFU). CFU works with educating and inspiring farmers to adapt to this method of farming. They work with a system of field workers, farmer coordinators and lead farmers. The field officers' work is to inform farmers about the methods of CF, to do this they arrange meetings and field days where knowledge is shared about CF and how to use it. Their work also includes meeting farmers on a regular basis to see

[72] Food and Agriculture Organization of the United Nations (FAO). [Electronic resource].
[73] Ibid.
[74] Conservation Farming Unit, *Users Handbook Manual*, 2001.

the progress made and to help with eventual difficulties. Each one of the field officers works with ten *farmer coordinators* whose major role is to train the farmers in CF and also collect reports of the performance of the program. The farmer coordinators work with another ten farmers, called the *lead farmers*. The lead farmers are then responsible for thirty farmers each and their role is to organize her/his group members by supplying training materials and arrange training venues on behalf of the farmer coordinator. To reach out to more farmers a new approach has started in 2009 which involves the headmen in each village.

Appendix 2: Questionnaire

General

- Age of farmer?
- Male/Female?
- Education and previous occupations?
- Previous stay in urban areas?
- Family-members?
  - Their age?
  - Children in school?
- Landownership? (Titled deeds/Traditional land)

Farming, general

- How many hectares are used for farming?
- How many hectares are used for conventional farming and how many for CF? [1]
- What crops/legumes are grown in each field?
- For how long have you been farming?
- Do you use hand hoe farming or ADP? [2]
- Do you grow enough maize to feed yourself and your family? Do you have food for all the months of the year? For how many months do you lack of food?
- Do you sometimes during the year work for somebody else? Or do you sometimes hire someone to work for you?
- Own, borrow or rent animal draft power? If no ADP, have you had it before?
- What are the major expenditures during the year?
- Where do you sell your maize?

Conservation Farming

- Have you heard about CF? *
- Have you considered using it? *
- What would be needed to make you consider using CF? Can you mention a couple of things? *
- From whom did you hear about CF? (CFU ext. staff, lead farmer, neighbour etc...)
- When did you hear about it the first time?
- What made you start using CF?
- How long have you been using CF?
- What do you think about CF? Advantages/disadvantages?

- Are there/ what are the changes in results since you started using conservation farming? (1st year, 2nd year, 3rd year…)
- Do you find it difficult to use CF compared to conventional farming?

Economic factors affecting the choice of CF *(if conventional farmer, the perception of CF)*

- What are the most difficult inputs (for the production) to acquire?
- With CF, do you use more or less of:
  - seed
  - land preparation
  - fertilizer
- With CF, more or less time in labor for:
  - land preparation
  - weeding
- Have you seen a change in labor requirements since you started farming with CF?
- Draw map for labor requirements for the past season.
- Do you find it difficult to use CF compared to conventional farming?
- Do you find it difficult to replicate what you have learned in CF training?
- If you do not have a handbook, can you remember how to practice CF?
- If you have one lima of CF and one lima with conventional farming, which one gives higher yields?
- Since you started using CF, have you been able to purchase more of: [3]
  - ADP
  - bicycles
  - roof
  - other (animals, solar cells, schooling, etc.)

Expansion

- Are you planning to expand with CF?
- Why/Why not expansion?
- What would be needed for you to expand to more conservation farming?

Comments and critiques on our questionnaire

1. We did not ask all the farmers how much of the land was farmed in CF/ conventional and how much land they had in total (apart from the land that is being farmed).

2. Sometimes we asked if the farmers had ADP, sometimes if they had animals which is not the same thing.

3. We did not ask the farmers in conventional farming if they had been able to purchase things the last couple of years. Could not ask this to someone who did not have food for the whole year.

*Only asked farmers in conventional farming.