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MALI 2035

The Future of Child Malnutrition In a West African State

A Forecast for the United Nations Development Programme
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OVERVIEW

The purpose of this study is to provide the United Nations Development Programme (UNDP) with information necessary to formulate policies that help reduce child malnutrition in Mali. The amount of malnourished children in this West African country varies between 30% and 40% according to different sources and definition. The UNDP and other organizations announced the Millennium Development Goals that contain the target of decreasing the proportion of malnourished children by half between 1990 and 2015. For Mali, this target looks almost unachievable. In order to fulfill the goal, existing forecasts suggest extending the period to 2035. However, no forecast is available that specifically addresses this question.

This forecast looks at the nutritional situation in Mali during the next 30 years. It will introduce and analyze country specific variables that potentially affect Mali within this time frame. Critical events will be chosen that have a high probability to significantly affect the future nutritional situation in Mali. The impact of these critical events will be projected on a base line scenario from International Futures (IFs), which serves as a reference setting. The following critical events are identified: 1. technological progress helps increase Mali's national agricultural production; 2. declining revenues from gold exports; 3. increasing revenues from cotton exports because of decreasing subsidies for US and EU producers; 4. decreasing revenues from cotton exports because of armed conflicts in surrounding countries; and 5. a decline of foreign aid money combined with an increasing need of Mali for this help. Using Trend Impact Analysis, this study projects the impacts of these events on the base line forecast.

The findings of the forecast are that achieving the goal of halving the amount of malnourished children in Mali until 2035 is possible but very unlikely if the future unfolds according to the assumptions in this study. The UNDP should use these insights for advocating policies that would help the poor and hungry people in Mali and around the world. The levers of influence are: 1. encouraging rich countries and global industries to transfer new agricultural technologies to Mali and other third world countries as quickly as possible in order to help them to increase their national food production. This third strategy must be accompanied by efforts to assure the proper use of these technologies and the money dedicated to them – the UNDP has to install a supervising regime that prevents Mali's elite from misusing these assets; 2. convincing rich nation states of the importance of developmental aid and enabling them to take a long-term approach according to which poverty reduction, elimination of hunger, and a future reduction of developmental aid reinforce each other over a longer period; and 3. advocating a global trade regime that eliminates disadvantages facing third world agricultural producers (in the case of Mali it is cotton). If these steps are followed rigorously, the achievement of the hunger reduction goal for Mali between 2015 and 2035 becomes a probable, realistic future.

After defining the research questions, this report gives an overview of existing forecasts on related topics for Mali and Africa. In general and specifically for the case of Mali, the causes of hunger are explored. Based on this knowledge, critical events are identified that are likely to change the base line forecast of future child malnutrition. In the next step the methodology Trend Impact Analysis is used to produce a new forecast that builds and the base line and recognizes the critical events identified earlier. The paper finishes with interpreting the results of the forecast and formulating a very general policy advice for the UNDP based on critical events that can be used as levers for intervention.

PART 1 – AREA OF FORECAST INTEREST AND POTENTIAL CLIENTS

In this first part of the paper, the basics are laid out. It will provide a rough overview of Mali's poor economic, political, and nutritional situation. It will make the study's purpose and motivation clear and address the United Nations Development Programme as the major client. At the end, the main concepts of interest are discussed and the research questions are formulated.

Area of forecast interest

This forecast will focus on the future nutritional situation in Mali (West Africa). Mali is one of the larger West African states that has no sea borders. It is surrounded by Mauritania, Algeria, Niger, Burkina Faso, Cote d'Ivoire, Guinea, and Senegal. The value of Mali's Human Development Index (HDI) is 0.337. Its actual HDI rank is 172, which means that only three countries rank lower (Niger, Sierra Leone, and Burkina Faso) (UNDP 2003). Although the HDI places Mali at the lower end, its political system is regarded as fairly democratic. Both, the Freedom House Indicator and the POLITY-Project rank Mali according to its political freedom / democracy above most of its West African neighbors and the African and West African average (IFs V.5).

Mali's actual nutritional situation is serious. Both child malnutrition and overall malnutrition is persistent. In 2000, about 20% of the overall population was malnourished in accordance to calorie consumption. Child malnutrition was even higher, at 29% (IFs V.5). Other indicators show an even worse situation: between 1995 and 2001, over 40% of all children under the age of 5 were under weight for their age, an indicator that combines stunting and wasting (UNDP 2003).

Motivation and Client

This paper is motivated by the severe nutritional condition in Mali and the likelihood of continuance of this situation, which is expressed by different forecasting scenarios. The United Nations Development Programme (UNDP) is the main client of this forecast. Using the Millennium Development Goal No. 1 (MDG1), the UNDP addressed the global reduction of hunger explicitly as one of humanity's main targets for the future. The annual Human Development Report protocols the advances and backlashes towards this goal. In addition, several comprehensive national reports on the progress towards the achievement of the MDGs were written in the past. As of now, no report on Mali exists. Assuming the intention of the UNDP to publish such a Mali-specific report, the UNDP will be interested in this forecast. Findings of this project can help the UNDP to write a well-founded report on Mali and to promote steps that make Mali's achievement of the Millennium Development Goal No. 1 more likely. In addition to the interest in the topic, the UNDP also possesses the necessary funds and the moral authority to realize such a project.

Specific research question

This paper deals with the nutritional situation in Mali within the next 30 years. This forecasting period reflects findings of present forecasts, such as IFs' base case scenario (see figure 3). According to IFs, Mali will have halved its 1990 percentage of malnourished children by 2035. Halving this number is part of the Millennium Development Goals (MDG) announced by the UNDP and the World Bank, but, these institutions plan to achieve the goals by 2015.

Malnutrition can be measured in multiple ways. The two most common ones are malnourishment based on being under weight for age and malnourishment based on a lack of energy consumption. This paper will work with energy intake because of two reasons: first, it is very appropriate for national long-term studies (Millennium Project Task Force on Hunger 2004, 209) and second, in the case of Mali more energy consumption data is available than numbers based on weight. In addition to that, one can focus on overall malnutrition or child malnutrition. For the purpose of this paper it is appropriate to address child malnutrition. Many anthropological studies have shown that undernourished children are a very significant indicator for a bad nutritional situation in general and high levels of poverty. Children are usually the last social group that gets affected by hunger and malnutrition. Parents tend to provide their children with food as long as possible. Structural analyses of household spending show that feeding one's children properly has one of the highest priorities within one family or household. Therefore, if child malnutrition exists in a society one can also assume a very bad nutritional situation in general and the presence of high levels of poverty. Again, data for child malnutrition is often more reliable and easier available. To sum up, this forecast will look at undernourished children based on calorie consumption.

Methodologically, a history-based forecast of the amount of malnourished children in Mali until 2035 will be combined with a case study of the country. The goal of this case study is to develop a list of critical events, which might change the country's nutritional future as expressed through the base case scenario. In addition to simply addressing possible future events that are likely to affect Mali's nutritional situation, weight is given to the question of UNDP's potential responsibility. Since UNDP is not interested in having its role reduced to a mere observer, this report will also develop a list of possible levers for intervention. However, a specific policy plan is not part of this paper; the potential levers will be identified only. This project should be seen as a first step towards helping UNDP undertaking specific action to reduce the number of malnourished children in Mali.

The specific research questions therefore are:

1. *Which events are likely to affect the proportion of malnourished children in Mali during the next 30 years provided by the base line forecast?*

2. *How strong and in which direction can these events bend the base line forecast? In which ways are the number of malnourished children in the next 30 years likely to evolve?*

3. *Which levers for intervention exist that the UNDP can use in order to decrease child malnutrition in Mali?*

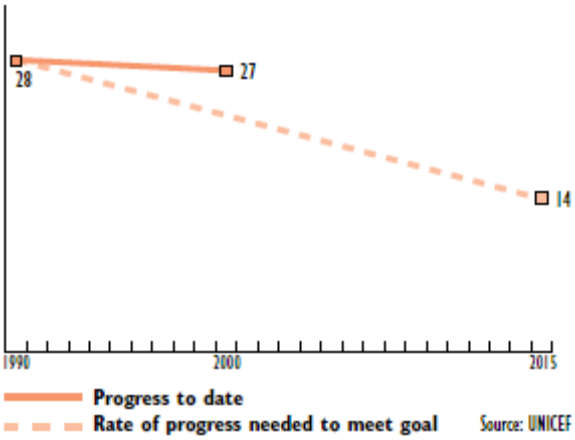
PART 2 – EXISTING FORECASTS, RAW DATA, AND CRITICAL EVENTS

In this part, existing forecasts of malnutrition in Mali and Africa will be presented. Further, it will show that the historic data on child malnutrition available for Mali are very rare and do not allow for a meaningful extrapolation. IFs' forecast will therefore be used as the base line forecast for this study. After a short overview of general causes of hunger, a complex causal diagram illustrates the situation in Mali. Based on that diagram, five future events will be picked that are likely to occur and affect the forecasted variable.

Forecasts of Malnutrition in Africa and Mali

Since this project is written for a UN agency, United Nations publications will be reviewed extensively. In the regional MDG report for Africa, Mali is not mentioned specifically (UNDP and UNICEF 2002). However, this report states that Africa as a whole has made little progress in reducing malnutrition and improving its nutritional situation. A few countries are on track in reaching the goals on time; the majority is not. Africa as a whole has not managed to significantly reduce the number of underweight children: in 2000 this proportion equaled 27%, compared to 28% in 1990 (see Figure 1). Although the report does not specifically include a forecast, it strongly implies that current trends do not see Africa reaching its goal of halving its proportion of malnourished children by 2015.

Figure 1: Development of the proportion of underweight children under five years of age in Africa



Source: (UNDP and UNICEF 2002, 12)

Each year, the UNDP publishes a global Human Development Report. In 2002, Mali was attested to be far behind in achieving MDG 1 (UNDP 2002, 49). Again, no forecast was included that addressed the question as to when Mali should complete this task.

In 2003, the UNDP focused its Human Development Report on the MDGs. For the first time, it came with a regional forecast of the time necessary to achieve these goals if current progress holds constant (UNDP 2003, 33). According to this forecast, sub-

Saharan Africa will have halved the proportion of malnourished people somewhere between 2100 and 2200. No further information is given about the methodology of this forecast. It is important to be aware of the purpose of this report. The UNDP probably wants to influence member states to change their policies and dedicating more resources towards the achievement of the MDGs. Therefore, this forecast should be treated carefully since it is likely to predict a more negative scenario. In addition, based on its achievements during the last 10 years, Mali has probably been outperforming other Sub-Saharan states in reaching this goal (UNDP and UNICEF 2002, 7).

A forecast of food availability in Low Income Countries is conducted by Theodore J. Gordon. Its methodology – Trend Impact Analysis – can be helpful for this study because it builds on time-series variables for which future values are forecasted. Most valuably, it allows controlling of such a trend line – which serves as a base case – for various critical events. It provides an easy-to-use tool to calculate the effects that these wild cards may have on the base line. It also allows for specification of each wild card according to its estimated impact and its probability of occurrence.

Available Raw Data

Unfortunately, Mali has a lot of white spots on its data sheets. Variables that would be highly relevant for this project are not available in an extended time series. In addition, it is hard to distinguish measured raw data from estimates or averages. Still worse, major institutions such as the World Bank, the UNDP, and other UN organizations provide different values for variables that are operationalized in exactly the same way (see figure2).

Figure 2: Historical data - malnourished children in Mali

	HNPstats / World Bank	**UNDP HDR 1999-2003**	**IFs history data**
Definition	**Child malnutrition:** "the percentage of children under 5 whose weight by age is less than minus two standard deviations from the median of the reference population. The data have been compiled from a variety of primary and secondary sources, including the World Health Organization, World Health Statistics Annual, UNICEF, State of the World's Children, and United Nations, Update on the Nutrition Situation" (World Bank – HNPstats)	**Under weight for age, children under age five** "Includes moderate underweight, defined as more than two standard deviations below the median weight for age of the reference population, and severe underweight, defined as more than three standard deviations below the median weight." (UNDP 2003, 357) Note: numbers are given for time periods only, without specifying the exact year	**MalnChil%[-1]** **Percentage of children under 5 malnourished** **Note:** Not based on weight but on energy consumption Source: World Bank's CD-ROM database (social indicators)
[1995-2000]		40 - 43	
1980			59
1987	30.6		
1991			30
1996	26.9		29
2001	33.2		

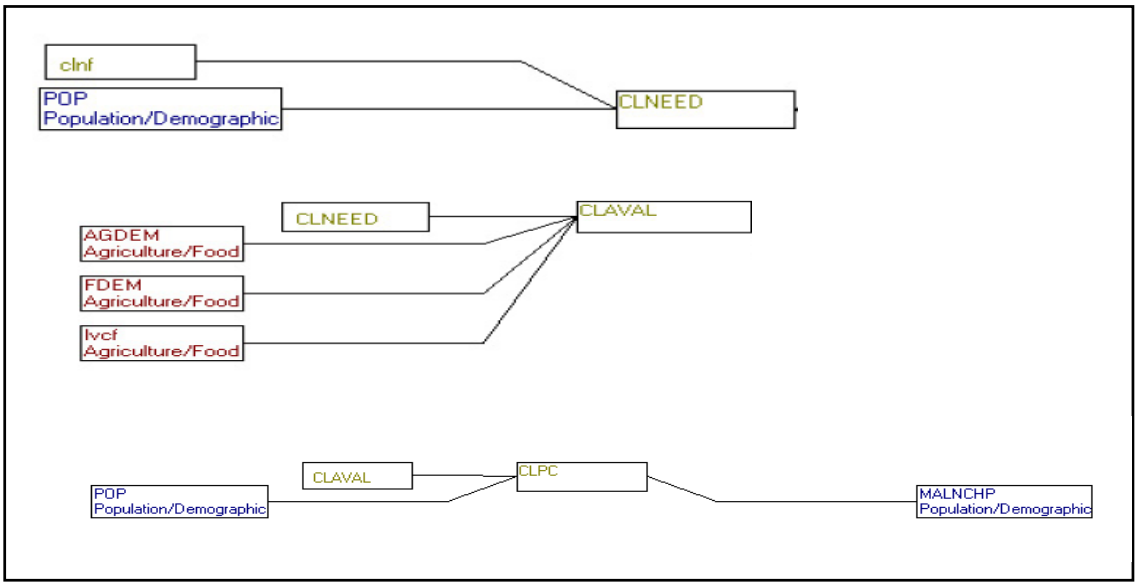
In addition to these historic data, forecasted values are available. IFs' base case scenario contains a forecast for malnourished children under 5 in Mali (MALNCHP). This variable does not define malnutrition as underweight for age. Here, malnutrition is operationalized with daily calorie consumption per capita (see figure 3).

Figure 3: IFs forecast of malnourished children in Mali until 2035
MALNCHP

Year	percentage	Year	percentage	year	percentage
2000	29,00	2012	23,96	2024	19,84
2001	27,90	2013	23,66	2025	19,41
2002	27,88	2014	23,35	2026	18,96
2003	27,57	2015	23,50	2027	18,51
2004	27,11	2016	22,75	2028	18,40
2005	26,66	2017	22,44	2029	17,57
2006	26,21	2018	22,12	2030	17,80
2007	25,79	2019	21,78	2031	16,57
2008	25,38	2020	21,42	2032	16,70
2009	24,99	2021	21,50	2033	15,56
2010	24,63	2022	20,66	2034	15,30
2011	24,29	2023	20,26	2035	14,50

To make it clear, these numbers have never actually been measured in Mali. They are calculated by the forecasting program International Futures (IFs). The way in which this calculation works can be illustrated by a flow chart consisting of the single drivers that influence the variable MALNCHP (see figure 4).

Figure 4: IFs drivers that influence MALNCHP (source: IFS drivers)



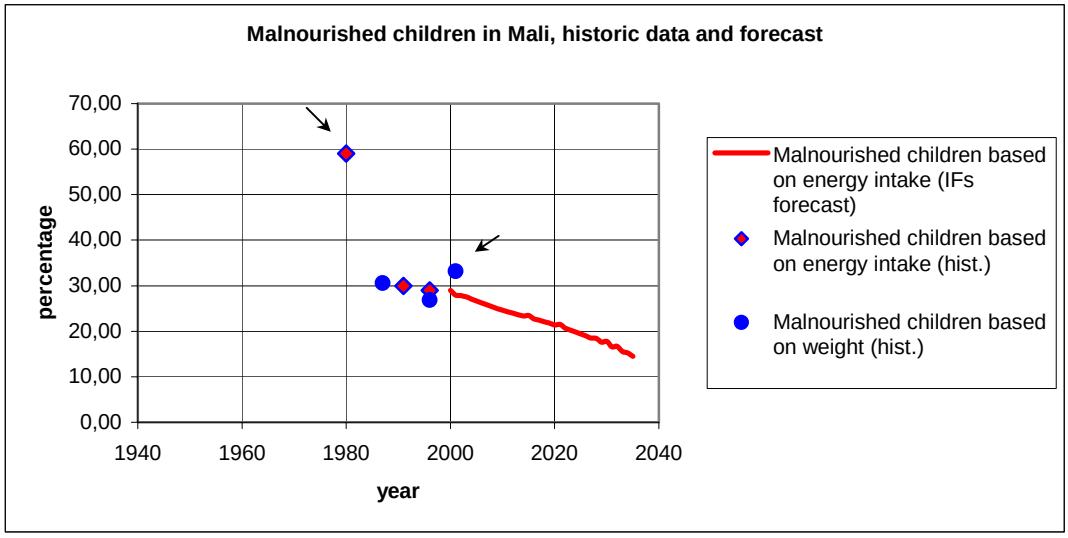
The percentage of malnourished children under 5 (MALNCHP) is calculated according to the following criteria:

- Calories per capita available (CLPC)
  - Calories available (CLAVAL)
    - Calories Need: each age cohort is linked to a certain age-specific, daily need for energy (CLNEED)
    - Several agricultural variables expressing the energy need for agriculture, agricultural supply, and livestock supply
  - Demographic structure of the population (POP)
- POLCONV a variable expressing special political settings that influence food distribution/availability. This variable is needed to model the convergence of outliner cases towards predicted 'normal' values.

Figure 5 shows all data series mentioned above except the UNDP data. The forecasted percentage of malnourished Malian children is declining constantly through 2035. Compared with the historical data for malnourished children based on weight, this forecast seems realistic (see figure 5).

The sample sizes of the two historical data series are too small to extrapolate a future trend line in a reasonable way. Because of the small sample size, potential measurement errors would have enormous effects on the trend line. However, if the two outlying points (marked in the diagram with arrows) are ignored, the 4 remaining points seem to lie on a trend line through the IFs-forecast that extends back into the past.

Figure 5: Percentage of malnourished people in Mali, past and future



To conclude, the IFs forecast of the future percentage of malnourished children under the age of 5 in Mali is a realistic future scenario. It is reasonable to use in this project because it is backed by historical data.

The Nature of Malnutrition and Hunger

Before we can analyze the causes of Mali's bad nutritional situation, we need to look at hunger and malnutrition more in general. The following paragraphs will enable a better understanding of hunger and malnutrition by identifying a set of levels on which people are regularly denied safe and sufficient access to food. At first, important terms will be defined:

> *Malnutrition results from the interaction of inadequate diet and infection and is reflected in poor infant growth and an excess of morbidity and mortality in adults and children alike. Undernutrition is malnutrition due to a deficiency of calories and vitamins and minerals interacted with acute infection, while over-nutrition is malnutrition due to an excess of certain nutrients such as saturated fats and added sugars in combination with low levels of physical activity. The vast majority of malnourished individuals in the developing world experience undernutrition. An individual who is food secure, but suffers, say, from frequent and severe bouts of diarrhea will not be able to use the food for growth and development and will experience undernutrition (Millennium Project Task Force on Hunger 2004, 33-34).*

This definition distinguishes malnutrition, undernutrition, and food security. For this paper it is helpful to focus on malnutrition and food insecurity. The *Millennium Project Task Force on Hunger* under Jeffrey Sachs provides a useful overview of different kinds of barriers to safe access to food (see figure 6). A lack of access in one of those four categories will lead to malnutrition.[1]

Figure 6: Access to food in the quantity and quality necessary for a healthy life

Type of Access	**Issues and Key Questions**
Physical	Relates to food production, agricultural productivity and the ability of markets to deliver food to consumers and inputs to farmers. Is there food in the farm and in the markets year-round?
Economic	Relates to prices and incomes—what is the affordability of the food in the market for poor consumers? Can people afford to consume home production?
Social	Relates to insufficient access to food because needs are either undervalued or because they lack the power to press their claims (women, children, HIV-AIDS orphans, ethnic minorities). Can certain groups within the household and community get access to food purchased or grown?
Physiological	Relates to the body's ability to use the nutrients for growth and development, as infection diminishes access to ingested nutrients. Can the body use food consumed for growth and development or are disease loads too high?

Source: (Millennium Project Task Force on Hunger 2004, 51)

[1] For a comprehensive discussion of food security look at Susanna Davies' book (Davies 1996, 15).

At the most basic level, an adequate nutrition is denied because of physical barriers. For rural population that means food production is insufficient, for urban dwellers it means there is no food available in the markets. The biggest part of hungry people in Africa, who are often small farmers, is denied access to food on this very basic level. Typically, those households have no alternative monetary income and depend on their own food production. Often, they are unable to produce enough food for themselves because of low agricultural productivity, natural disaster, for example droughts, and the seasonality of their food supply combined with the lack of financial means and proper storage facilities (Millennium Project Task Force on Hunger 2004, 51).

Even if enough food is physically available many people stay hungry because the simply cannot afford it. This economic level hits poor people on the countryside as well as in cities. Poverty is recognized as one of the major single causes of hunger (UNDP 2002, ; 2003, ; Millennium Project Task Force on Hunger 2004, 13-14). Similar to this, social barriers exist that deny people access to physically available food. Often, female household members get less food than their male relatives. Besides this gender bias, ethnicity, age, and having HIV/AIDS are three other common sources of discrimination.

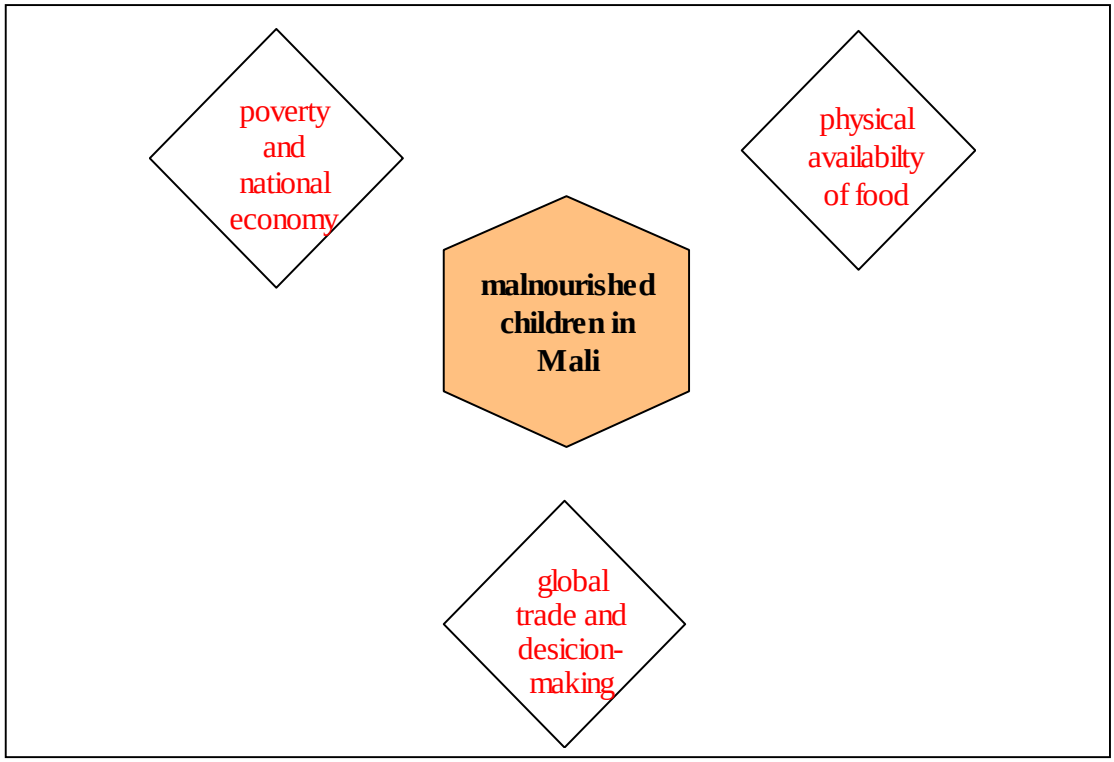
Last, a physiological barrier to proper access to food exists. On this level, food is often denied to very vulnerable groups of society, such as babies and children. Poor childcare almost automatically results in food insecurity of the babies. They also depend on their mothers acting in accordance with hygienic standards when feeding them. Unclean and insufficiently treated water easily causes diarrhea, and sick bodies are unable to use the nutrients effectively.

To sum up, on each of these four levels a person can be denied sufficient access to food and nutrients. In most cases, people affected on one of these levels are poor. As already mentioned above, fighting global poverty is the single most important action in order to reduce malnutrition. In this context, a global level comes into play. Hunger in poor third world countries often can be directly linked to actions of the rich countries. One example is trade policy. The US and most EU countries subsidize their own farmers heavily with the result that third world producers without a comparable state support cannot compete on the world market. The present rules of global trade – set and sanctioned by the World Trade Organization (WTO) and the General Agreement on Tariffs and Trade (GATT) – regularly disadvantage third world producers of agricultural products. These poor countries are forced to open their markets for imports and therefore let the highly subsidized products in. In addition, the US and EU countries keep the levels of protection of their agricultural market so high that third world producers are effectively denied access to it. Besides that, flows of global aid are a means to reduce food insecurity that many poor people in the third world face. Concerning international development aid, a better and more effective approach to hunger and malnutrition is in sight. In the past, hunger in developing countries was perceived mainly as a question of survival. Now, it is more and more understood and accepted that a virtuous circle exists: reducing hunger, reducing poverty, and human development influence each other in a positive way (Millennium Project Task Force on Hunger 2004, 29).

The Causes of Malnutrition in Mali

This chapter will develop a causal understanding of malnutrition in Mali. This is necessary in order to identify potential future events that may affect the base line forecast for malnourished children in Mali. To visualize the relationships, causal diagrams will be used.

Figure 7: Malnourished children in Mali – levels of influence



In a first step, the basic levels that influence malnutrition in Mali must be pointed out (see figure 7). Building on the previous chapter, three major levels of influence exist: poverty and the national economy, global trade and decision-making, and physical food availability. The relationships between these levels and malnutrition were discussed in the previous chapter in general. Now, a second step will identify the single drivers and variables within these levels. These levels can overlap in some parts. Therefore, the same variable may appear in more than one level.

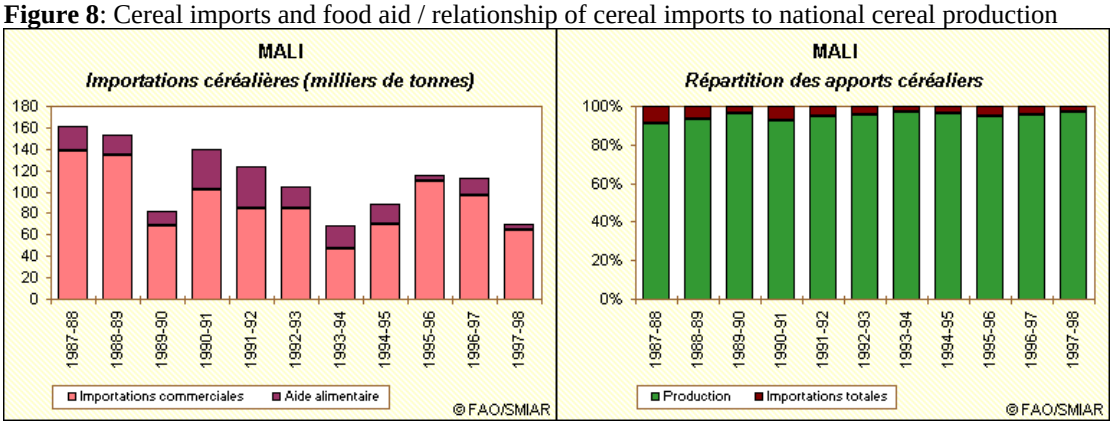
a) Physical Food Availability

The study of Mali's physical food availability will almost exclusively focus on cereals. This is feasible because of Mali's historical dietary pattern and the availability of relevant data. Mali's population gets 70% to 80% of its daily energy intake from cereals (Millstone and Lang 2003, 79). Three major sources of cereal exist for Mali: national agricultural production, imports, and international food aid. The main natural constraints for national food production are droughts.

Net cereal imports together with international food aid equal 4% of Mali's total cereal consumption. 10% of net cereal imports consist of international food aid. Therefore,

Mali is not heavily dependent on food aid. Less than 1% of its total food consumption comes from that source. However, Mali depends highly on cereal imports since cereals play a very important role in the national diet (Earth Trends 2003).

Figure 8: Cereal imports and food aid / relationship of cereal imports to national cereal production



source: http://www.fao.org/giews/french/basedocs/mli/mliaid1f.stm and
http://www.fao.org/giews/french/basedocs/mli/mliimp1f.stm (April 27, 2004)

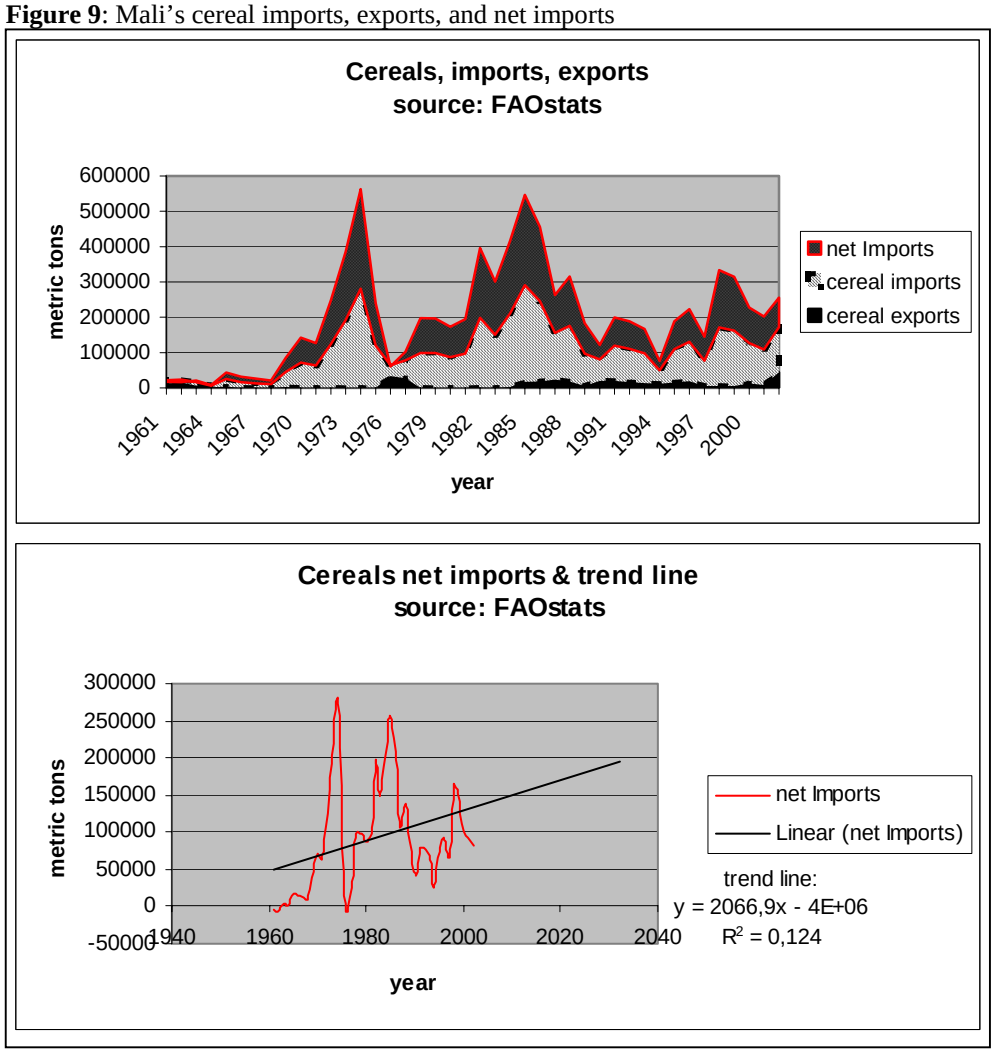
To illustrate these relations, figure 8 can be helpful. However, to get a more complete picture of Mali's cereal situation, it is necessary to compare its cereal imports with cereal exports. Looking at the two charts in figure 9, it becomes obvious that Mali has been a net importer of cereals in most of the years since 1960. The curve for net imports in the upper diagram has to be treated with care. It does not show absolute numbers but rather the difference between imports and exports. Exports haven never exceeded the mark of about 33,000 tons a year. However, recent developments could be the beginning of a break with that trend. In 2002, Mali exported 44,511 tons of cereals.

In the second chart in figure 9, the trend line for Mali's net imports has a positive slope, indicating that net cereal imports can be expected to grow in the future. This forecast is based on the extrapolation of the historic data by calculating a best-fit line. The quality of this best fit is expressed with the variable R^2 with the value 0.124. That means, this line can explain 12.4% of the variations of the explained variable (net imports). This R^2 is not very high; however, looking at the charts can explain this low fit rate. There are two huge peaks - one between 1970 and 1980, the other between 1980 and 1990. These peaks represent the two major droughts that occurred in Mali during the second half of the last century (one happened in 1973-74, the other in 1984-85).

This information allows the conclusion that the development of net cereal imports in the future is highly dependent on the frequency of droughts. This paper will not conduct a separate forecast of droughts in Mali or in the Sahel. It will work with the assumption that several droughts will occur in Mali within the next 30 years. The climate in this area of Africa was very unstable during the whole 20th century. Frequent short-term fluctuations between dryer and wetter periods became normality. Rain has always been irregular and historic rain patterns become worthless forecasts because of sudden changes during the last decades (Swift 1977, 457). Therefore, this

study assumes that net cereal imports will increase even more within the future because of continuing occurrence of severe droughts.

Figure 9: Mali's cereal imports, exports, and net imports

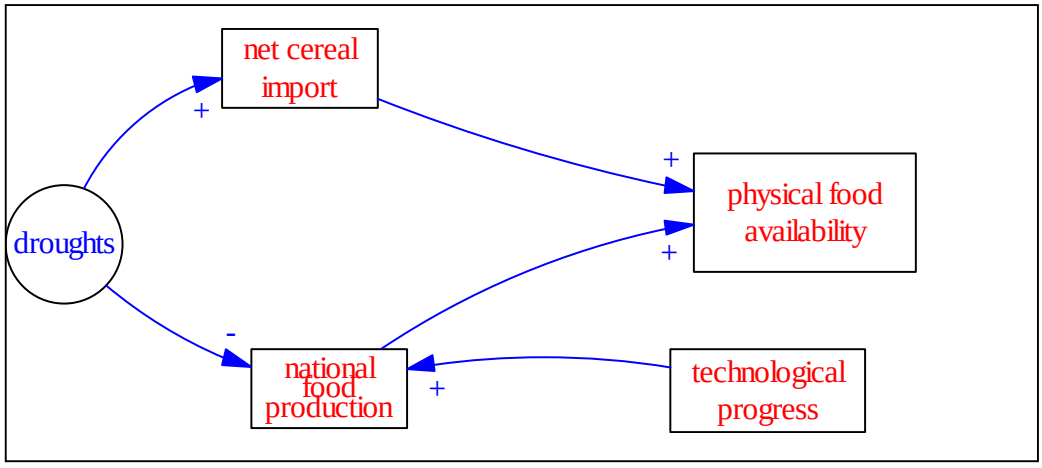


In addition to the import of cereals, the droughts also affect Mali's own agriculture. This certainty of future droughts limits the development of the national food production. Even with new technologies, improvements will be constrained. Technological progress could include new, cheap, and effective irrigation techniques that will not decrease soil fertility because of salinization or more robust, genetically modified seeds. However, theoretically the possibility for an extensive development of Mali's agriculture exists. Out of Mali's total land surface, 14% can be used for agriculture. As for now, not more than one third of this land is cultivated (FAO 2004).

To sum up, the physical availability of food in Mali mainly depends on net cereal imports and the national agriculture. International food aid can be ignored. This report assumes that severe droughts will happen in irregular periods within the forecasting horizon and the relative weight of imports and national production is therefore likely to change. The single most important variable for physical food availability in Mali will be increasing net cereal imports.

Figure 10 shows the variables that are assumed to influence physical food availability in a causal diagram. Variables that appear within circles instead of boxes are regarded as fixed in the future. For example, the report assumes that no general uncertainty exists about the happening of severe droughts within the forecasting period; in contrast, 'net cereal import' appears in a box because the future values of this variable are uncertain.

Figure 10: Physical Food Availability



b) Poverty and National Economy

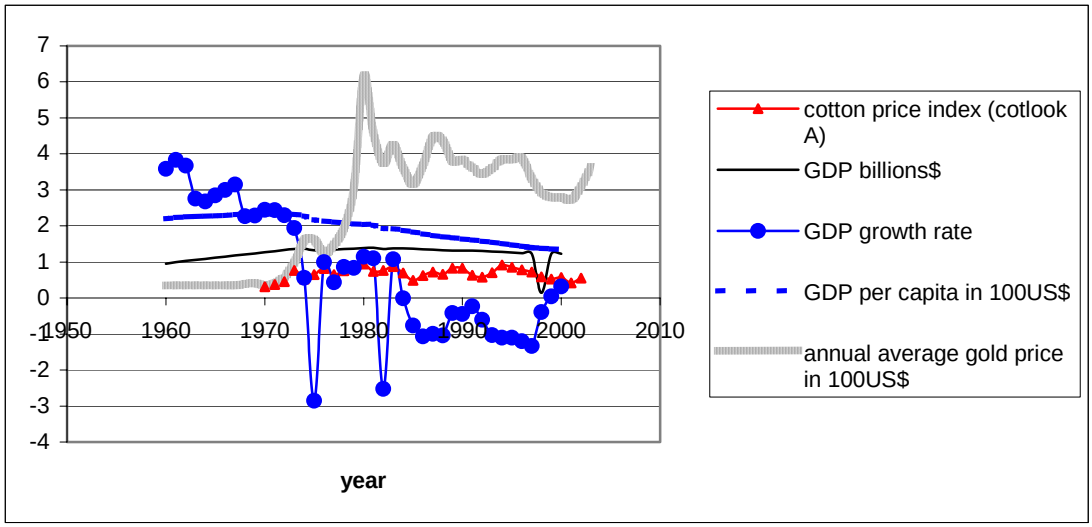
We identified poverty as a major cause of hunger (UNDP 2002, ; 2003, ; Millennium Project Task Force on Hunger 2004). In general, more poverty leads to more hunger and more hunger results in more poverty. In order to address poverty, it is necessary to look at the national economy. Mali's domestic economy is concentrated on agricultural production for the domestic market – most peasants are small farmers and produce only for their household consumption – and on the export of cotton and gold. Agriculture counted for about 44% of GDP in 1998. Cotton and gold are Mali's most important export earners. In addition to Mali's own economic performance, an increasing part of its GDP consists of international aid money (see figure 14).

The future nutritional situation in Mali will depend, among other factors, on how revenues from cotton and gold exports will develop. Besides poverty reduction, Mali is forced to use this foreign exchange to pay for the net import of cereals that is necessary to feed its people. Additionally, many poor people from Mali get a significant proportion of their household income from producing and selling cotton. If cotton prices fall or if the people are not able to sell their product, they are likely to suffer.

Consequently, it is important to look at the historic development of the prices of gold and cotton. 'Cotlook A', a well-respected price index for cotton, shows the price of cotton on the world market constantly fluctuating between 0.5 and 1 cent/lbn over time (see figure 11). No extreme peaks are visible in this chart. Figure 12 shows the development of export prices for cotton in relation to the same price in 1995. Here it is visible how much the export price of cotton fell during the last 10 years. Although those price changes equal changes of less than 1 cent/lbn, they affect small producers

from Mali enormously. The reason is that low per-unit profit margins make those price changes affect poor, small-scale producers around the world even more.

Figure 11: GDP of Mali, gold price, and cotton price index



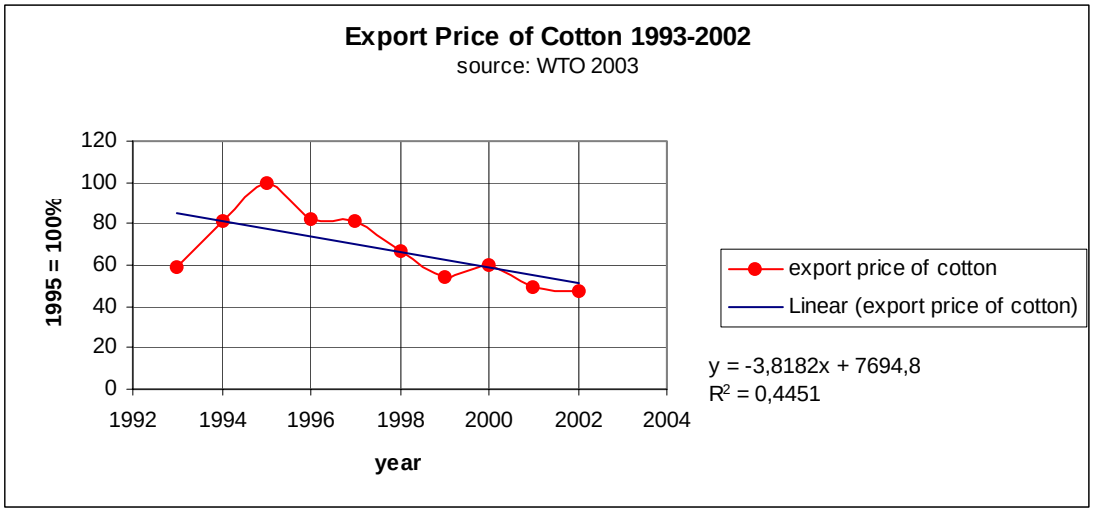
Source: World Gold Council, Cotton Outlook, IFs

According to BBC news, Mali's cotton farmers face threatening competition from cotton producers in the US and in EU countries, which swamp the market with state-subsidized products (BBC 2004). They produce on a much larger scale and can afford to stay in business despite ever-decreasing profit margins for cotton. Yet, actual events appear as a sign for change in the cotton subsidies. Recently, a WTO committee decided in favor of Brazil, Benin, and Chad. Brazil sued the US at the WTO for its subsidies for national cotton producers. These subsidies, Brazil's and now the WTO's argument goes, are violating WTO free trade rules (Dilger 2004). Not related to that event, EU officials presented specific plans to reduce EU subsidies for agricultural production in general and for cotton specifically. Therefore, it looks like the global market for cotton will become freer and more competitive in the future. It is questionable how much Mali's small cotton producers will benefit in the long run. The law case was started by Brazil. Many African countries suffer much more from these subsidies than Brazil, but they lack the money to finance a WTO lawsuit. It is not sure if Mali's farmer can compete against the producers from Brazil because the Malian state cannot support them in a comparable way. It would be wrong to assume the interests of Mali and Brazil to be identical.

Another problem for Mali's cotton producers was the armed conflict in the Ivory Coast in 2002. Mali exports its cotton via harbors on the West African coast. Therefore, the growers depend on safe land connections from Mali to the big coastal cities. Conflicts in this area have had large impacts on the well-being of the cotton growers and exporters from Mali because they had to switch harbors which is time and money consuming. Forecasts of the probability of civil wars in West Africa give no reason to expect a decline in the number and duration of such conflicts. One study forecasts probabilities for outbreaks of civil war before 2005 of 10% and higher for the following West African countries: Senegal, Mali, Nigeria, Ghana, Ivory Coast, Guinea, and Cameroon (Moradi). Ivory Coast, Guinea, and Senegal are situated

between Mali and the Atlantic Ocean. There is no reason to believe that the future will look more peaceful in West Africa.

Figure 12: Export Price of Cotton



source: (WTO 2003)

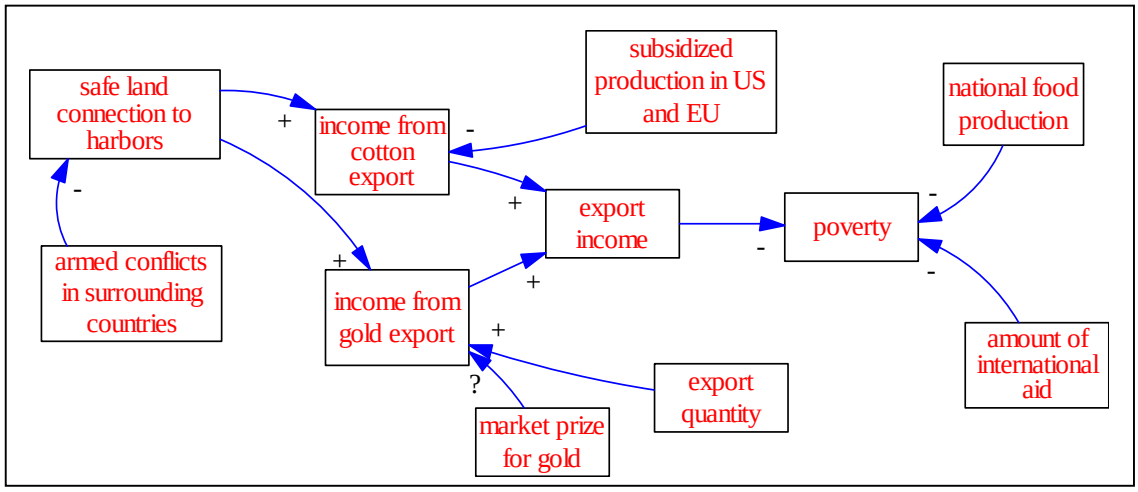
Yet, the export of cotton is a very important source of wealth that is needed to decrease malnutrition and poverty in Mali. The small cotton producers are very vulnerable against common and frequent changes in the cotton price. However, their biggest problem is their lack of competitiveness against large-scale producers from the US and EU countries that benefit from huge state subsidies. Momentarily, it looks like these subsidies will decrease in the future and put Mali's producers in a better position. Additionally, Mali's cotton production is vulnerable to armed conflicts in the countries they separate it from the ocean harbors. There is no sign that these conflicts will disappear in the future.

Gold is the second most important export earner of Mali. As in the case of cotton, these export revenues are of essential importance in the fight against malnutrition and poverty. A chart analysis of the annual average gold price in the past (see figure 11) gives reason to forecast a further declining price for gold. All major local maxima since 1975 (main peaks in the chart) lie on roughly the same line with a negative slope. Therefore, this study will assume a further continuous decline in the world market price for gold. Given this, Mali has to export more gold in order to keep the revenues at least constant. As for now, it looks like Mali is significantly increasing its gold production (Mobbs 1998, ; Yager 2002). However, long-term increase will depend on the exploration and opening of new mines. Many companies restrain from this because of Mali's poor infrastructure. If no new major gold mines are opened, Mali will lose export income because of the declining gold price.

To sum up, to reduce individual poverty and to enable the Malian state to effectively fight malnutrition, export revenues are of essential importance (see figure 13). The national economy is basically limited to agricultural production that is often consumed within the producing household. The two major export earners are gold and cotton. In order to increase or at least sustain the actual level of export income, two

factors are important. First, the export of cotton depends on the global trade system. A reduction of subsidies in the US and in EU countries will benefit Mali. Second, earnings from the export of gold primarily depend on the further increase of export quantity, since the price is likely to fall. A collapse of the national and regional road infrastructure would decrease the exports of both products, which depend on access to the Atlantic harbors.

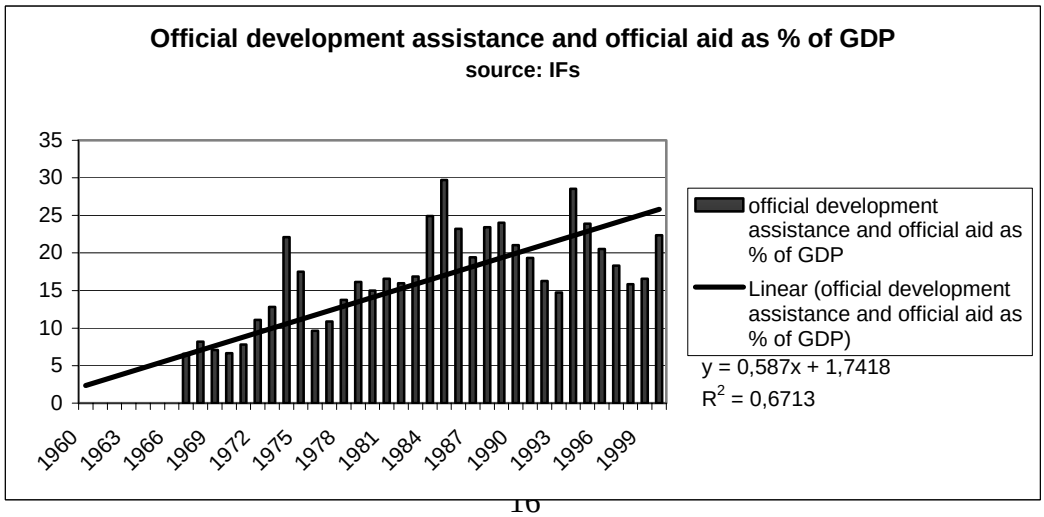
Figure 13: Poverty and the National Economy



c) International Aid Money and Global Economy

Although Mali is not a major recipient of international food aid, it is highly dependent on development assistance and official aid (see figure 14). Since 1969, foreign financial aid has accounted for an average of 14% of annual GDP. For the past 20 years, that average has been 21%. Twice during this period, international aid approached 30% of GDP. Again, these two peaks appear shortly after the two major droughts that occurred in Mali. It is thus obvious that Mali is very reliant on international aid. The trend line through the whole period for which data exist has a very steep and positive slope. Based on this trend line, Mali's dependency on aid money will continue to increase in the future. It can be assumed that a significant decline in foreign aid will affect poverty and nutritional patterns in Mali.

Figure 14: official aid as % of GDP

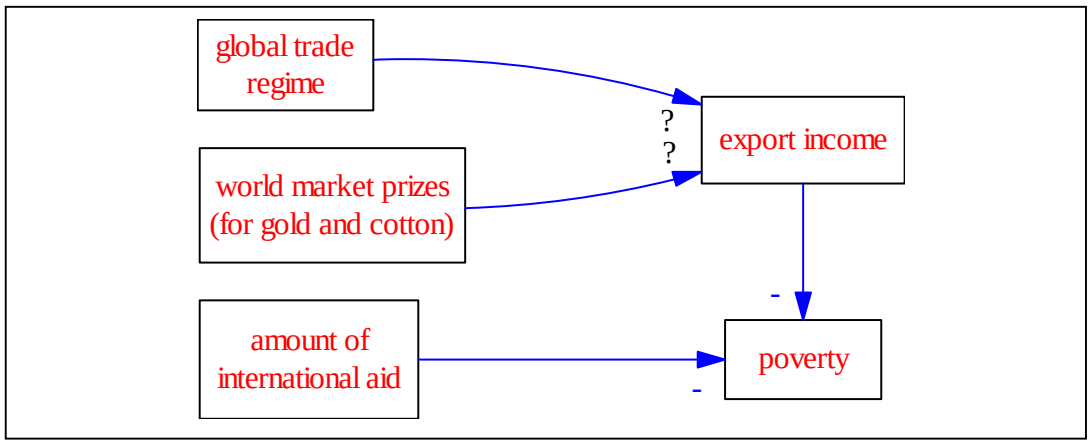


In order to know how this dependency affects Mali's nutritional situation, it is necessary to talk about the development of international aid money in the future. Several trends and drivers seem realistic. The amount of developmental assistance directed towards Mali is likely to increase because of a decrease in the total amount of countries that need such help. Another vision focuses on the fact that most OECD countries cut their spending for developmental aid. These cuts are visible in the total national numbers and in the percentage of GDP dedicated to these objects. A third position emphasizes that more and more international aid money has the form of military aid. It is questionable if military aid would help Mali to improve its nutritional situation. Because of this uncertainty about how much international aid money will be available in the future, this study will focus on the aspects of dependency defined as the percentage of international aid money of the annual GDP. The more Mali depends on foreign aid to pay for cereal imports, the more likely becomes a situation in which a sudden decline in this help would have horrible effects on malnutrition.

Other variables from the global economic level that influence malnutrition in Mali are the global trade regime WTO and world market prices. These variables have been discussed in the previous chapter on national economy and poverty and therefore, it can be more briefly here. The WTO is responsible for setting and monitoring the rules of international trade. As the example of subsidies for cotton producers has shown, the form of these rules and international behavior according to them has significant effects on small producers in Mali. If the contemporary trend of the WTO officials continues, Mali's cotton producers will have better chances in the future to sell their produce for a decent price. In addition to that, world market prices are set on this global level. This paper will take global market prices as a given, which cannot be influenced voluntarily.

To sum up, variables on a global level influence food security in Mali in different ways (see figure 15). The amount of international aid money is of vital importance for Mali being able to import cereals. Decreasing aid money will threaten this possibility. The WTO can set rules that allow or deny small cotton producers in Mali to make a living.

Figure 15: global trade and decision-making

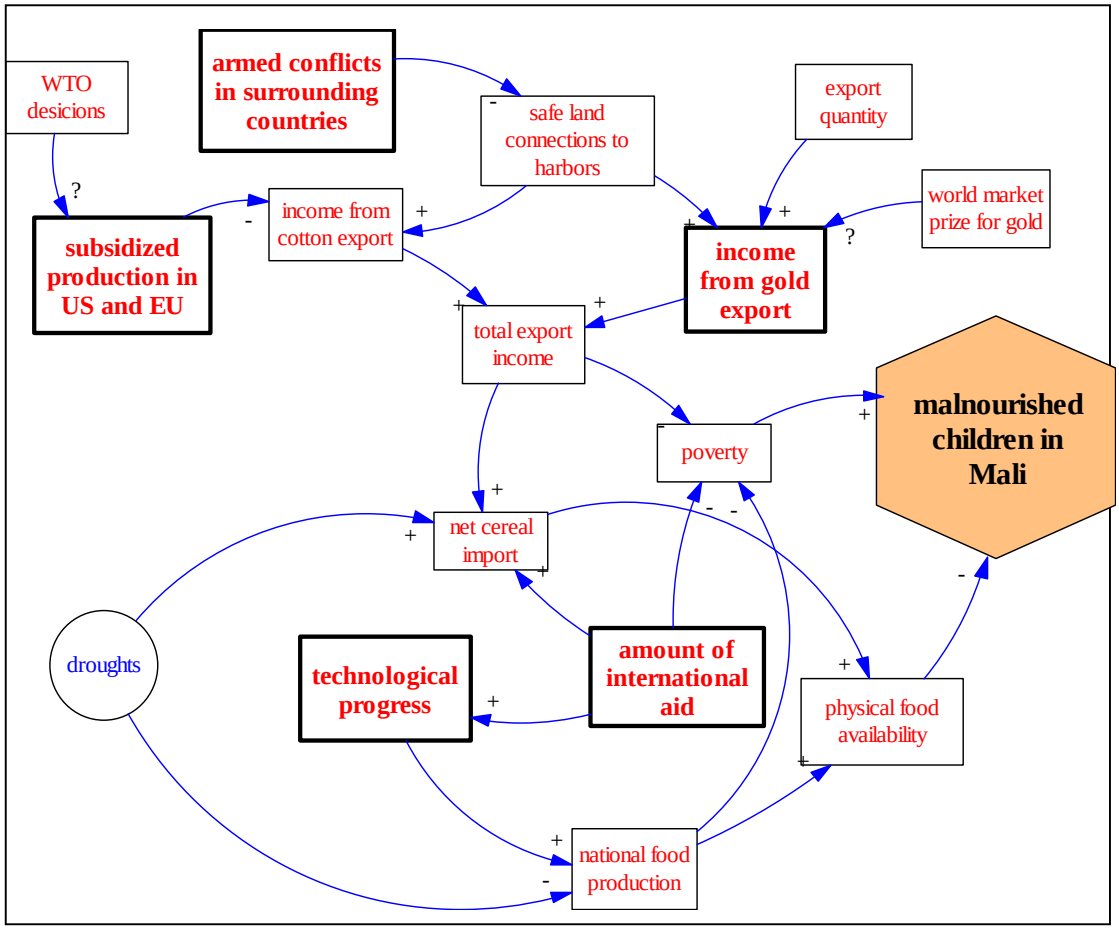


Critical Events Based on Causal Domain Knowledge

Over the last paragraphs, three causal diagrams were developed. Now, in order to get a comprehensive picture of variables that are related to Mali's nutritional situation, these diagrams will be put together (see figure 16). The arrows in the diagram are marked with a plus, a minus or a question mark. Plus means a positive relationship, minus a negative one. A question mark symbolizes a relationship with an unknown direction. Variables that appear in circles are assumed to have future values that are relatively certain. Variables written into boxes with a thicker frame line will be used as critical events to influence the base line forecast in the TIA.

It should be noticed that this causal diagram does not attempt to mirror reality. It merely is a tool to visualize the findings of the previous chapters. Of course, there are additional variables that have effects on malnutrition in Mali and additional relationships between the variables in the diagram. This diagram is a compromise between comprehensiveness and clearness. However, the author believes, that this diagram represents the most important variables and connections.

Figure 16: Comprehensive Causal Diagram for Malnutrition in Mali



With the help of this map it is easier to identify possible future events that may influence the base line forecast for the percentage of malnourished children in Mali. Since this forecast is planned as a guide for further action and should help the UNDP advocate policies among its member states that help increase the amount of

malnourished children (MGD1), the number of events is limited to a maximum of five. These five events should be selected according to the criteria of probability and impact. The forecast gains a lot, if the most probable and most important events can be identified. This assures a high level of significance for the study and makes it at the same time better understandable and easier to comprehend.

The occurrence of droughts will not be used as such a critical event. It is assumed that droughts will occur during the forecasting period in a frequency and intensity comparable to the past decades. Therefore, the effects of droughts are already reflected by the base line forecast. Concerning the national agriculture of Mali, without significant help or input from outside no major increase in physical food availability will be possible because of the climate and poverty. Hence, only technological progress can improve Mali's own food production. Another variable that will not be used as a critical event is the net import of cereals. It was laid out earlier that Mali depends heavily on these imports in order to feed its people because the national food production is limited. However, this forecast assumes that the availability of cereal on the world market will be unchanged during the forecasting period. Thus, Mali's net cereal imports are not constrained by the world supply but by Mali's ability to pay for it. Therefore, this forecast will focus on critical events that either increase Mali's national food production or its ability to purchase food on the world market.

Technological progress means all future inventions that increase food productivity in Mali. Examples are new seeds – based on biotechnology or traditional breeding – that require less water and can cope with Mali's climate in a better way or new irrigation techniques. It is clear that Mali will not be able to pay for such new methods. If such technologies exist, they must be financed with international aid money in order to allow Mali to benefit. The first event that is likely to influence the future amount of malnourished children in Mali therefore is:

1. *Future technological progress combined with the necessary international funding will increase Mali's agricultural productivity and its physical food availability and therefore reduce the number of malnourished children.*

Since Mali's dependence on international aid money is very high and likely to increase in the future (compare figure 14), international aid will be addressed a second time with the next event. As laid out earlier, it is necessary to look at the amount of aid money available to Mali and at its need for these assets at the same time in order to get a meaningful result. We have to keep in mind that there are good reasons that back either the assumption of a decrease as well as an increase in the total amount of international aid money. We can assume that at a certain point there will be a significant decrease in aid money. With much more certainty one can state that Mali's need for this help is likely to continue growing. Therefore, the second event is:

2. *Mali's need for international aid money will grow strongly (aid money as percentage of GDP). Light increases in the total amount of money will not change the nutritional situation. We assume that at a certain point rapid and immense decreases will worsen malnutrition among children.*

The next three events will address the global arena and Mali's export economy. Looking at the export of gold, we can state that Mali's income is determined by the price and the quantity exported. Analyzing the past development of the gold price we assume a further decline in the future. In order to keep incomes constant, Mali will have to increase production. Although there were some successes reported for the years 2000 and 2001, this report questions if production can be extended continuously. Problems are the rudimentary form of infrastructure and the fact that many potential new gold mines are situated at border regions. Political instability in the neighbouring countries would make gold production a risky business in these areas. Especially in the background of the brutal civil war that has been going on for a couple of year now in Sierra Leone because of diamonds (Campbell 2002). Event number three therefore is:

3. *Mali cannot balance a falling price for gold with increasing production. A decreasing total export income will increase the number of malnourished children.*

Armed conflicts have a long tradition in post-colonial West Africa. The citied studies provide no reason to assume a decline over the next 30 years. If these conflicts happen in countries through which Mali's cotton producers have to export their goods to the Atlantic harbors they will suffer from substantial losses. Event number four is:

4. *Armed conflicts make it impossible or very difficult for Malian producers to export cotton. A decreasing GDP will lead to an increase in malnutrition among children.*

Besides the transportation problem, Mali's cotton producers suffer under the cheap produce from the US and EU countries which is highly subsidized by those states. At the moment, it looks like the WTO will sanction these subsidies and enforce a freer world cotton market in which Mali's small producers will be better able to compete. This event number five is:

5. *The reduction of subsidized cotton supply on the world market puts Mali's producers in a better position and increases Mali's GDP. The number of malnourished children will decrease.*

PART 3 – METHODOLOGY

This part introduces the methodology that will be used for the forecast - Trend Impact Analysis. It describes the single steps of the technique and assures that the methodology is appropriate for the specific problem and also feasible. It ends with showing how a Microsoft Excel Sheet calculates the forecasted variables.

The Methodology – Trend Impact Analysis

The future development of malnourished children in Mali will be forecasted by using Trend Impact Analysis (TIA). The general weakness of time series techniques is that they base forecasts only on historic data (The Futures Group International 2003). They assume that all major drivers will be constant over time. This assumption is very unrealistic when dealing with the future of complex systems, such as environment, global trade or malnutrition (Wack 1985b, 73). Unprecedented events are likely to occur, especially if forecasts cover a period of more than only a few years. Therefore, TIA combines forecasts of a certain variable based on the extrapolation of historic values of this variable with effects of critical events in the future (Gordon 2003a).

Conducting a TIA involves four steps. First, one produces a base line forecast of the variable of interest. This is usually based on historic values of the variable that are extrapolated. Several types of curves can be tested for representing the historic values. The best-fit curve is usually determined by looking for the function with the biggest R^2-indicator. Second, one compiles a set of possible future events that – if they happen – will influence the values of the variable of interest. For each year of the forecasting period one has to define the probability that these events will happen and their estimated impact on the forecasted variable if they occur. Third, the forecaster assigns a random number between 0 and 1 for each event. This random number stays the same for all years of the forecasting horizon. In each year, where the probability of occurrence is higher or equal to the random number, the event is assumed to happen and affects the base line forecast. If several events are included in the model, the single impacts of all events for one year are added and the base line forecast is changed according to the sum. Fourth, the same procedure is repeated several times. Experts share the opinion that a good TIA requires several thousand repetitions for which new random numbers are assigned every time. However, because of usual time constraints, a TIA with more than 100 repetitions is acceptable (Gordon 2003a, 19). All forecasted values are analyzed for each year; usually the median, the first, and the third quartile are given. Now, a chart can be drawn showing the base line forecast, the median, and the two quartiles of the TIA (Gordon 2003a, 4-8).

For this study, the critical events are regarded as unconnected. The outcome and effect of one event does not affect the probability or impact of the other ones. This is certainly not very realistic; however, controlling for such interconnectedness of variables requires a much more sophisticated theoretical approach and much more complicated software procedures. The author of this paper is not aware of any TIA that was conducted in the past and that paid attention to such cross-sectional relations.

The attempt of this paper and the possibilities of this methodology are not to predict the future. Predictions usually try to find out how the future really will be. Instead, this paper produces a forecast. In this understanding, a forecast aims at creating a scenario that is one realistic possibility of how the future will look like. In this case, the base line forecast functions as a mini scenario – usually the term scenario is used for much more elaborated and complex views of the future – that is influenced by the critical events identified earlier (Wack 1985b, ; Wack 1985a). In short, this forecast draws a picture of one realistic possibility of how the nutritional future in Mali will look like. Its real value is to see how certain events and interventions can change the possible future outcome. Therefore, this project is not so much about knowing the future in detail but about knowing enough to be able to change it.

Appropriateness of the Methodology for the Project

TIA is appropriate for this project because of several reasons. First, it has been used on similar projects for a long time now, for example in order to forecast future availability of calories in Low Income Countries by the 'State of the Future Project'(Gordon 2003b). Second, it fits the purpose of this paper perfectly: to forecast how certain events will influence the development of the number of malnourished children in Mali in the future. Third, TIA is a relatively easy to handle quantitative technique, which does not require the use of special software. It is doable with SPSS or Microsoft Excel. Fourth, TIA is a very transparent methodology. It requires specifying all events that are assumed to influence the future values of the variable of interest. It is possible to criticize a TIA specifically for its selection of events, for the assigned impacts or the estimated probabilities. This makes TIAs testable, and therefore, gives them a special scientific character.

A weakness of this method is that the probabilities and impacts of the events have to be given or calculated outside the model. Therefore, researchers should be careful with assigning these numbers. Additional forecasts, for example using the Delphi technique, or precise research can give security. Another problematic point is the fact that the list of events is very unlikely to be complete, especially if the forecasting period is long. Therefore, this list should always be treated as incomplete and readers of the forecast have to be aware, that only a subset of possible future events is applied. In short, specifying each future event explicitly is a double-edged sword. It allows criticizing the forecast in detail but makes it obvious that only a small spectrum of the future can be considered.

Technological Realization of the Methodology

These paragraphs demonstrate how the method will be used in order to forecast the future development of malnutrition in Mali. It will also assure that it is possible to conduct a TIA with the common software packages Microsoft Excel and SPSS.
This table includes variables that will be entered into an Excel sheet. In this example only two events will be included. For the forecast, the number is simply extended to five.

Figure 17: Variables used for TIA

Variable name	**description**
year	Year of observation/forecast
baseline	Base line forecast for malnourished children in Mali based on IFs.
probabilityA	The probability that event A will occur in each year. For each year, a number between 0 and 1 is given. The higher the number, the more likely is the occurrence of this event.
randomA	For each run of the TIA, a random number is assigned for each event. The random number stays the same for all years. The random numbers are generated with Microsoft Excels function "Random Number Generation".
impactA	A number that represents the impact that event A will have on the baseline forecast if the event will occur. The impact is given as a percentage change rate.
probabilityB	Similar to the previous three variables. Express the specification

randomB	of event B.
impactB	
realimpactA	For each year the base line forecast is multiplied with impactA **if** the probability for the specific year is higher or equal to the assigned random number.
realimpactB	See previous description.
realimpactAB	RealimpactA and realimpactB are added.
newvalues	Finally, for each year the base line forecast and realimpactAB are added. This variable represents the new forecast.

Summary
To sum up, TIA is a tool that is highly appropriate for forecasting the number of malnourished children in Mali. It allows the quantitative treatment of the wild cards that were elaborated in part 2 of this paper and enables the projection of their impacts on the base line forecast. The technique is not only appropriate but also feasible given the time and budget constraints of this paper. With SPSS and Microsoft Excel, the procedure can be conducted with a reasonable degree of automation.

PART 4 – FORECAST

In this part, the forecasted results are presented and interpreted. Based on the findings, levers for intervention are identified and a general policy advice for the UNDP is formulated. All in all, if the future unfolds according to the assumption of the forecast, the MDG1 is unlikely to be achieved for Mali even in 2035. However, it is not unrealistic and if the UNDP manages to convince the leaders of the rich countries to undertake the right steps, a better future for Mali's children is likely to come.

Assigning probabilities and impacts
As a first step of the TIA, we have to specify the five events according to probability of occurrence and impact. The assigned numbers are visualized in the charts of figures 18 and 19. The complete datasheet can be found at the end of this forecast as appendix 1. It is visible that three events start with a low probability and end high; the other two go vice versa. Technological progress, decreasing foreign aid, and decrease in gold income are very unlikely to happen in the very near future. However, all three tend to become more likely in the future. The occurrence of wars around Mali and decreases of cotton subsidies in the US and EU countries are events that have a very high probability in the next future. However, as time passes they tend to become more unlikely. As for the wars, it is assumed that the global community will find ways of suppressing them. Most of these conflicts are waged for control over resources.

Figure 18: Probability of occurrence

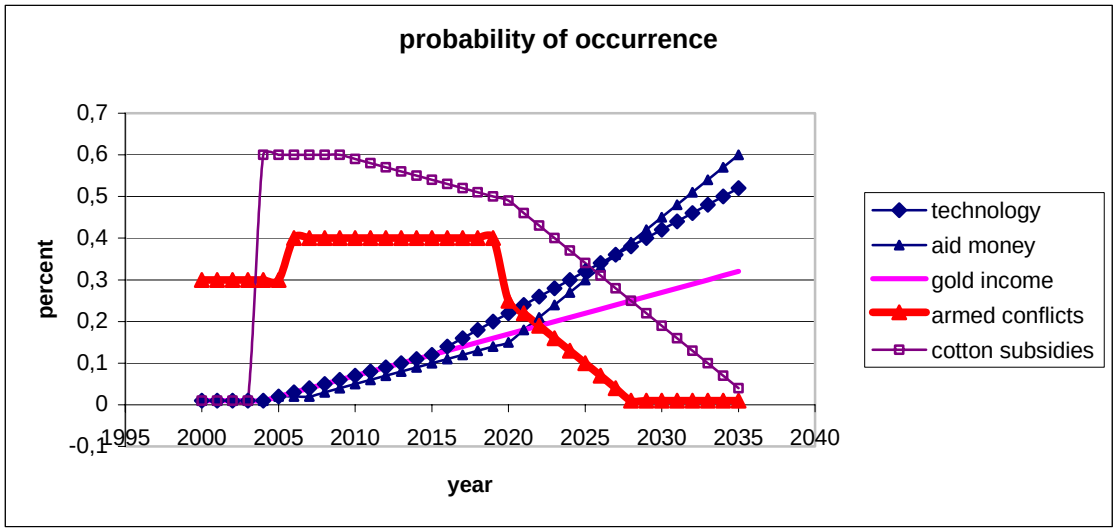
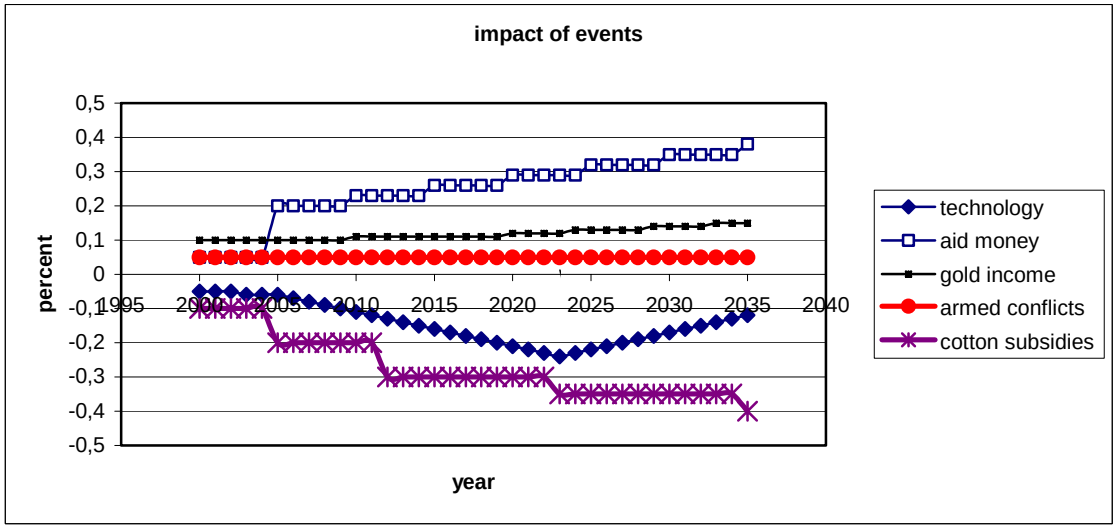


Figure 19: Impact of Events



In the future it may become possible to extinguish these incentives. For example, if technology improves, it may become possible to test germs if they were produced in a conflict area and they may be excluded from trade. The cotton subsidies are very likely to drop now because of the recent policy of the WTO. In the long run, it is assumed that they are less likely to decline because of two reasons. First, the US and EU countries will fight hard for the protection of their agricultural producers. Therefore, the legal victory of Brazil will not start a chain reaction. This report assumes, that many more legal cases will have to follow – liberalizing the global agricultural trade will be a long and for many countries an exhausting way. Second, the actual WTO activities are the result of Brazil's lawsuit against the US. It cannot be assumed that Brazil and Mali will always have the same interests. If, for example, Brazil's wage level grows in the future, Brazil might at some point start arguing for protective measures itself and Mali will probably not be able to fund a comparable law case by itself.

The impacts of decreasing aid money, and a decrease in gold revenues are assumed to increase more and more over time. For both impacts, the reason is that they are strongly linked to a second variable. For aid it is assumed that a light decrease of the total amount of money going into Mali comes together with a continuously increasing need of the country for these assets. Gold revenues depend on price and the quantity of exports. This forecast assumes an almost linear decline in the price, which parallels a growing decrease in export quantity because it will become more and more difficult to build new gold mines. The impact of civil wars around Mali is kept constant over the whole period. Even if the assumption holds that the probability declines, the impact will stay unchanged because the causality will not alter. Roads will be blocked and transportation of goods will become difficult and dangerous. Technological progress will have an increasingly reducing impact on malnutrition until a certain maximum is reached. After that, progress will still have a reducing effect, however its absolute impact is declining. The assumption that yields cannot be increased infinitely is based on the law of diminishing marginal benefits, which is known very well in agriculture for centuries. Decreasing subsidies are assumed to have an increasingly negative impact on the amount of malnourished children. It is assumed that liberalization will affect more and more areas and can be described as a snowball effect – starting small and becoming bigger and bigger.

Possible Errors and Shortcomings of the Forecast

The author is convinced that no forecast can ever be perfect. Having this in mind, there are some weaknesses of this paper, which shall be addressed here. This is not meant to be a discussion about the correctness of the prediction. As mentioned earlier, the goal of this study was not to claim that its result mirrors the future 1:1. This project aims at developing one possible and realistic scenario of how the future can look like. The forecast is even not the major purpose of this paper for itself. The project is about getting an idea of how the future nutritional situation among Mali's children can be improved.

Leaving this obsolete critique at side, there can still some weak points be identified within the study. Clearly, the assigned probabilities and impacts for the critical events are questionable (see figure 18 and 19 and appendix 1). Although they were chosen according to best available knowledge, intuition played a big role during the selection process. However, this weakness is also a strength of the applied methodology. The issue is transparency. All events that were applied are identified clearly in the study and are quantified according to probability of occurrence and impact. If a critical reader feels that some of the numbers are unrealistic or if further forecasts, for example based on the Delphi method and expert knowledge, suggest different values for these variables, the forecast can easily be changed and the results compared.

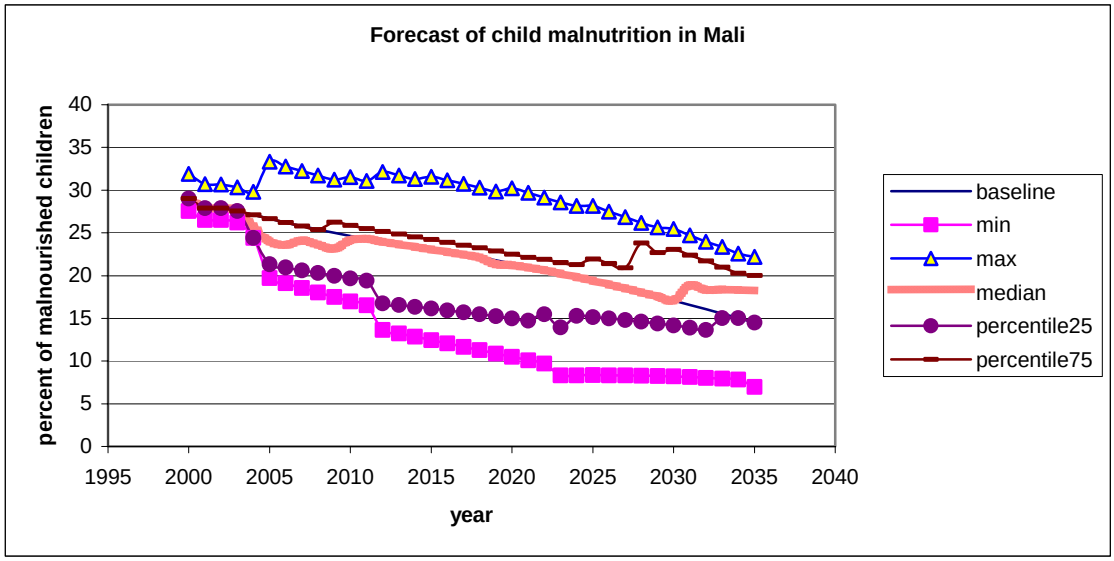
Another acceptable critique aims at the analysis of the variables that drive hunger and child malnutrition in Mali. Again, this list was put together according to the best knowledge available. However, it is not unlikely that expert scholars of Mali may want to add or delete some drivers. The same is true for causal relations among them. This methodology is transparent and everybody is welcome to use its framework and to improve the findings. The author himself is aware that some areas were excluded from the causal diagrams. Further studies should address the households of Mali as a further level of analysis. Malnutrition is often gender or age biased and household

dynamics can help in acknowledging this issue. Another level that was only explored marginally in this study is the national and regional political level of Mali. Maybe an actor-based model could aim at motives and intentions of members of the state elite and state officials that can be assumed to follow more their own goals than pursuing the common wealth. Finally, while this forecast focused heavily on energy intake as the major cause of malnutrition, other origins exist. Further work in this area could investigate disease burden or availability of public health facilities as the driving forces behind child malnutrition in Mali. Many researchers who focus on famines point at collapsing national infrastructures as one major cause. It would be interesting if this is also true for long-term malnutrition.

Interpretation of the Findings

The TIA was run 150 times. According to Gordon, that should be sufficient (Gordon 2003a). That means, for each forecasted year 150 values were calculated. Then, each year was regarded as a variable having 150 observations at different point in time. The 150 observations for each year were summarized with common descriptive statistical indicators: minimum and maximum value, the median, percentile 25, and percentile 75 (see appendix 2 for the raw numbers and figure 20 for a chart). For the purpose of this project it is better to know the value of the median than the arithmetic mean. The latter is much more sensitive for extreme minimum and maximum values and therefore less reliable than the median in order to express a reasonable 'middle'. The range between the two given percentiles equals 50% of the total observation per year. The difference between percentile25 and the minimum value are the lowest 25% of all observations per year; the difference between percentile75 and the maximum value represents the highest 25% of all observations per year.

Figure 20: Forecast



Therefore, one important interpretation of this chart is to look at the area enclosed by the two percentile lines. This area excludes the extreme values that are either higher than percentile75 or smaller than percentile25. Given the assumption that the extreme values are less likely to occur in the future than the values surrounding the median,

the area between the two percentile lines functions as a corridor of the most probable future values for the forecasted variable. Besides these most likely values, a second part of the interpretation is looking at the extremes. Although the minimum and maximum values close to the two percentile lines are less likely to occur, they provide a picture of the range of possible values of the forecasted variable. To sum up, the values between the two percentile lines represent the most likely future development of the amount of malnourished children in Mali, the values between the percentile lines and the minimum and maximum lines give an idea of the possible range of the future.

Looking closer at the diagram (see figure 20), we can divide the forecasted future into two parts: the time before 2025 and after. The median declines almost continually. It starts at over 25%. In 2025 it breaks the 20% mark. From 2025 until 2035 its forecasted values oscillate between 17% and 20%. If we focus on the range between the percentile lines, it makes sense to look at two points in the future: at 2035 and at 2020, which is right in the middle between the present and 2035. In 2020, the percentage of malnourished children in Mali is most likely to find between 25% and 15%. In 2035 this range converges to the spectrum between 20% and 15%. Looking at the minimum and maximum values for the same years, we also get a declining trend. In 2020, values around 30% or 10% would be extreme but not unrealistic. In 2035 this would be true for values around 22% or 7%. To sum up, in 2020, the proportion of children that are malnourished is most likely to be found between 25% and 15%, however, values from 30% to 10% are still realistic. In 2035, Mali has to be prepared for values between 22% and 7%. The most likely ones will be between 20% and 15%.

Advice for the UNDP - Levers for Intervention

As a part of the Millennium Development Goals, the UNDP is committed to the reduction of hunger in the world. One specific target is to halve the proportion of malnourished children until the year of 2015 referring to numbers from 1990. This goal is advocated globally as well as nationally. In the case of Mali, the target would mean to reduce the proportion of malnourished children from 30% in 1990 to 15% in 2015. In the light of this forecast, this goal is doomed to fail if no major changes will happen.

For 2015 the median forecast is 23%. The range of the most probable values is 16% to 24%. According to this study, values between 12% and 31% would be realistic. Keeping this in mind, it makes sense for the UNDP to focus on a more distant future. It will be more realistic to achieve the 15%-goal in 2035 than in 2015. However, even in 2035, the future looks challenging. While the target point of 15% is within the range of realistic values, the more likely ones are higher than this goal. This allows the conclusion that if the UNDP is still committed to achieving MDG1 it has to address events that are likely to affect the forecasted variable. If things will go on as assumed in this forecast, the goal of halving the proportion of malnourished children in Mali will not be achieved, neither in 2015 nor in 2035. Based on this study, the UNDP can help reducing malnutrition in Mali by using the right levers to advocate change. Mali's income from gold exports is beyond the reach of the UNDP. No UN organization can influence the gold price on the world market and the UNDP lacks the knowledge and motivation to increase the production capacity of Mali. However, all four remaining events can be influenced. This forecast suggests focusing on three of

them: technological progress in the national agriculture, flows of international aid money, and subsidies for cotton producers in the US and EU countries.

The strategy of the UNDP should aim at these three variables simultaneously. The UNDP has the moral authority to advocate its member states to make new agricultural technologies easier available for poor countries, for example Mali. This discussion has to address critical issues, such as intellectual property rights and the compensation for this help. The UNDP should assure that the receiving governments, in order to reduce hunger and poverty in the first place, use international developmental aid wisely. If industrialized countries are willing to provide the technology to increase Mali's food production and aid money is spent explicitly for this issue and not on prestigious military projects of the elite, this can be the beginning of a virtuous circle. Reducing hunger should significantly reduce poverty and should allow the rich countries in the long run to decrease their monetary aid for the third world. The UNDP's task would be to serve as a transmitter and negotiator. Donating countries have to be convinced of this positive relationship between hunger reduction and poverty elimination. Their view has to be changed from the short-term perspective – which means high payments for distant places in the world – to a long-term perspective that promises a decline in aid and the improvement of millions of lives. Parallel to these efforts, the UNDP should urge high UN officials like Kofi Annan to advocate a clear third world position during further debates of global trade liberalization. The present WTO laws disadvantage third world agricultural producers significantly. If the US and EU countries stop subsidizing their large-scale cotton producers small farmers in Mali and other African countries would have a realistic chance to sell their produce for a better price and improve their quality of life with their own power.

CONCLUSION

Reducing the amount of hungry people in the world and in Mali by 2035 by half is possible. This forecast helped identifying important levers for intervention. If the UNDP is committed to its declared Millennium Development Goals it has the power to bend the trend. If the future unfolds along the lines laid out in this study, the goal is very unlikely to become reality – neither in 2015 nor in 2035. However, if the UNDP uses its moral authority and administrative resources to advocate for a change in three essential areas, the Mali's children can hope for a better future.

The UNDP must convince the rich countries, which have the potential funds to provide developmental aid, to work jointly together. Transfer of technology will help Mali's farmers to produce more food for their own market. Obviously, Mali should not be encouraged to export this surplus or produce cash crops. Given this, elimination of hunger and reduction of poverty will reinforce each other in a virtuous circle. To provide the necessary funding, developmental aid has to be increased. The responsibility of Mali's government and administration is to secure that these funds are directed towards poverty reduction and elimination of hunger. The UNDP has to install a strict and effective monitoring system. Especially if the forecast holds that Mali's dependence on foreign aid will increase in the future, the UNDP should be concerned about a smooth and uninterrupted flow of these assets in order to prevent a catastrophe. World trade regulations are not in the UNDP's area of responsibility. However, UN representatives should try to convince the powerful WTO members to end the disadvantages of third world agricultural producers by uneven duties to liberalize national markets and subsidize own producers.

APPENDIX

Appendix 1: Probabilities and Impacts of critical events

	probability	impact	probability	impact	probability	impact	probability	impact	probability	impact
	Event number	1		2		3		4		5	
Year	description	technological progress		Decrease of Aid money		Decrease in gold income		Armed conflicts in area		Decreseing subsidies	
2000		0,01	-0,05	0,01	0,05	0,01	0,1	0,3	0,05	0,01	-0,1
2001		0,01	-0,05	0,01	0,05	0,01	0,1	0,3	0,05	0,01	-0,1
2002		0,01	-0,05	0,01	0,05	0,01	0,1	0,3	0,05	0,01	-0,1
2003		0,01	-0,06	0,01	0,05	0,01	0,1	0,3	0,05	0,01	-0,1
2004		0,01	-0,06	0,01	0,05	0,01	0,1	0,3	0,05	0,6	-0,1
2005		0,02	-0,06	0,02	0,2	0,02	0,1	0,3	0,05	0,6	-0,2
2006		0,03	-0,07	0,02	0,2	0,03	0,1	0,4	0,05	0,6	-0,2
2007		0,04	-0,08	0,02	0,2	0,04	0,1	0,4	0,05	0,6	-0,2
2008		0,05	-0,09	0,03	0,2	0,05	0,1	0,4	0,05	0,6	-0,2
2009		0,06	-0,1	0,04	0,2	0,06	0,1	0,4	0,05	0,6	-0,2
2010		0,07	-0,11	0,05	0,23	0,07	0,11	0,4	0,05	0,59	-0,2
2011		0,08	-0,12	0,06	0,23	0,08	0,11	0,4	0,05	0,58	-0,2
2012		0,09	-0,13	0,07	0,23	0,09	0,11	0,4	0,05	0,57	-0,3
2013		0,1	-0,14	0,08	0,23	0,1	0,11	0,4	0,05	0,56	-0,3
2014		0,11	-0,15	0,09	0,23	0,11	0,11	0,4	0,05	0,55	-0,3
2015		0,12	-0,16	0,1	0,26	0,12	0,11	0,4	0,05	0,54	-0,3
2016		0,14	-0,17	0,11	0,26	0,13	0,11	0,4	0,05	0,53	-0,3
2017		0,16	-0,18	0,12	0,26	0,14	0,11	0,4	0,05	0,52	-0,3
2018		0,18	-0,19	0,13	0,26	0,15	0,11	0,4	0,05	0,51	-0,3
2019		0,2	-0,2	0,14	0,26	0,16	0,11	0,4	0,05	0,5	-0,3
2020		0,22	-0,21	0,15	0,29	0,17	0,12	0,25	0,05	0,49	-0,3
2021		0,24	-0,22	0,18	0,29	0,18	0,12	0,22	0,05	0,46	-0,3
2022		0,26	-0,23	0,21	0,29	0,19	0,12	0,19	0,05	0,43	-0,3
2023		0,28	-0,24	0,24	0,29	0,2	0,12	0,16	0,05	0,4	-0,35
2024		0,3	-0,23	0,27	0,29	0,21	0,13	0,13	0,05	0,37	-0,35
2025		0,32	-0,22	0,3	0,32	0,22	0,13	0,1	0,05	0,34	-0,35
2026		0,34	-0,21	0,33	0,32	0,23	0,13	0,07	0,05	0,31	-0,35
2027		0,36	-0,2	0,36	0,32	0,24	0,13	0,04	0,05	0,28	-0,35
2028		0,38	-0,19	0,39	0,32	0,25	0,13	0,01	0,05	0,25	-0,35
2029		0,4	-0,18	0,42	0,32	0,26	0,14	0,01	0,05	0,22	-0,35
2030		0,42	-0,17	0,45	0,35	0,27	0,14	0,01	0,05	0,19	-0,35
2031		0,44	-0,16	0,48	0,35	0,28	0,14	0,01	0,05	0,16	-0,35
2032		0,46	-0,15	0,51	0,35	0,29	0,14	0,01	0,05	0,13	-0,35
2033		0,48	-0,14	0,54	0,35	0,3	0,15	0,01	0,05	0,1	-0,35
2034		0,5	-0,13	0,57	0,35	0,31	0,15	0,01	0,05	0,07	-0,35
2035		0,52	-0,12	0,6	0,38	0,32	0,15	0,01	0,05	0,04	-0,4

Appendix 2: Frequencies of forecasted values per year

year	baseline	min	max	median	percentile25	percentile75
2000	29	27,55	31,9	29	29	29
2001	27,9	26,51	30,69	27,9	27,9	27,9
2002	27,88	26,49	30,67	27,88	27,88	27,88
2003	27,57	26,19	30,33	27,57	27,57	27,57
2004	27,11	24,4	29,82	25,75	24,4	27,11
2005	26,66	19,73	33,33	23,99	21,33	26,66
2006	26,21	19,13	32,76	23,59	20,97	26,21
2007	25,79	18,57	32,24	24,11	20,63	25,79
2008	25,38	18,02	31,73	23,6	20,3	25,38
2009	24,99	17,49	31,24	23,12	19,99	26,24
2010	24,63	16,99	31,53	24,14	19,7	25,86
2011	24,29	16,52	31,09	24,29	19,43	25,5
2012	23,96	13,66	32,11	23,96	16,77	25,16
2013	23,66	13,25	31,7	23,66	16,56	24,84
2014	23,35	12,84	31,29	23,35	16,35	24,52
2015	23,05	12,45	31,58	23,05	16,14	24,2
2016	22,75	12,06	31,17	22,75	15,93	23,89
2017	22,44	11,67	30,74	22,44	15,71	23,56
2018	22,12	11,28	30,3	22,12	15,48	23,23
2019	21,78	10,89	29,84	21,34	15,25	22,87
2020	21,42	10,5	30,2	21,21	14,99	22,49
2021	21,05	10,1	29,68	20,94	14,74	22,1
2022	20,66	9,71	29,13	20,66	15,5	21,9
2023	20,26	8,31	28,57	20,26	13,93	21,53
2024	19,84	8,33	28,17	19,84	15,28	21,28
2025	19,41	8,35	28,14	19,41	15,14	21,93
2026	18,96	8,34	27,49	18,96	14,98	21,42
2027	18,51	8,33	26,84	18,51	14,81	20,92
2028	18,04	8,3	26,16	18,04	14,61	23,81
2029	17,57	8,26	25,65	17,57	14,41	22,67
2030	17,08	8,2	25,45	17,08	14,18	23,06
2031	16,57	8,12	24,69	18,89	13,92	22,37
2032	16,07	8,04	23,94	18,32	13,66	21,69
2033	15,56	7,94	23,34	18,36	15,02	21
2034	15,03	7,82	22,55	18,34	15,03	20,29
2035	14,5	6,96	22,19	18,27	14,5	20,01

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