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A brief comparison of scenario assumptions of four scenario studies: IPCC-SRES, GEO-3, Millennium Ecosystem Assessment and FAO towards 2030

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This investigation has been performed by order and for the account of < >, within the framework of project xxxxxx, <title project in English>.

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Abstract

Preface

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1. Introduction

1.1 Setting and purpose

Scenarios will play an important role in the "International Assessment of Agricultural Science and Technology for Development" (IAASTD in order to address focal questions like: What can be plausible futures for agriculture and its role for global environmental change and what is the place of agriculture (and agricultural knowledge, science, and technology; AKST) in that future? Within the process of the IAASTD, the decision has been made to base the scenarios studies and further scenario development on the scenarios developed earlier within the Millennium Ecosystem Assessment. Each of these scenarios will be enriched through a more comprehensive representation and analysis of the development of AKST and analysed in the context of global development goals (in particular the Millennium Development Goals), key challenges for agricultural development and consequences for the policy and institutional context. The scenario analysis will concentrate on the 2000-2050 period.

This short paper compares several earlier scenario studies in order to facilitate the discussion with IAASTD on scenarios. As most relevant regarding to the IAASTD the following studies were identified: IPCC-SRES, GEO-3 (UNEP), the Millennium Ecosystem Assessment (MA) and the FAO study World agriculture towards 2015/2030. The paper focuses mainly on those elements of the scenarios that are most relevant with respect to our purpose (the IAASTD). These were:

- Direct driving forces: the (quantitative) assumptions on demographic changes and on GDP per capita;
- Qualitative assumptions regarding technological change / innovation;

The description of the results of the scenarios focuses on:

- Per capita food intake (total and of animal origin) in the different scenarios;
- The number of animals;
- The crop yield per ha;
- The area under arable crops and the area for grass and fodder production

2. Description of scenarios

In this Chapter we provide a brief overview of the main storylines and means of quantification underlying the different scenarios studies.

2.1 Type of scenarios

An assessment of the scenario literature as part of the Millennium Ecosystem Assessment revealed that in most studies published over the last few years a limited set of 'archetype' scenarios can be found (Raskin et al., 2005). These include the following:

1. *Economic optimism scenarios*. Scenarios with an orientation on market dynamics, economic optimism, associated with rapid technology development.
2. *Reformed market scenarios.* This set of scenarios has a similar basic philosophy as the first set, but includes policies to correct market failures with respect to social development, poverty alleviation and environmental protection. These policies do not aim to fundamentally change the way society is functioning.
3. *Global sustainable development.* The third set of scenarios has a strong orientation of environmental protection and reducing inequality. Solutions are found by global cooperation, lifestyle change and adopting much more efficient technologies.
4. *Regional competition.* Regional competition scenarios assume that regions will focus more on the regional identity and interests. As a result, tensions among regions/cultures will arise. In general, these are low economic growth scenarios, in particular in current low income regions.
5. *Regional sustainable development.* The last set is formed by scenarios that focus on finding regional solutions for current environmental and social problems. These scenarios combine lifestyle changes with decentralisation of governance.

A group of "business as usual" scenarios could possibly be defined as a sixth category. In general, this category encompasses more short-term scenarios that do not intend to explore the range of possible outcomes, but instead a more likely chain of events given present day trends.

Below we have indicated how the scenarios within the scenarios studies discussed here relate to these different archetypes. In some cases, however, this is not straightforward. For instance, the *Global Orchestration* scenario of the Millennium Ecosystem Assessment is not a full reformed market scenario as it is reactive in environmental policies. On the other hand, the scenario does assume strong social policies to reduce global poverty. It can thus be put in both the first and the second category. The same holds for the IPCC *B1* scenario – which shares many elements of a global sustainable development scenario, but assumes no policies for a major environmental problem, climate change. Variants of B1 that include climate policy[1] are therefore better representation of this particular archetype.

[1] (e.g. B1-450, a scenario that aims to stabilise greenhouse gas concentration at 450 ppmv CO_2-eq)

Table 2.1 : Overview of different scenario families

	IPCC-SRES	GEO-3	Millennium Ecosystem Assessment	FAO
Economic optimism, market liberalisation	A1	Markets First	*Global Orchestration*	
Reformed market scenario		Policies First	*Global Orchestration*	
Global sustainable development	*B1* (B1-450)	Sustainability First	TechnoGarden	
Regional competition, low growth	A2	Security First	Order from Strength	
Regional sustainable development	*B2*		Adapting Mosaic	
"Business as usual" (medium scenario)	*B2*			AT2015/2030

(Italics are used to indicate that scenarios are not completely consistent with the group in which it is categorised.

If classified in this way, the sets of archetype scenarios share important assumptions for different domains. The table below aims to summarise these assumptions in very general terms. In case differences within the set exist, broad ranges are indicated. Nevertheless, table provides a rather consistent view of the main assumptions within each scenario type.

Table 2.2 : Overview of common characteristics in scenario families

	Economic optimism	**Reformed markets**	**Global sustainable development**	**Regional competition**	**Regional sustainable development**	**FAO**
Economic development	Very rapid	Rapid	Slow-rapid	Slow	Slow/medium	Medium
Population growth	Low	Low	Low	High	Medium	Medium
Technology development	Rapid	Rapid	Medium-Rapid	Slow	Slow-medium	Medium (Rapid in some regions)
Main objectives	Economic growth	Various goals	Economy, Environment, Equality	Security	Local sustainability	-
Attitude towards env. Protection	Reactive	Pro-active – reactive	Pro-active	Reactive	Pro-active	Medium
Trade	Globalisation	Globalisation	Globalisation	Trade barriers	Trade barriers	Globalisation
Policies/institutional development	Policies create level playing fields for markets	Policies help reducing market failures	Strong global governance	Strong national governments	Local steering; local actors	

2.2 Quantification

Various models were used to develop the scenarios. Below, we indicate the main models that were used in each exercise. In IPCC-SRES, the six participating models were used each to quantify the same parameters, as a mean to identify uncertainties. In the other studies, most models were selected to model specific parameters, and outcomes of one model were used as input for the next.

Table 2.3 : Overview of models used in different studies

	IPCC-SRES	**GEO-3**	**Millennium Ecosystem Assessment**	**FAO**
Models used in quantification	AIM, ASF, IMAGE **,** MARIA MESSAGE, MiniCam,	PoleStar, IMAGE, AIM, WaterGAP, GLOBIO	IMPACT, IMAGE, AIM, WaterGap	FAO
Main interest	Greenhouse gas emissions	Global environmental change	Changes in ecosystem services;	Changes in agricultural production

2.3 Storylines of the scenarios

IPCC-SRES

The *A1 storyline* and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B).

The *A2 storyline* and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented. Per capita economic growth and technological change are more fragmented and slower than in other storylines.

The *B1 storyline* and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

The *B2 storyline* and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of

economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

Scenarios GEO-3

Markets first - Most of the world adopts the values and expectations prevailing in today's industrialized countries. The wealth of nations and the optimal play of market forces dominate social and political agendas. Trust is placed in further globalization and liberalization to enhance corporate wealth, create new enterprises and livelihoods, and so help people and communities to afford to insure against — or pay to fix — social and environmental problems. Ethical investors, together with citizen and consumer groups, try to exercise growing corrective influence but are undermined by economic imperatives. The powers of state officials, planners and lawmakers to regulate society, economy and the environment continue to be overwhelmed by expanding demands.

Policy first - Decisive initiatives are taken by governments in an attempt to reach specific social and environmental goals. A coordinated pro-environment and anti-poverty drive balances the momentum for economic development at any cost. Environmental and social costs and gains are factored into policy measures, regulatory frameworks and planning processes. All these are reinforced by fiscal levers or incentives such as carbon taxes and tax breaks. International 'soft law' treaties and binding instruments affecting environment and development are integrated into unified blueprints and their status in law is upgraded, though fresh provision is made for open consultation processes to allow for regional and local variants.

Security First - This scenario assumes a world of striking disparities where inequality and conflict prevail. Socio-economic and environmental stresses give rise to waves of protest and counteraction. As such troubles become increasingly prevalent, the more powerful and wealthy groups focus on self-protection, creating enclaves akin to the present day 'gated communities'. Such islands of advantage provide a degree of enhanced security and economic benefits for dependent communities in their immediate surroundings but they exclude the disadvantaged mass of outsiders. Welfare and regulatory services fall into disuse but market forces continue to operate outside the walls.

Sustainability first - A new environment and development paradigm emerges in response to the challenge of sustainability, supported by new, more equitable values and institutions. A more visionary state of affairs prevails, where radical shifts in the way people interact with one another and with the world around them stimulate and support sustainable policy measures and accountable corporate behaviour. There is much fuller collaboration between governments, citizens and other stakeholder groups in decision-making on issues of close common concern. A consensus is reached on what needs to be done to satisfy basic needs and realize personal goals without beggaring others or spoiling the outlook for posterity.

Millennium Ecosystem Assessment

Global Orchestration – This scenario depicts a globally connected society that focuses on global trade and economic liberalization and takes a reactive approach to ecosystem problems but that also takes strong steps to reduce poverty and inequality and to invest in public goods

such as infrastructure and education. Economic growth in this scenario is the highest of the four scenarios, while it is assumed to have the lowest population in 2050.

Order from Strength – This scenario represents a regionalized and fragmented world, concerned with security and protection, emphasizing primarily regional markets, paying little attention to public goods, and taking a reactive approach to ecosystem problems. Economic growth rates are the lowest of the scenarios (particularly low in developing countries) and decrease with time, while population growth is the highest.

Adapting Mosaic – In this scenario, regional watershed-scale ecosystems are the focus of political and economic activity. Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to the management of ecosystems. Economic growth rates are somewhat low initially but increase with time, and population in 2050 is nearly as high as in *Order from Strength.*

TechnoGarden – This scenario depicts a globally connected world relying strongly on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and taking a proactive approach to the management of ecosystems in an effort to avoid problems. Economic growth is relatively high and accelerates, while population in 2050 is in the mid-range of the scenarios.

3. Main driving forces

3.1 Population in the three studies scenarios

Figures 3.1 to 3.7 give an impression of the development of the population in the four scenarios for the world (total) and four the 6 regions as identified used by the MA-study. See Appendix 1 for an explanation of the MA definition of the regions.

- Successive demographic scenarios as published by the official institutes over the last 10 years have shown lower global population projection each time a new scenario was published. As the scenarios discussed here do base their assumptions on these publications, more recent studies generally have lower projections than older studies.
- As IPCC-SRES and GEO-3 are somewhat "older" scenarios, the population growth are highest in these scenarios. Therefore, the population growth is by far the strongest in the SRES-A2 scenario and in the GEO3- Security First Scenario, leading to a world population of 11,300 million in 2050.
- The scenario with the lowest population growth is MA-Global orchestration, leading to 8,179 million people in 2050.
- The difference between the scenarios is mainly caused by developments in Asia, Africa and Central and South America. The scenario's with the largest population start with an annual growth rate of 1.6% declining to about 0.9% in 2050. The scenarios with the lowest growth rate start with growth rates of 1.4%, decreasing to 0.15% in 2050.
- The UN's World Population Prospects gives a high, a medium and a low forecast for 2050, being 10,6, 8,9 and 7,4 billion respectively. The UN's high forecast is based on constant fertility rates and must be considered an extreme value (Hughes, 2005, in prep.).
- The FAO Towards 2030 study is based on a world population of 8,300 million people in 2030, being a medium projection. The same projection leads to 9,300 million people in 2050.

3.2 Per capita income growth in the three studies

In most studies, the per capita income is used as a measure of the development of economic development. The values are (as usually) expressed in US$ based on market exchange rates (mer). In literature there is a debate on whether purchasing power parity based estimates is a better indicator.

The figures show the GDP per capita growth (in % per year) for the period 2000-2025 and 2025-2050. The figures lead to the following conclusions:

- When comparing the three studies, the main difference is that in the SRES and GEO-3 scenarios the growth rates in developing regions (particularly in Africa) during the first period (2000-2025) is higher then in the MA-scenarios. This is due to the fact that in the MA-scenarios were for this period based on the assumptions in the World Bank's economic prospects to 2015 (World bank, 2002). This lead to a downward adjustment of the growth rates for most developing regions.
  As a result the degree of convergence is also somewhat lower in the MA-scenarios;
- When comparing regions, the large growth in Asia, which is sustained over many years, is most noticeable. The OECD countries show the most moderate economic growth, with the lowest variation between the scenarios;
- The highest economic growth is assumed in globalizing scenarios (economic optimism) like Global Orchestration / Markets First, whereas regional competition scenarios show significant lower economic growth (like Order from Strength / Security First).

4. Scenario results

4.1 Per capita food intake (total and of animal origin) in the different scenarios[2]

Total per capita food consumption (figure 4.1)

- Roughly, the MA regions can be divided in three groups: a group with a high caloric intake (MENA and OECD), a medium intake (Asia, FSU and LAM) and a low intake (SSA). The regions with a high intake (more than 3000 kcal per day) do not show a high increase, whereas the medium group (intake between 2500 and 3000 kcal per day) clearly converges to the current level of the high income countries in 2050. In the Sub-Saharan Africa region with an average total daily consumption of less then 2500 kcal per capita the situation slightly improves over time, but still in 2050 the average food intake is significantly lower then in the other regions;
- In all regions, food consumption increases in general the most in globalising scenarios (A1b, B1, GEO3: Policy First);
- In the scenarios A2 and Security First the food intake of the MENA regions declines, indicating a situation of food insecurity, mainly coming from an increase in population (Figure 3.3) and less possibilities of own food production, combined with an assumed low level of trade.

Per capita consumption of food from animal origin (figure 4.2)

- the differences between regions, scenarios and years in the consumption of animal products are much larger than in the total food intake;
- the consumption in Asia, LAM and SSA more or less doubles between 1995 and 2050; again with the highest values in the globalizing, economic optimism scenarios (A1, Markets First, Policy First);
- In regions with an intermediate consumption in 1995 (Asia and LAM), consumption in 2050 has risen towards 800 (up to 1000) in the globalising scenarios.
- In most OECD countries with an already high intake of animal products (around 1000 or higher) consumption remains more or less the same;
- In LAM and FSU, consumption rises towards OECD levels in almost all scenarios.

[2] For these numbers, no data from the MA and FAO scenario analyses were available.

4.2 The number of animals

Logically, the number of animals is determined by the animal intake to a high extent. However, in globalizing scenarios the animal efficiency is assumed to increase faster as well, leveling off the difference in number of animals between the scenarios.[3]

The number of dairy cattle (figure 4.6) decreases in most regions in almost all SRES (and GEO3) scenarios, with a strong decrease in LAM, SSA and FSU. Only in Asia some scenarios give an increase (A2 and also Security First). Most MA scenarios show a strong increase in most regions (notably LAM and SSA), while the numbers decrease in the OECD and FSU regions. In general, differences between the three studies are much larger then between different scenarios within one study. The main reason for the differences between SRES/GEO and MA is caused by a different modeling approach: in SRES/GEO the animal intake is simulated by IMAGE, whereas in MA the trade balance and food intake is simulated by IMPACT.

The number of pigs (Figure 4.7) slightly increases in most regions and in most scenarios. SSA shows a strong increase in the number of pigs in the SRES and GEO3 scenarios; whereas the MA scenarios show a weaker increase. Also Asia shows a strong increase (up to 30%) in some scenarios; especially in A2, Security First and Global Orchestration.

The number of poultry (Figure 4.8) doubles in some scenarios in Latin America, Asia, MENA and SSA between 2000 and 2030. The increase in the MA scenarios is generally lower than in the other studies. The differences between the scenarios of one study are not very large.

[3] Here, the differences between the SRES and GEO scenarios are lower than the differences between SRES/GEO and the Millennium Assessment scenarios. Therefore, we only plotted the SRES and MA numbers.

4.3 The crop yield per ha

The development of the crop yield per ha is presented for maize (Figure 4.3), rice (Figure 4.4) and temperate cereals (Figure 4.5). Here, we present the numbers per IMAGE region instead of MA region (see Appendix 1). Per crop, the most relevant regions were selected, because the presentation of all 17 Image-regions for each crop would yield non-readable graphs.

Maize
Although the growth in yield is relatively high in most developing regions, yields remain far below levels attained in OECD countries. Differences between studies and scenarios are not very dominant, although in most cases the globalized scenarios show the highest increase in yield growth (A1, B1, Markets First, Policy First, Sustainability First, Global Orchestration and TechnoGarden). East Asia shows the highest differences between studies: while the MA scenarios and the FAO study show an increase of around 40% in yield growth between 1995 and 2030, the SRES and GEO scenarios indicate an increase of only 10%. Clearly, this difference impacts the future size of arable land needed for food supply.

Rice
Here, the picture is comparable to the trends observed in the maize yield increase: strong increase in yield levels (20-60%) in developing regions, but still not levels which are attained in developed regions. In East Asia the highest increase in yields is in the MA scenarios and in FAO2030. In the other regions, differences between studies are smaller, although yield increase is higher in SRES (notably A1 and B1) and GEO3 scenarios.

Temperate cereals
In general, lower increase in yield growth than in other crops with exception of the regions Canada, USA, Latin America and Eastern Europe. In these regions, the yield approaches the level of OECD Europe, which remains constant in most of the studies (with the exception of the FAO study, in which the cereals yield increase might be caused by a shift of agricultural practices from Southern Europe to Northern Europe). Yield increase in MA scenarios is generally somewhat lower than in the other scenarios.

In general, the FAO estimate for technological increase is for some regions (mainly East Asia) on the high side, which contrasts a business as usual approach.

4.4 The area under arable crops and the area for grass and fodder production

The total crop area (all arable and perennial crops, excluding pastures and land for fodder production) is shown in Figure 4.9. The crop area is a product of increase in crop production and yield increase. In most scenarios these two factors are counteracting: scenarios with a high increase in crop production usually coincide with a high increase in crop yield and vice versa. Therefore, differences between scenarios are smaller than in the case of yield changes and crop production.

The pasture area (Figure 4.10) is fully dependent of the number of animals, the animal efficiency, the animal diet (crops or pasture) and the grazing intensity. Here, the differences

between scenarios are larger, since not all factors are counteracting. Acreages remain more or less the same in Asia, FSU and MENA. There is a decline in pasture area in LAM and OECD countries in most scenarios, but most clearly in globalizing scenarios where the animal efficiency shows the strongest increase, the animal diet has the largest shift to crops and the grazing intensity is highest. In Latin America pasture acreage increases in A2, Security First and Order from Strength, mainly because a slower decrease in feed efficiency and a lower increase in grazing intensity. In SSA the pasture area (strongly) increases in all scenarios, except for FAO2030.

4.5 Improvement in technology and agricultural management

In the Figures 4.11 to 4.17, the technological factors determining the number of animals and size of arable and pasture land are plotted. These factors are determined exogenously within the SRES and GEO3 scenarios (within the IMAGE model), whereas these factors are simulated endogenously in the MA scenarios (by the IMPACT model and thereafter implemented in IMAGE). Three important factors encompassing technological change in the scenarios are the management factor, the grazing intensity and the animal feed efficiency.

The *management factor* is an input variable representing the difference between the actual yield and the theoretically feasible yield of crops, based on climate and soil conditions. It is therefore a function of (less than ideal) management practices, technology and know-how.

Grazing intensity is the term used for the management factor for grass and fodder. It is thus defined as an input variable representing the difference between the actual yield and the theoretically feasible yield for grass and fodder, based on climate and soil conditions.

Feed efficiency is defined as the total amount of feed in kg dry matter (DM) required for the production of 1 kg of mutton, goat meat, poultry, eggs, pork, beef or cow's milk Therefore, a decrease in feed efficiency indicates an improvement in animal productivity.

The exception is the grazing intensity (Figure 4.14), which is an exogenous assumption in all studies and determines the amount of pasture land needed for animal feeding. In the Figures 4.11 to 4.13 the management factor for maize, rice and temperate cereals are depicted respectively and in the Figures 4.15 to 4.17 the feed efficiency (result of changes in animal productivity, off-take rate and extraction rate) of dairy cattle, pigs and poultry respectively are given. Again, these data are given for a number of IMAGE regions (see Appendix 1).

Management factor crops
In general, the MA scenarios are more optimistic in technology improvements in developing countries than the SRES (and GEO3) scenarios. Especially, maize and rice in East Asia show an increase in technology that is driven by a large increase in demand for these crops in this region. Clearly, the MA scenario Order form Strength shows an apparent lower increase in technology than the other MA scenarios. In developed and transition regions, the expectations in technology improvement are mixed: while SRES scenarios do not expect much improvement in OECD Europe for temperate cereals, the MA scenarios still show an increase. However, in FSU the SRES scenarios are more optimistic than the MA scenarios where no increase in technology is expected.

Grazing intensity
The grazing intensity in OECD Europe is clearly the highest given their agricultural practices in livestock production (landless and industrial practices). This grazing intensity in OECD Europe is expected to increase in all scenarios to minimize further damage to nature, with the exception of Order from Strength where ecosystem protection is less important. In Canada and the USA there are fewer incentives to increase the grazing intensity. Therefore, in some developing countries such as South America and Eastern Africa, the increase in grazing intensity is the largest, especially in technology driven scenarios like TechnoGraden and to a lesser extent A1, B1 and Global Orchestration.

Animal feed efficiency
The feed efficiency of land demanding dairy cattle (Figure 4.15) shows a tremendous decrease in the SRES (and GEO3 scenarios), whereas this decrease is smaller in the MA scenarios. This decrease in feed efficiency explains the decrease of pasture land, for example in the SRES scenarios in Central America. Again, the differences between the studies are larger than the differences between the scenarios within one study, confirming the need for a thorough look at these developments in feed efficiency.

The differences between projections for efficiencies of landless livestock like pigs and poultry are much smaller. Usually, economic driven scenarios (A1 and Global Orchestration) show the steepest decrease in feed efficiency, leading to less feed needed for these animals. In developed countries these animal efficiencies are not expected to decrease anymore. Therefore, some developing regions seem to catch up with the developed countries in the coming 50 years.

References

Annex 1: Methodological remarks

IMAGE implementation
All results as presented here result from the IMAGE implementation of the different scenario studies. There might be differences between these implementations and implementation by means of other models. This might especially by the case for the SRES-IPCC-scenarios, for which there are several implementations, although in most other models the land-use implementation is less detailed. In the GEO3 and MA scenarios, the IMAGE model was part of the official model framework being used for these scenario analyses.

Regions
Most results are expressed per world region as defined in the MA study. Since we calculate the results for the 17 IMAGE-regions, an aggregation had to be made (see Table below). The translation from countries to IMAGE regions can be found on http://www.mnp.nl/image/.

MA-region	IMAGE-regions
Asia	East Asia South Asia South East Asia
Middle East and North Africa (MENA)	Middle East Northern Africa
Sub Saharan Africa (SSA)	Eastern Africa Southern Africa Western Africa
Latin America	Central America South America
OECD	Canada Eastern Europe Japan Oceania OECD Europe USA
Former Soviet Union (FSU)	Former USSR

Annex 2: Figures

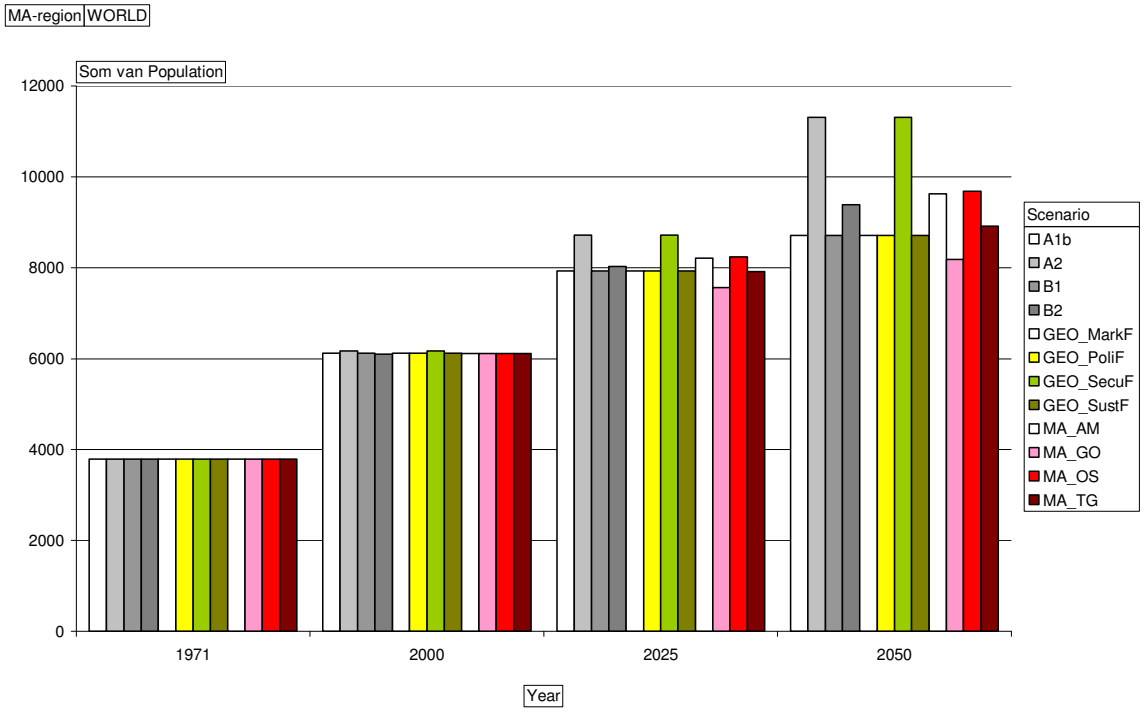

Figure 3.1 World population in the three studies

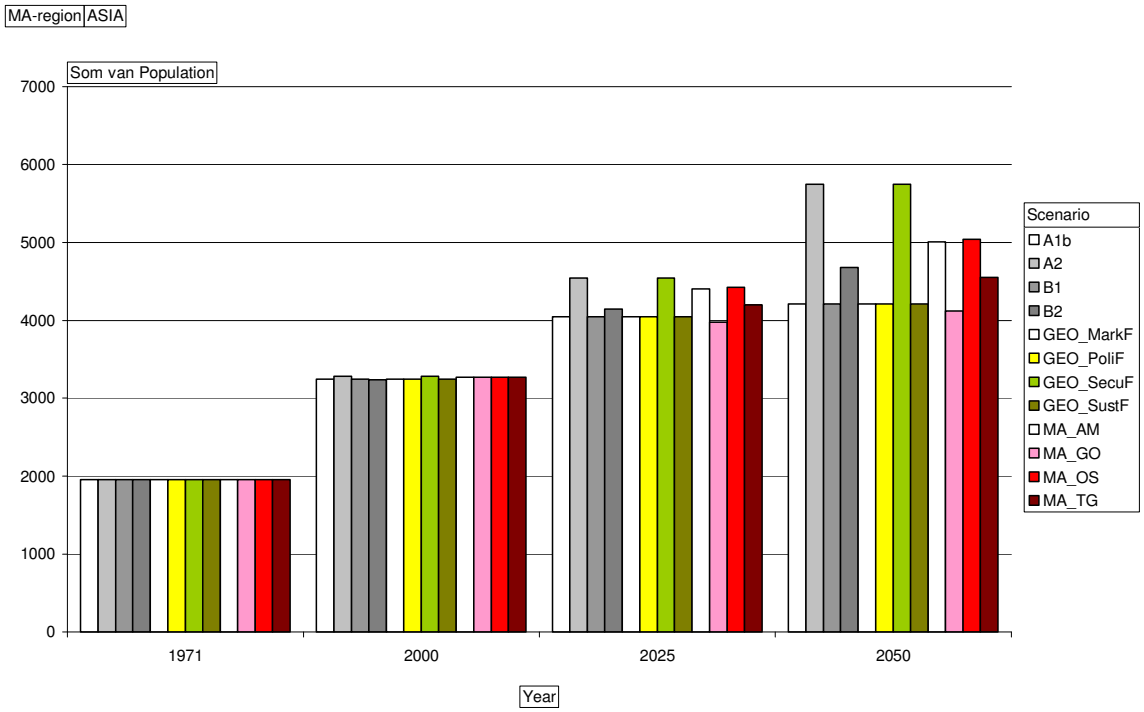

Figure 3.2 Population in Asia in the three studies

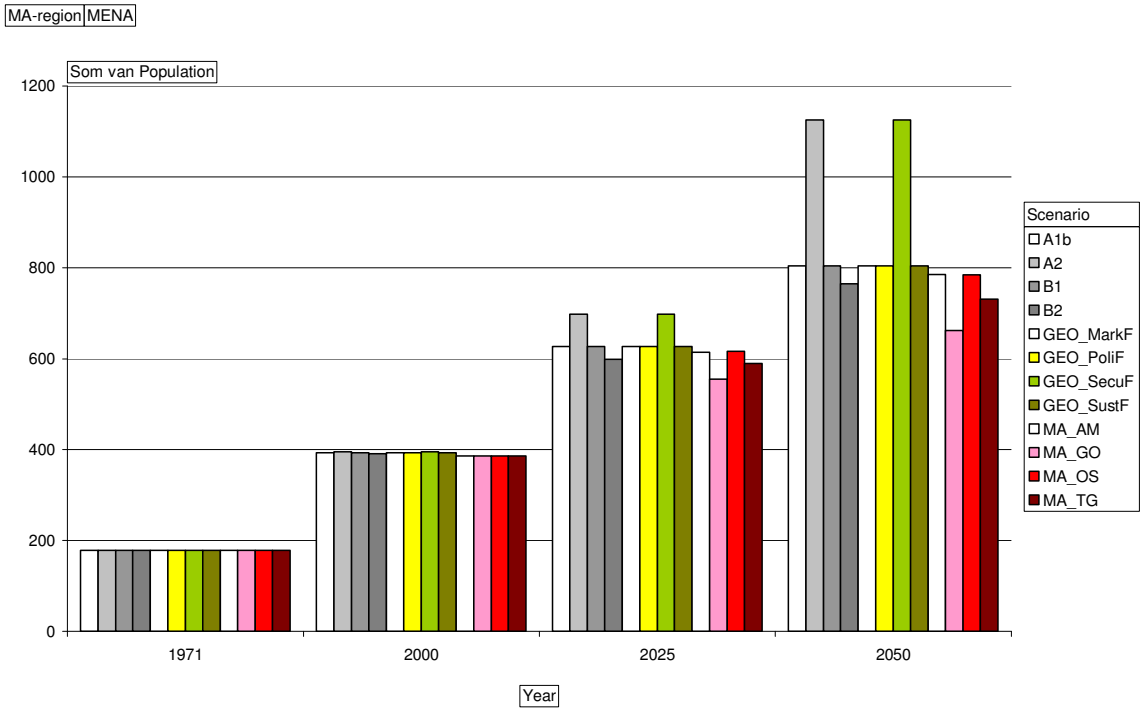

Figure 3.3 Population in North Africa and West-Asia in the three studies

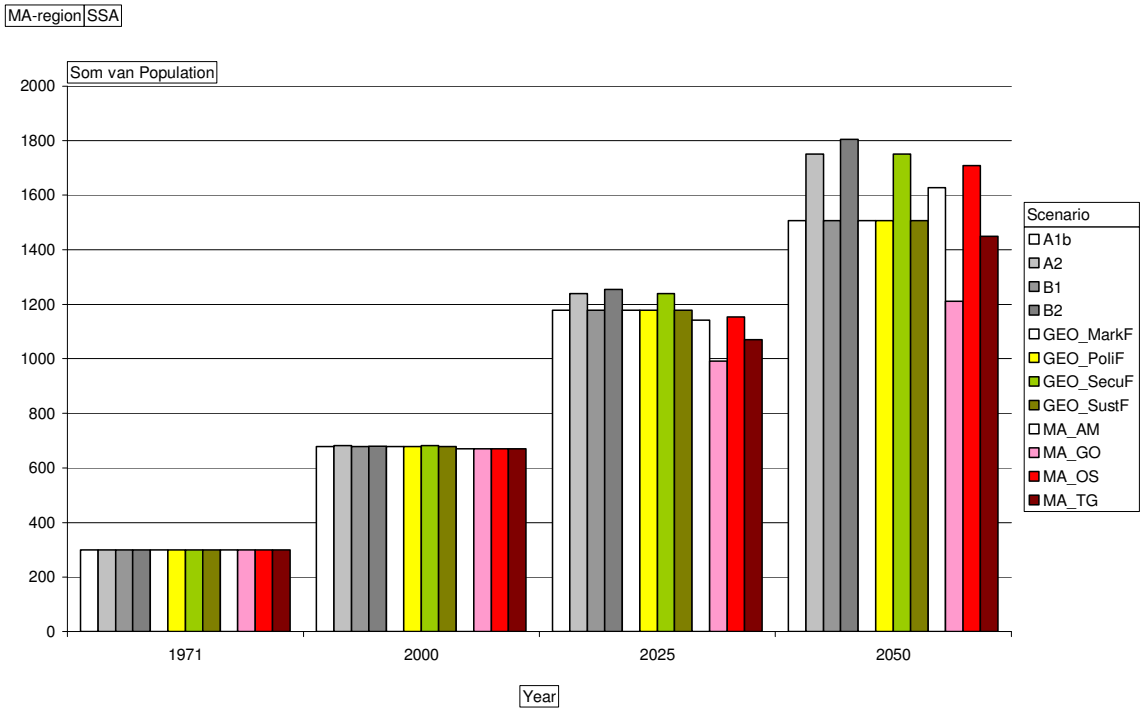

Figure 3.4 Population in Sub Saharan Africa in the three studies

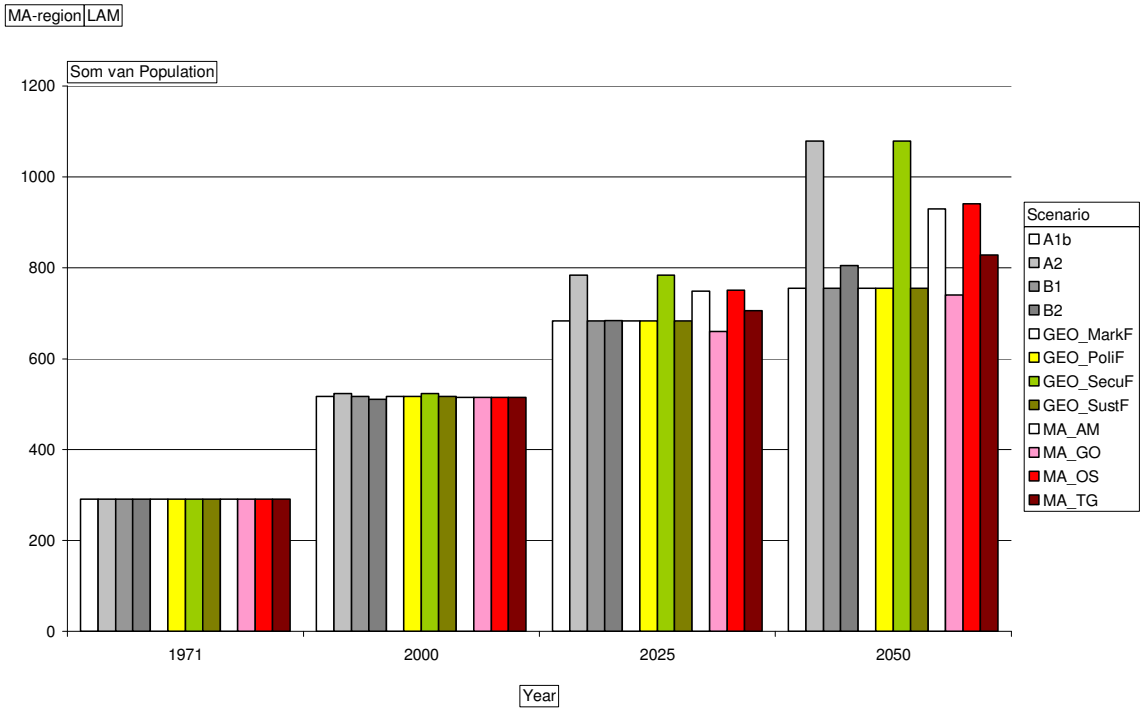

Figure 3.5 Population in Central and South America in the three studies

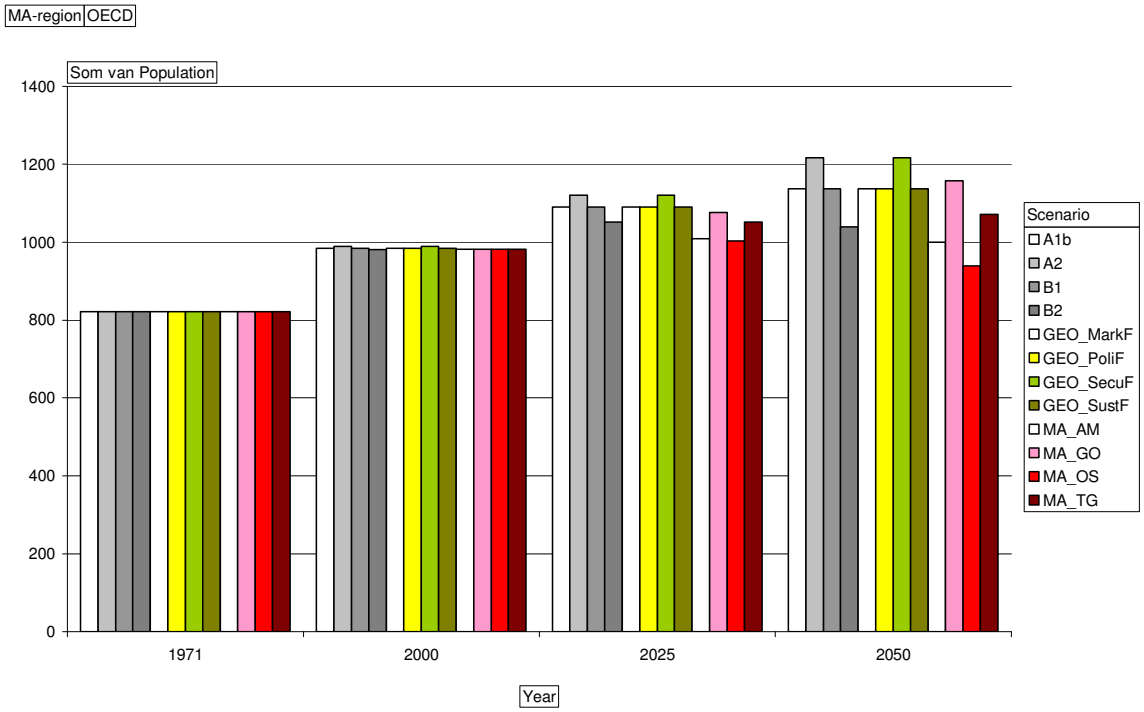

Figure 3.6 Population in the OECD countries in the three studies

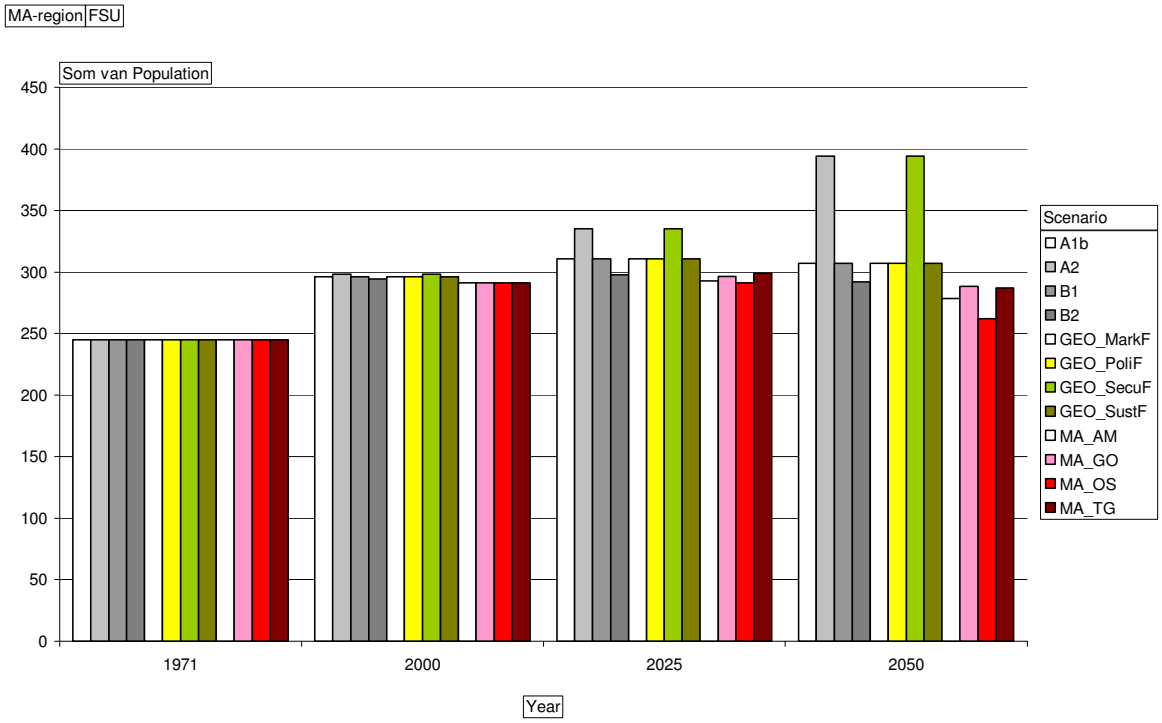

Figure 3.7 Population in the FSU in the three studies

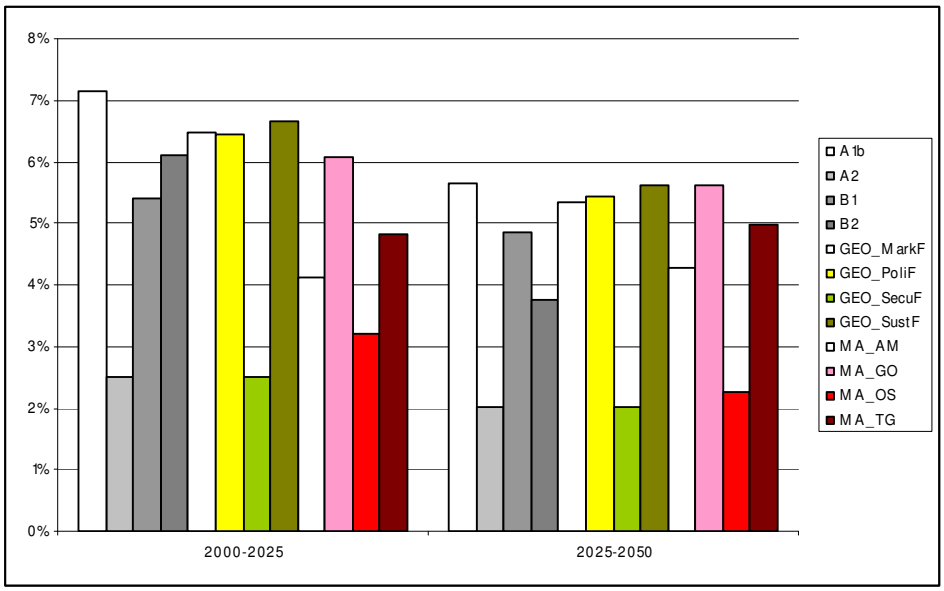

Figure 3.8 GDP per capita growth 2000-2025 and 2025-2050 Asia

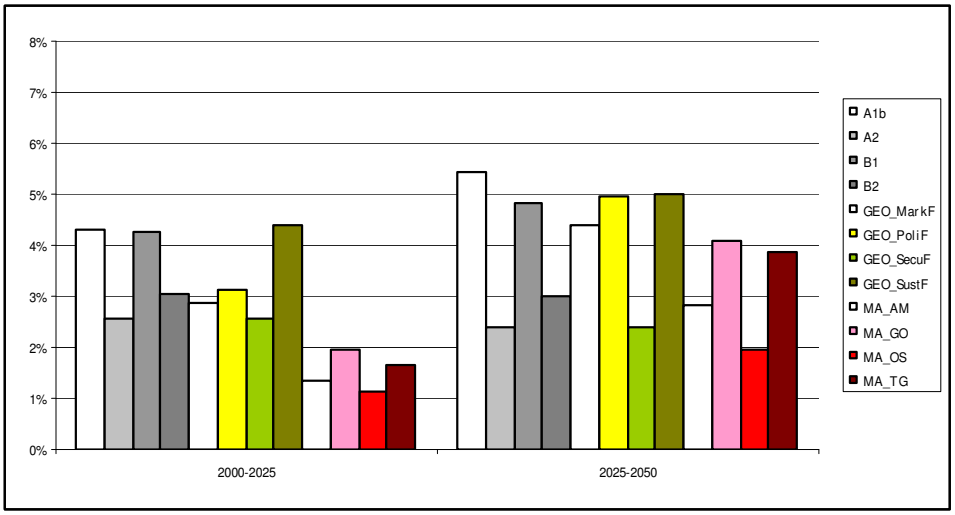

Figure 3.9 GDP per capita growth 2000-2025 and 2025-2050 in North Africa and West-Asia

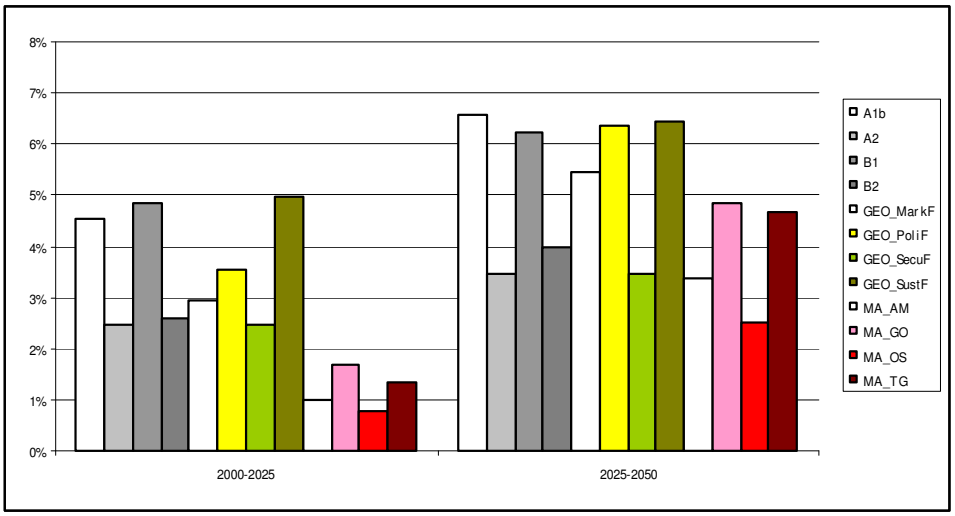

Figure 3.10 GDP per capita growth 2000-2025 and 2025-2050 in SSA

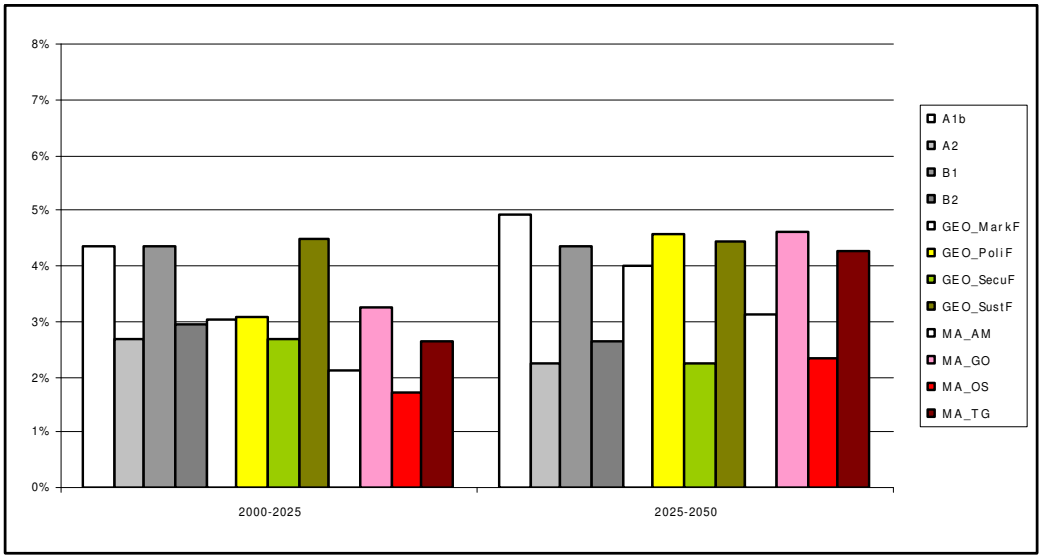

Figure 3.11 GDP per capita growth 2000-2025 and 2025-2050 in Central and South America

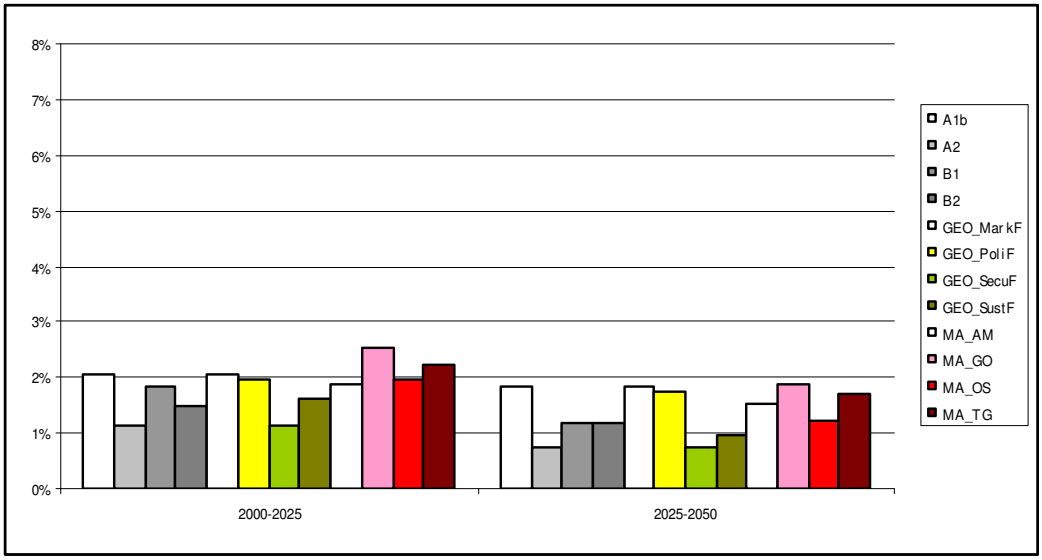

Figure 3.12 GDP per capita growth 2000-2025 and 2025-2050 in the OECD countries

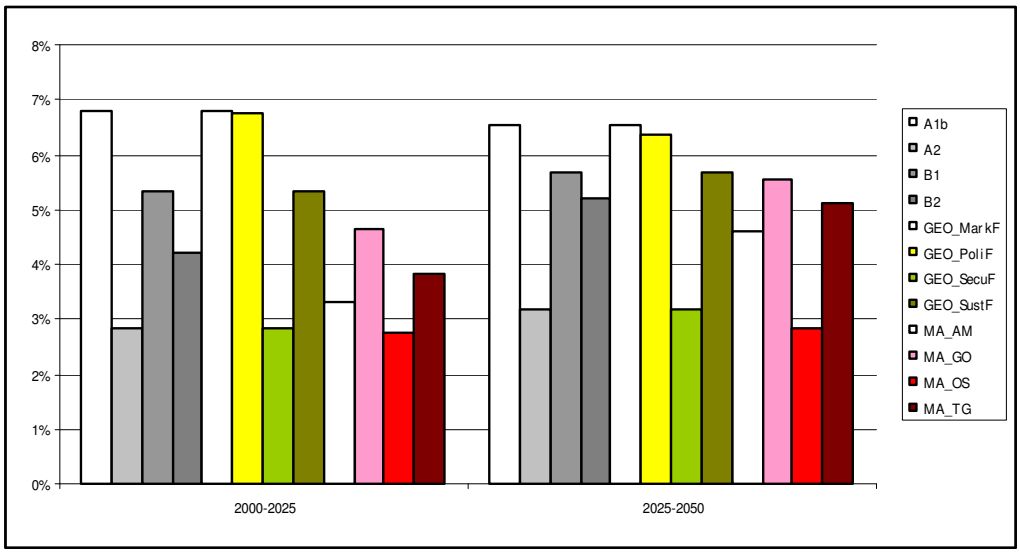

Figure 3.13 GDP per capita growth 2000-2025 and 2025-2050 in the FSU in the three studies

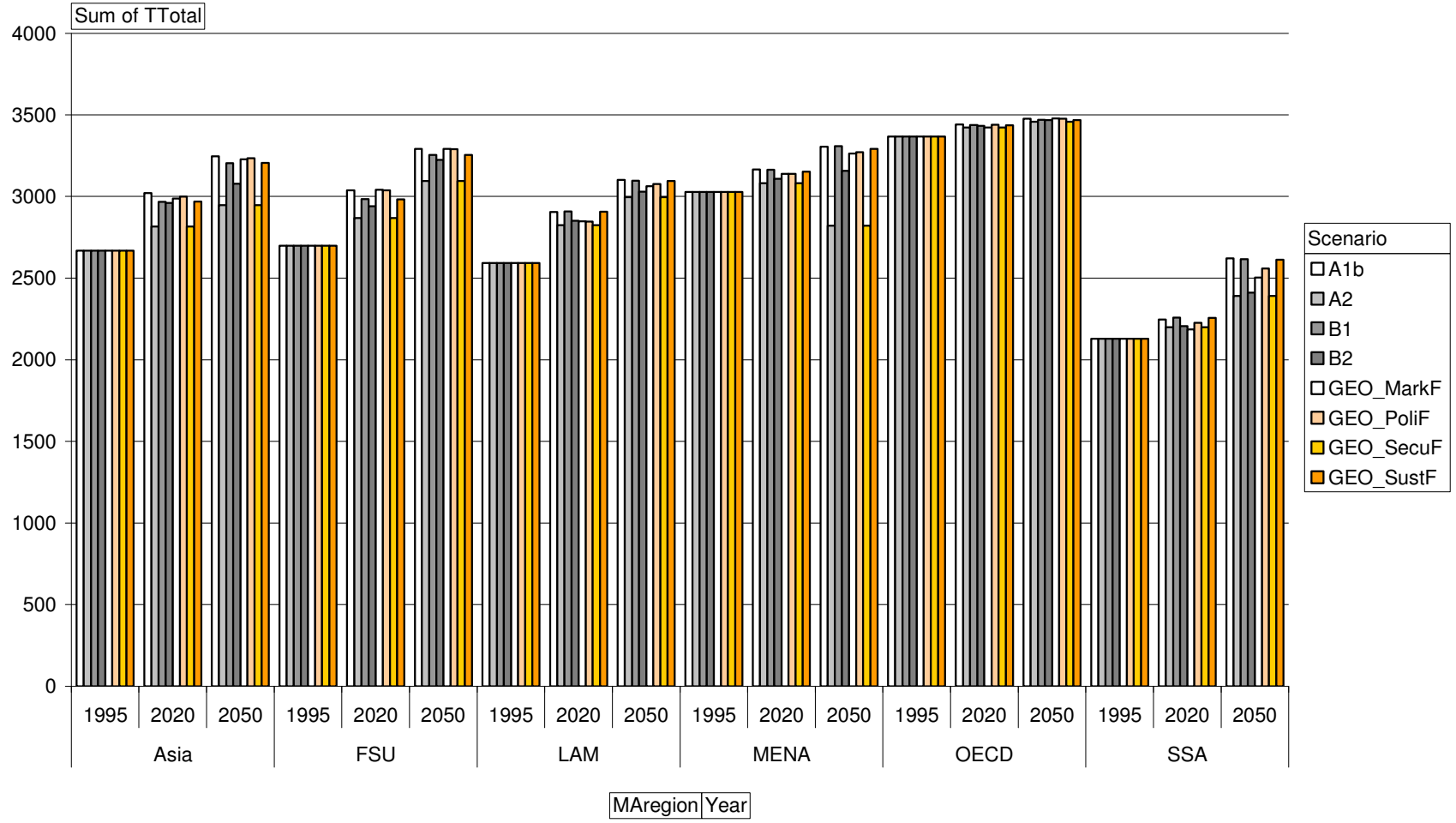

Figure 4.1 Total daily food intake (kcal per capita)

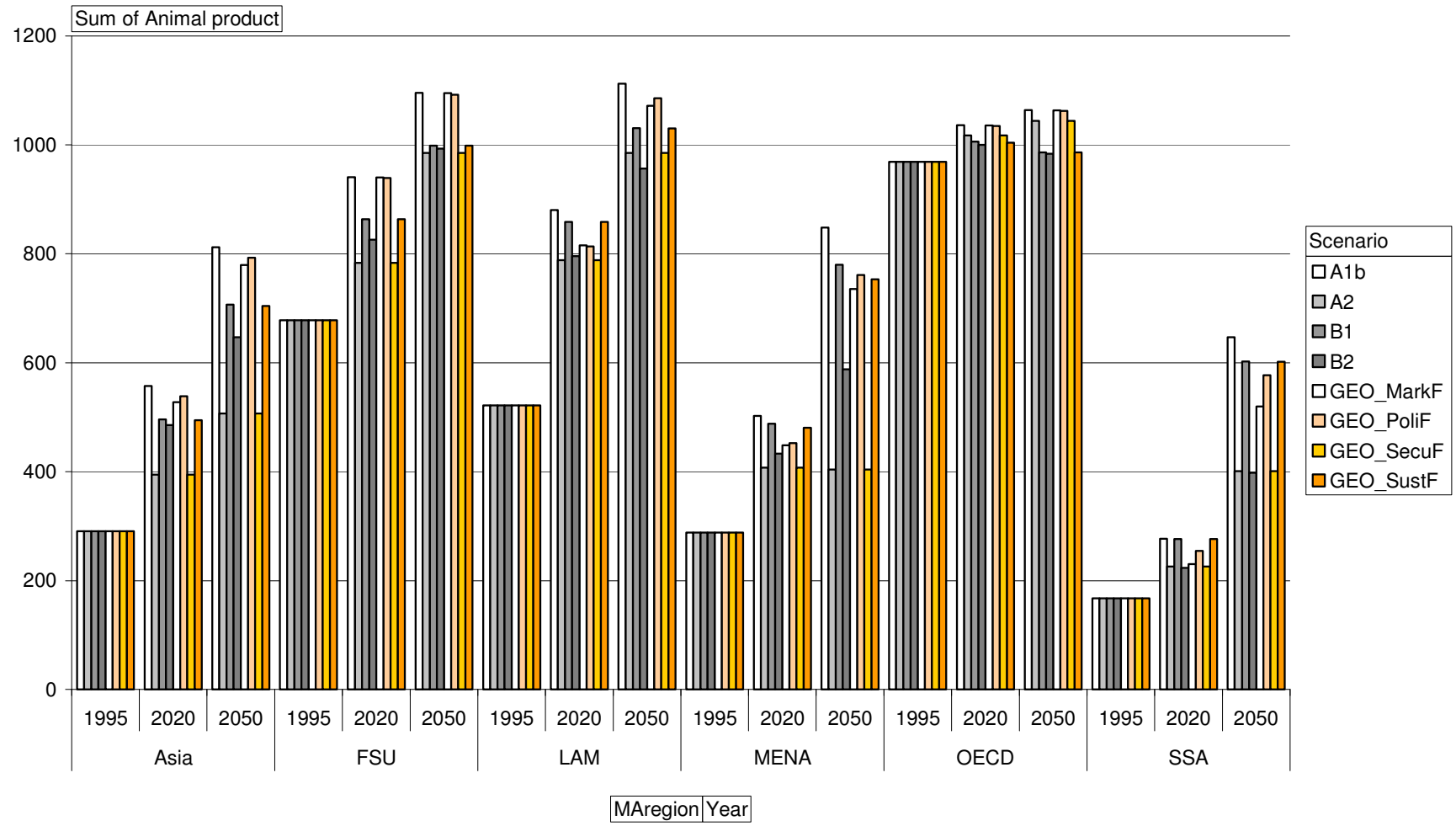

Figure 4.2 Average daily intake of food of animal origin (kcal per capita)

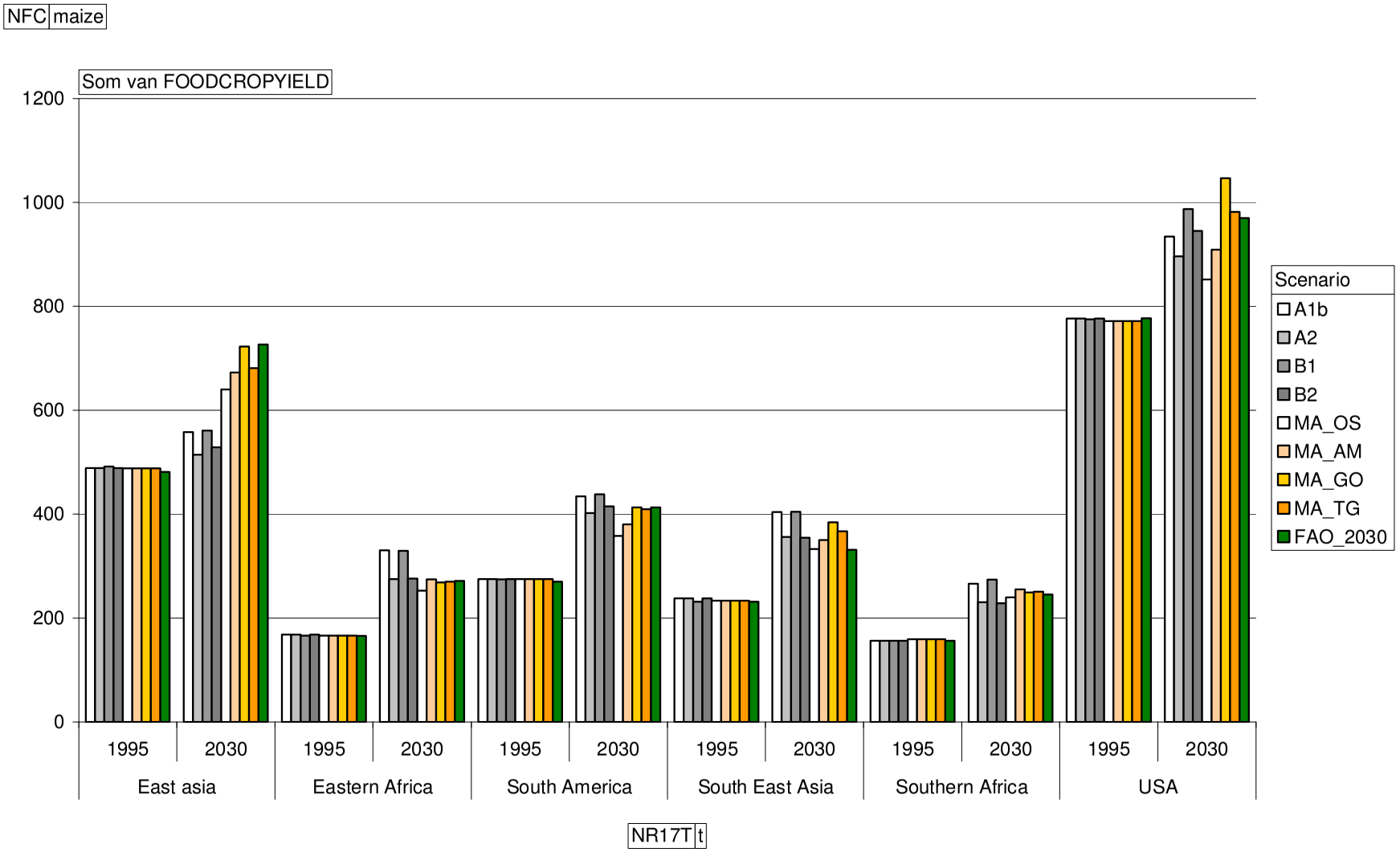

Figure 4.3 Average crop yield (in metric ton per km2) for maize in most relevant regions (divided by 100 gives metric tons per ha)

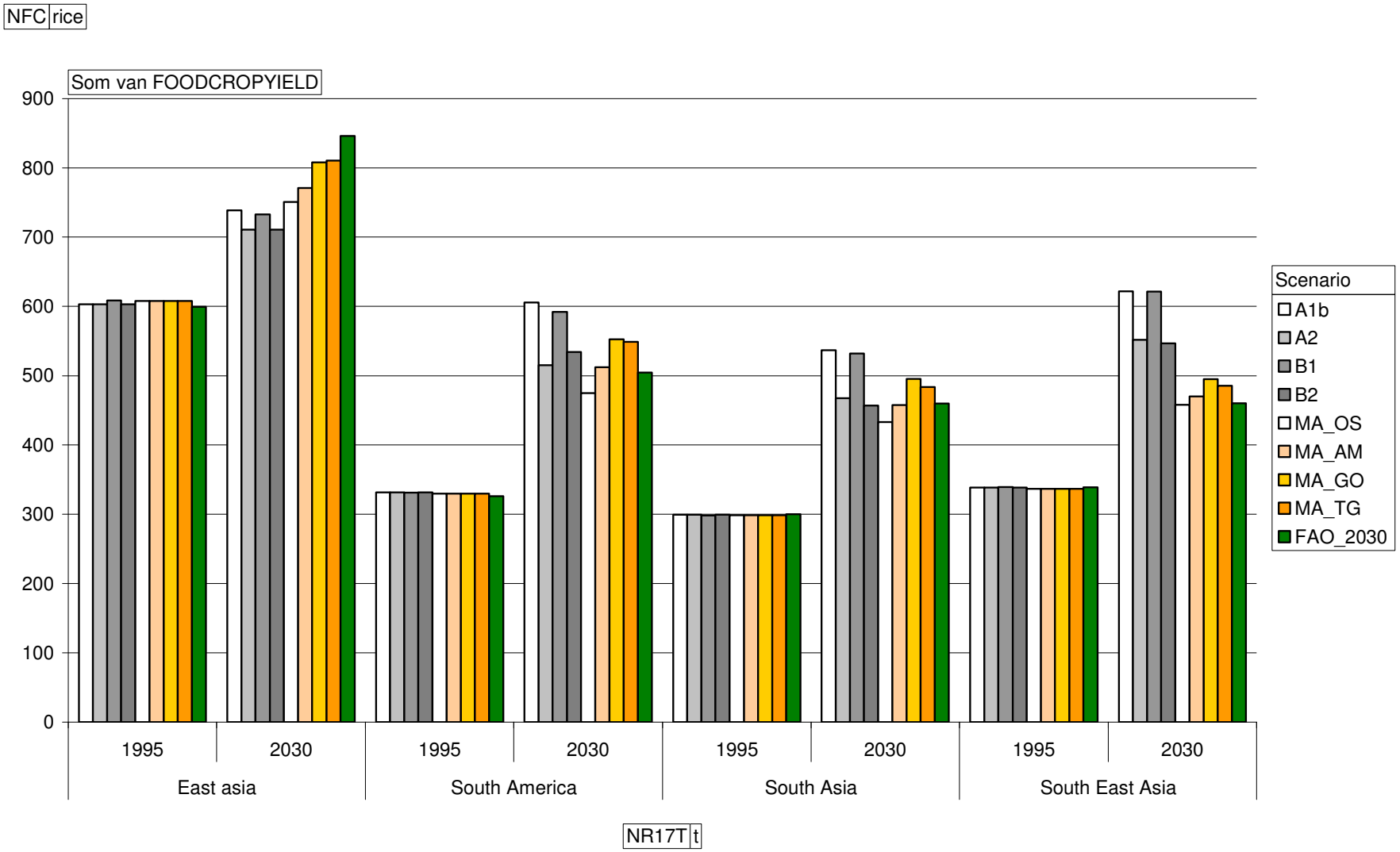

Figure 4.4 Average crop yield (in metric ton per km2) for rice in most relevant regions (divided by 100 gives metric tons per ha)

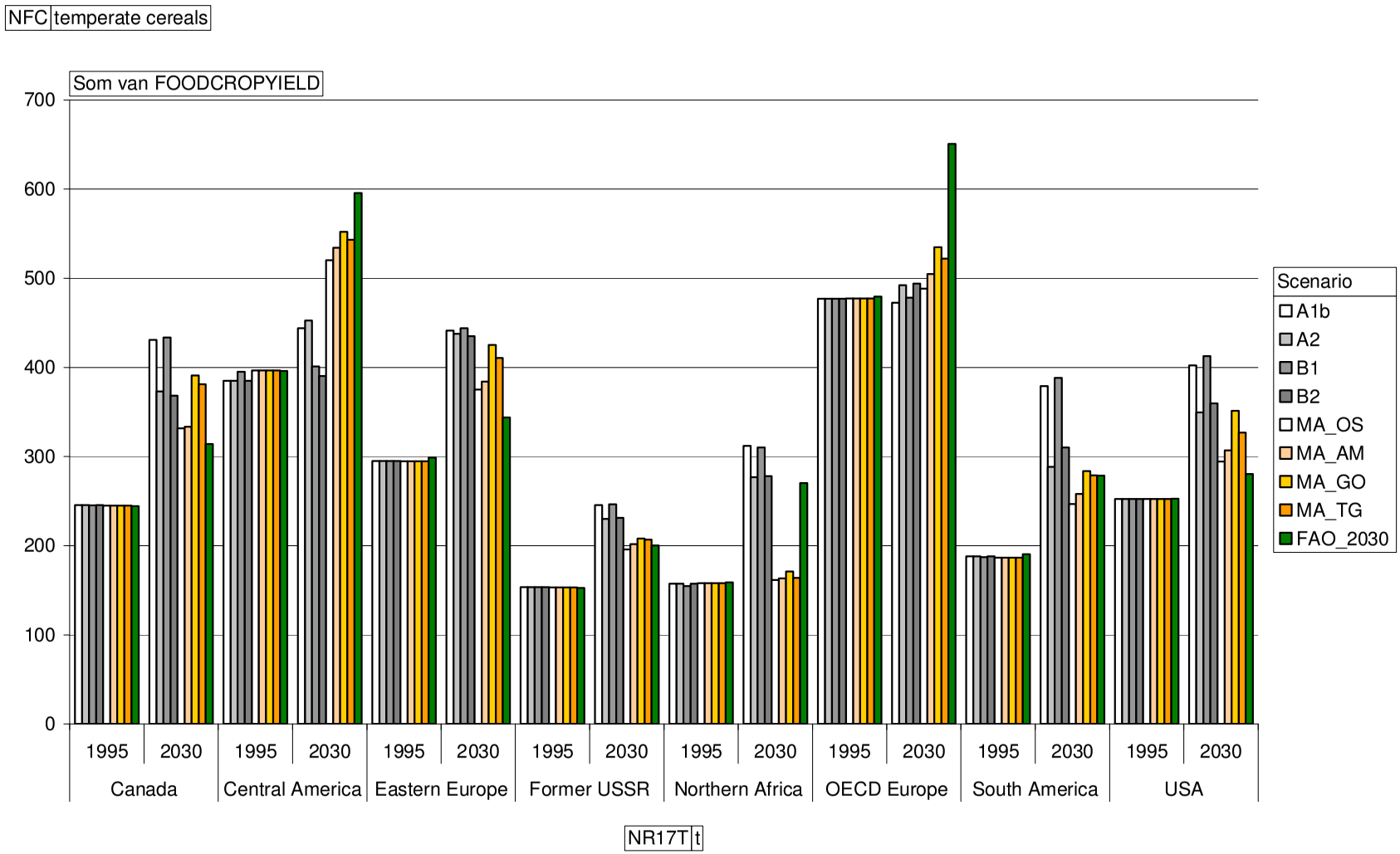

Figure 4.5 Average crop yield (in metric ton per km2) for temperate cereals in most relevant regions (divided by 100 gives metric tons per ha)

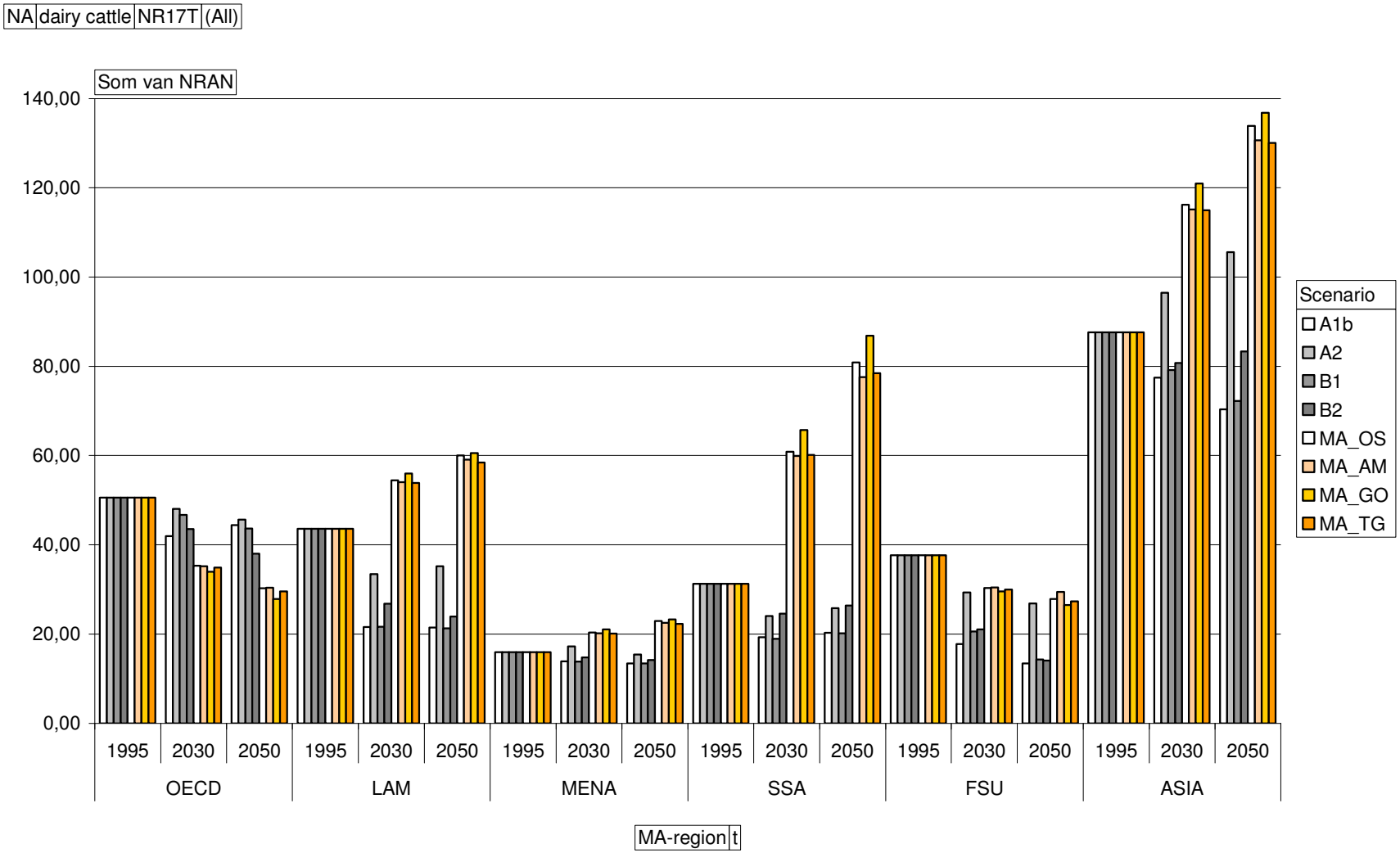

Figure 4.6 Number of dairy cattle (in million) in selected regions

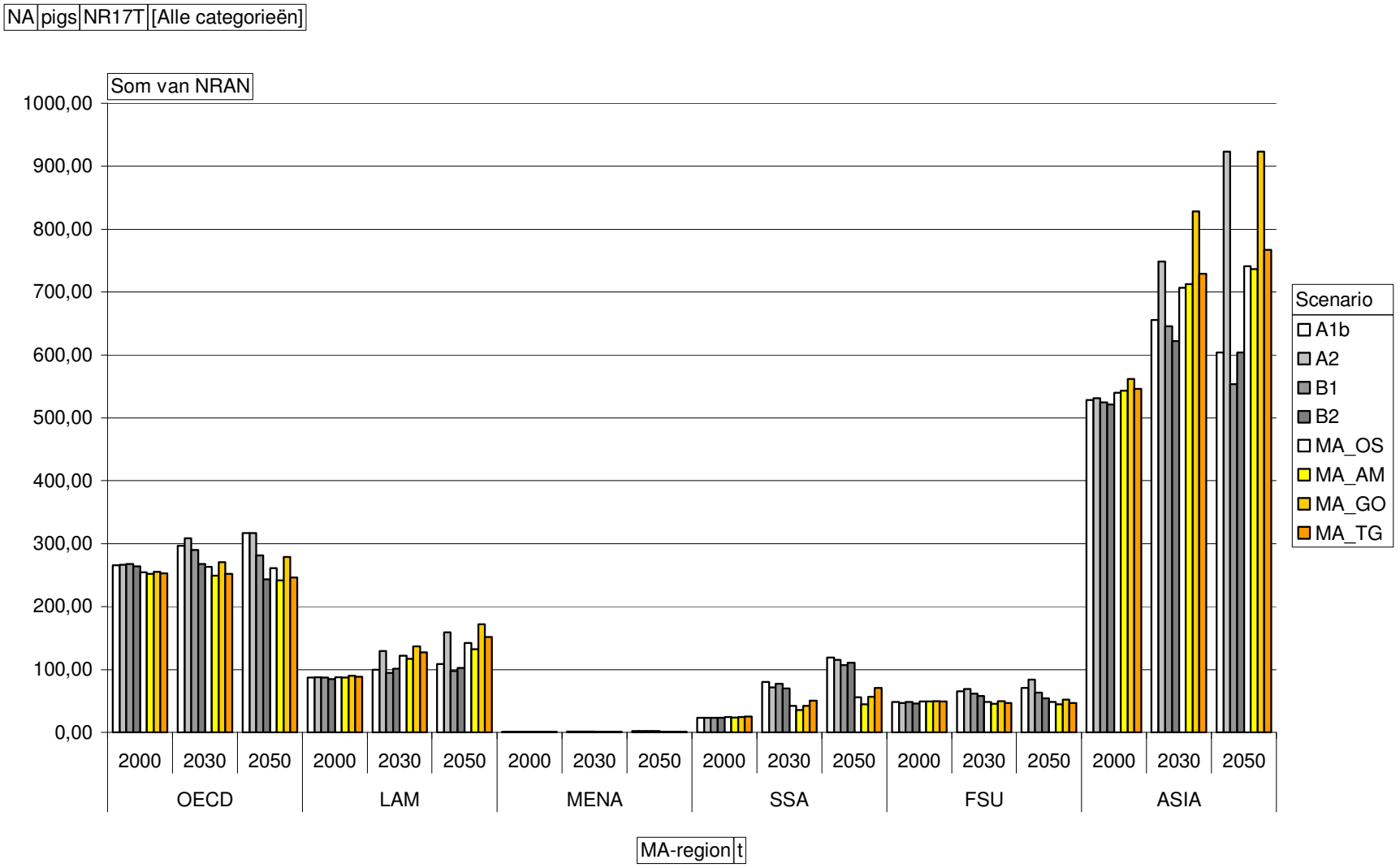

Figure 4.7 Number of pigs (in million) in selected regions

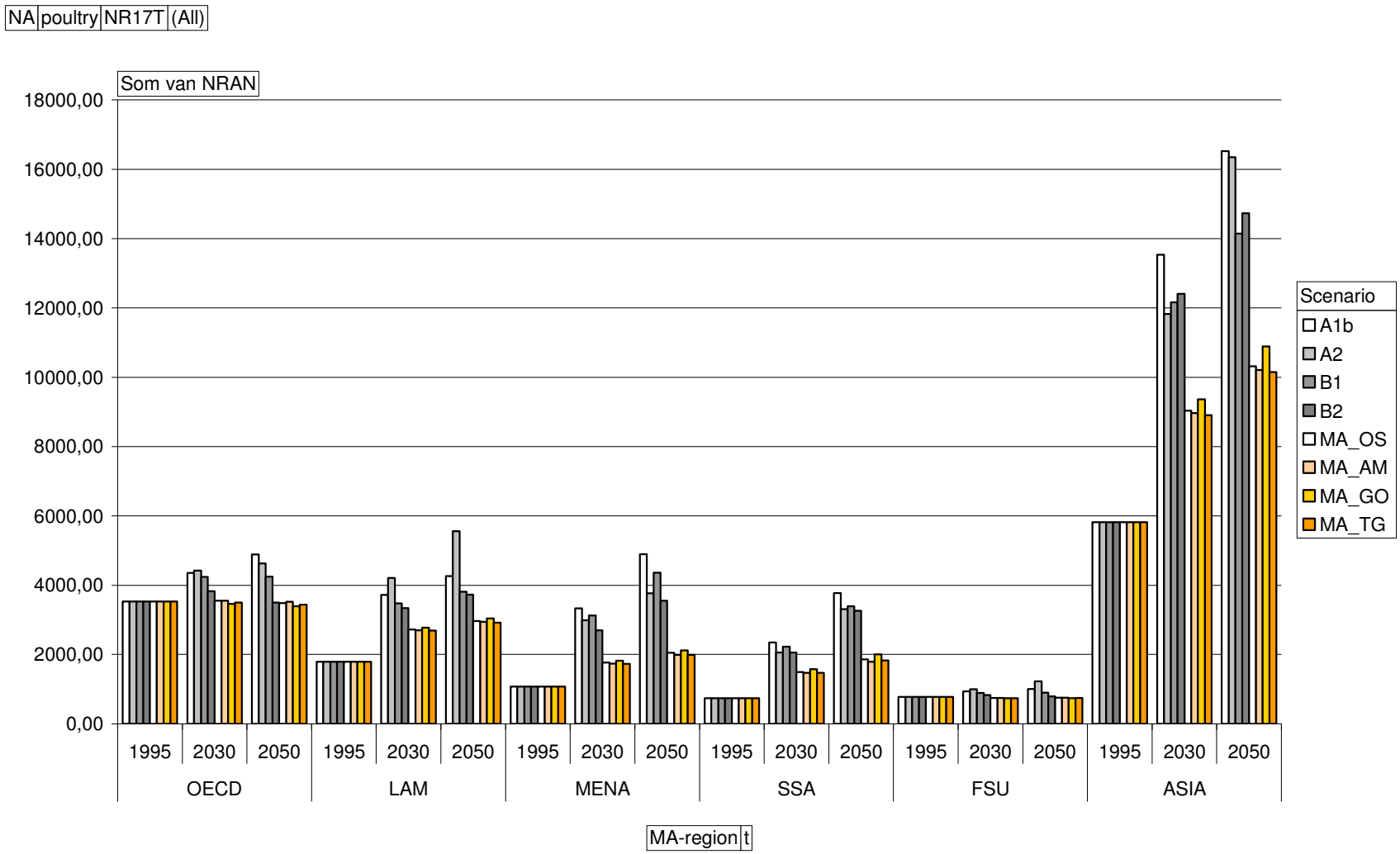

Figure 4.8 Number of hens (in million)

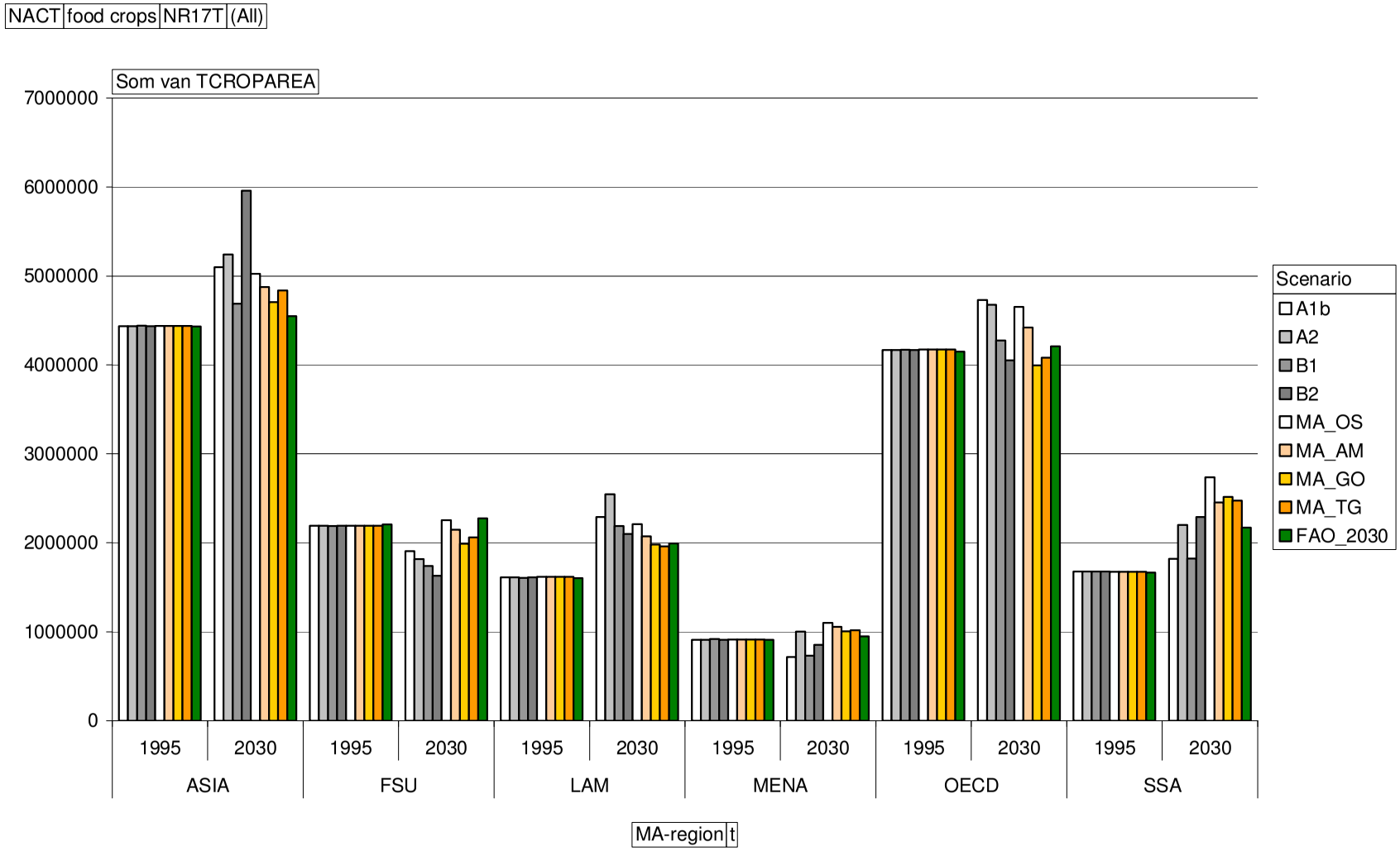

Figure 4.9 Food crop area (in km2; divided by 10 gives 1000 ha's)

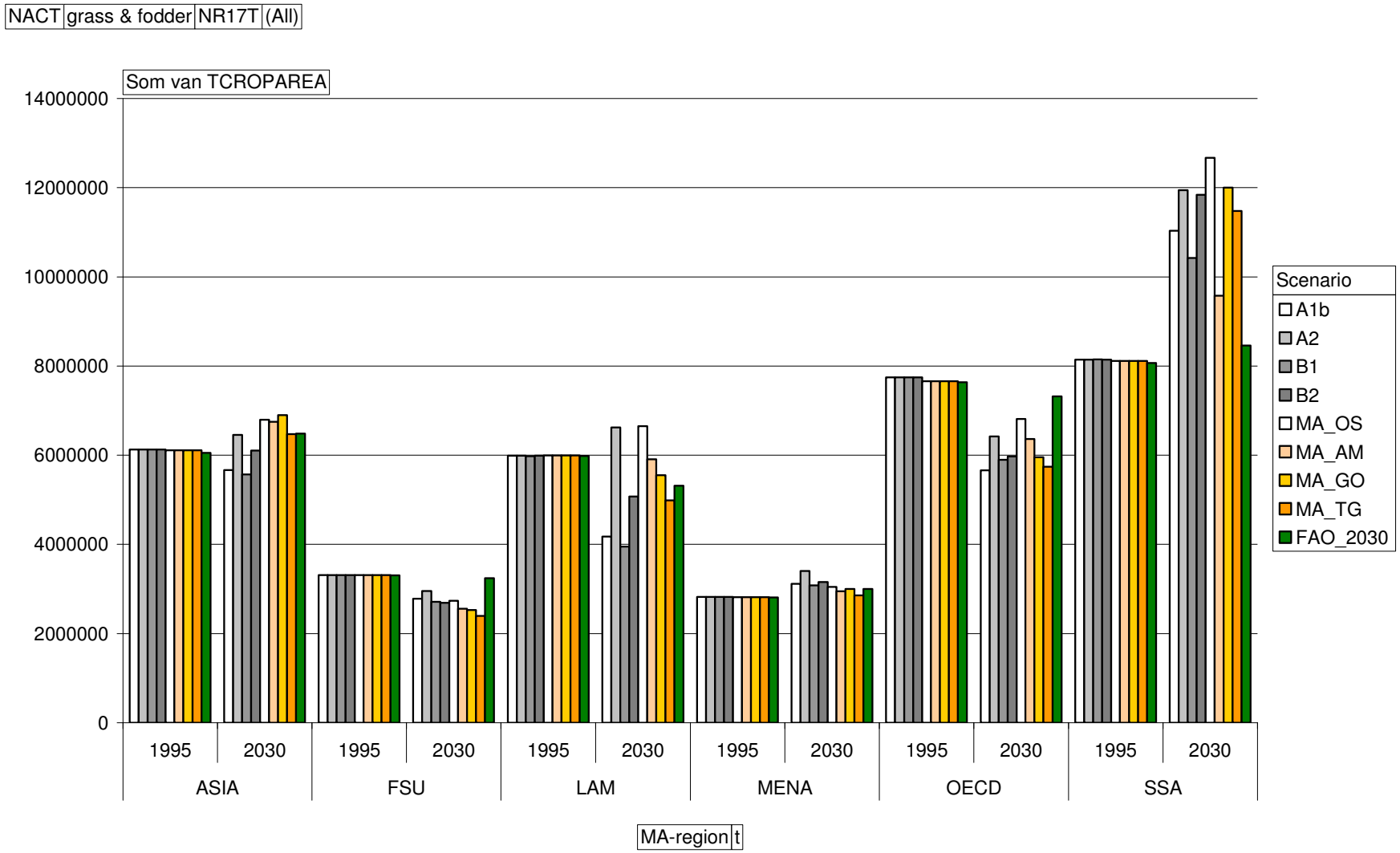

Figure 4.10 Grass and fodder area (in km2; divided by 10 gives 1000 ha's)

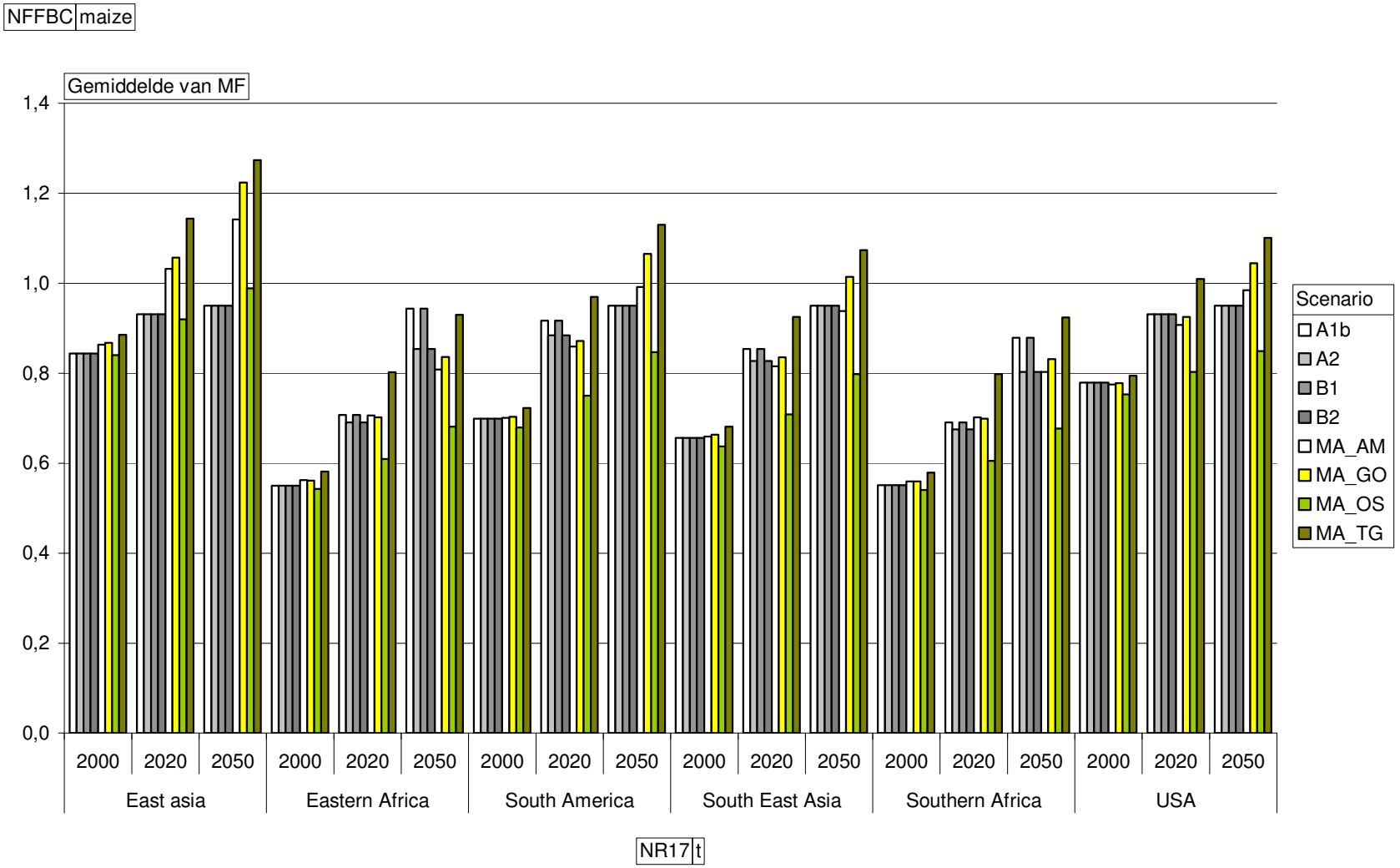

Figure 4.11 Management factor for maize in selected regions

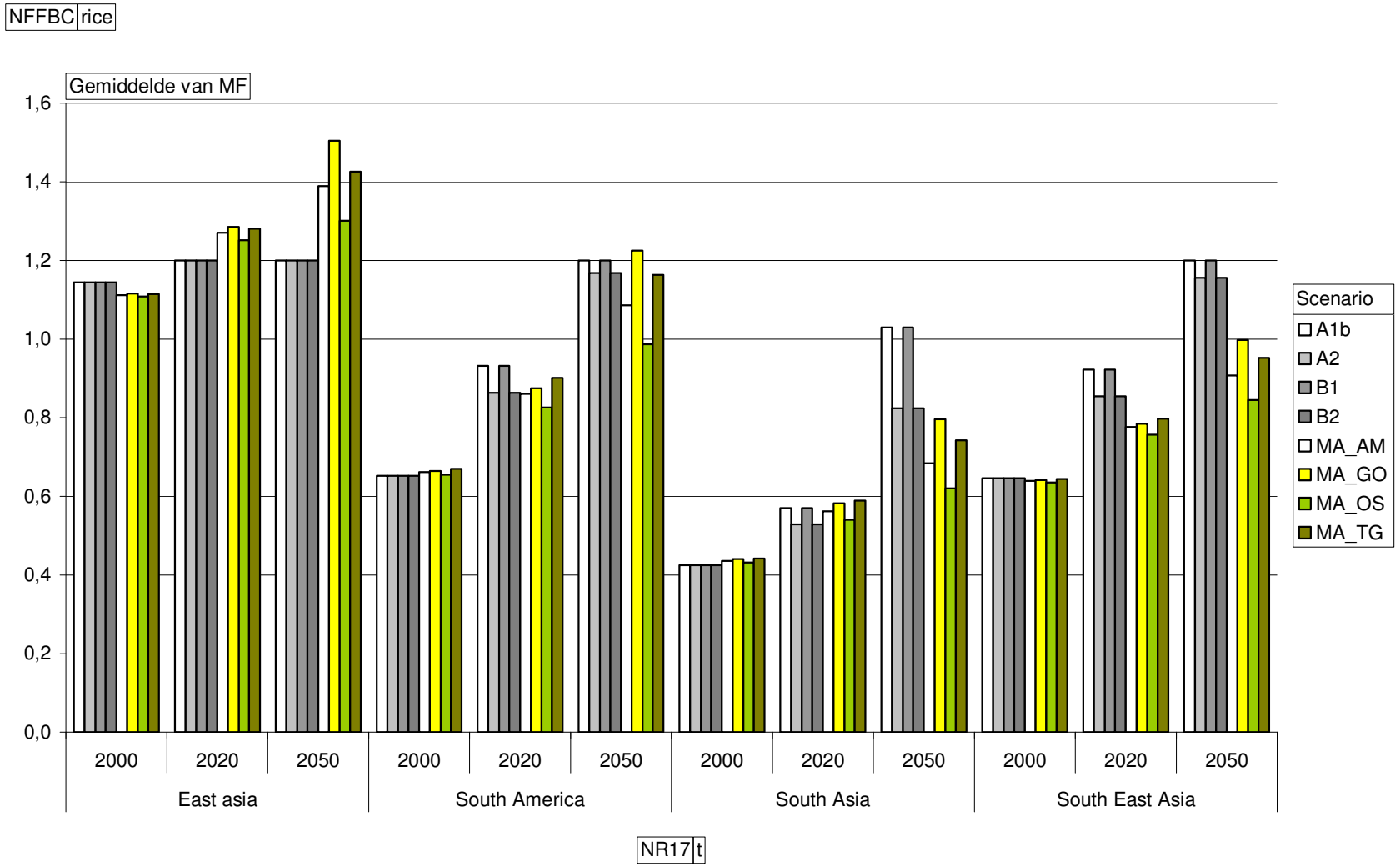

Figure 4.12 Management factor for rice in selected regions

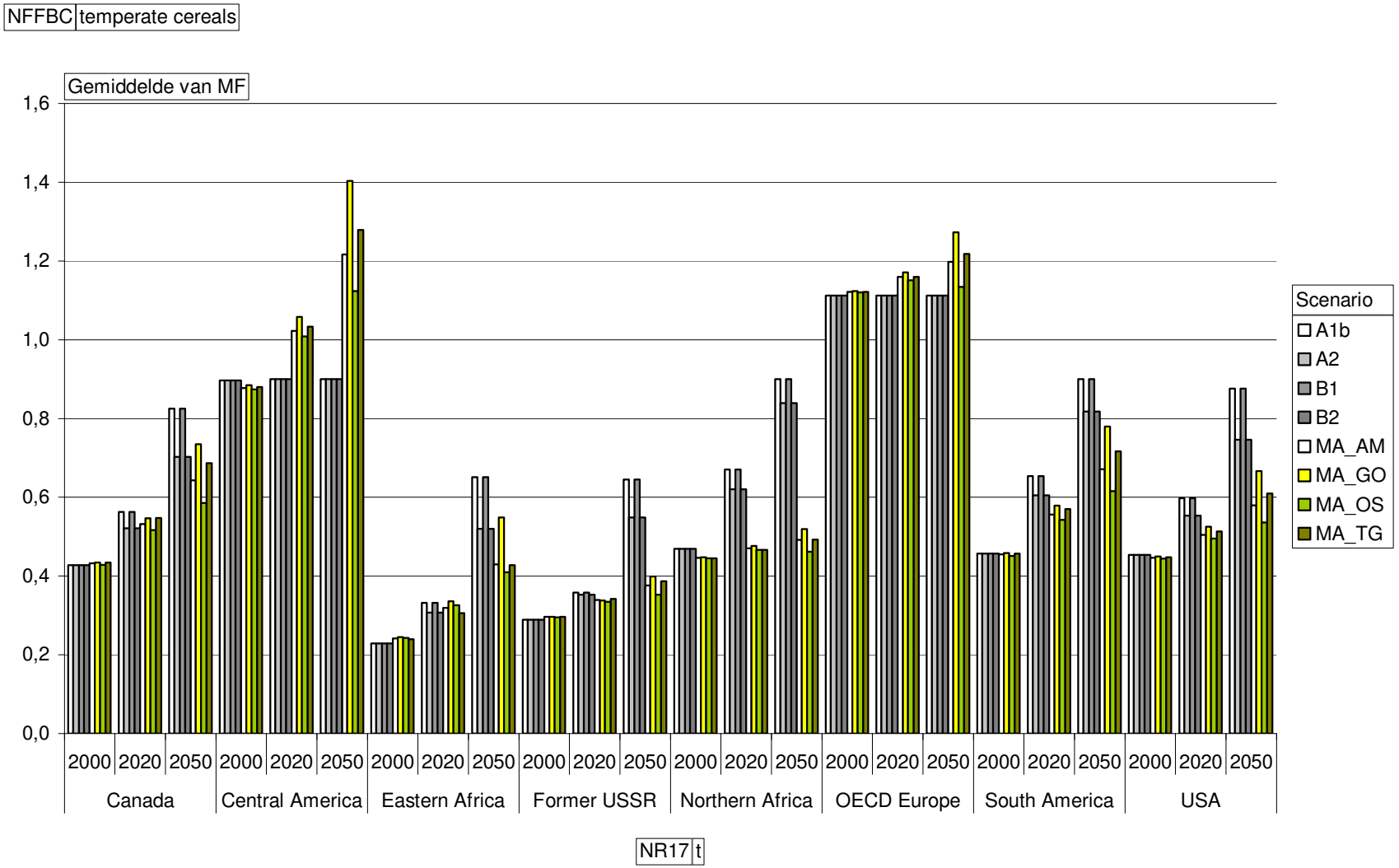

Figure 4.13 Management factor for temperate cereals in selected regions

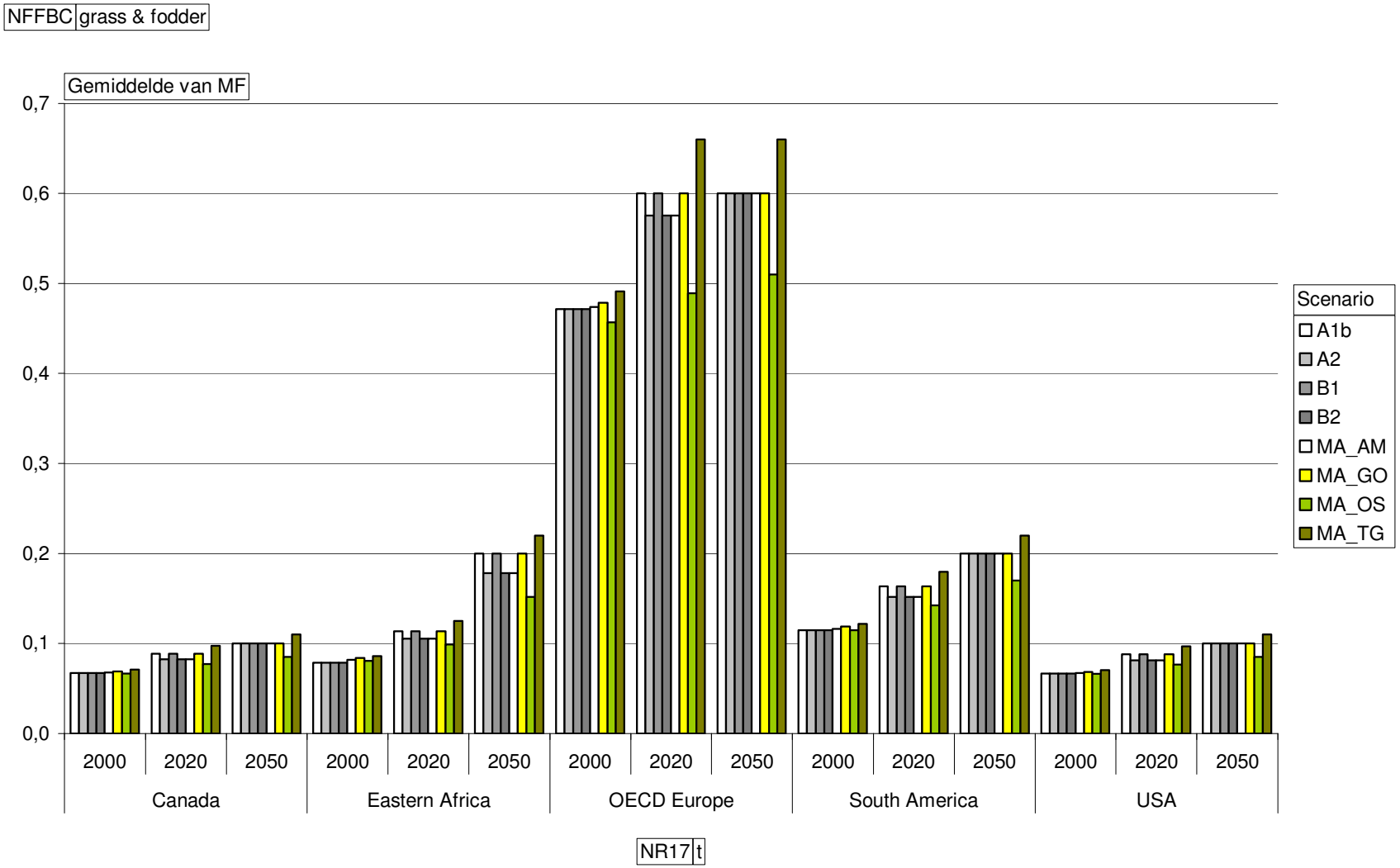

Figure 4.14 Grazing intensity for grass and fodder in selected regions

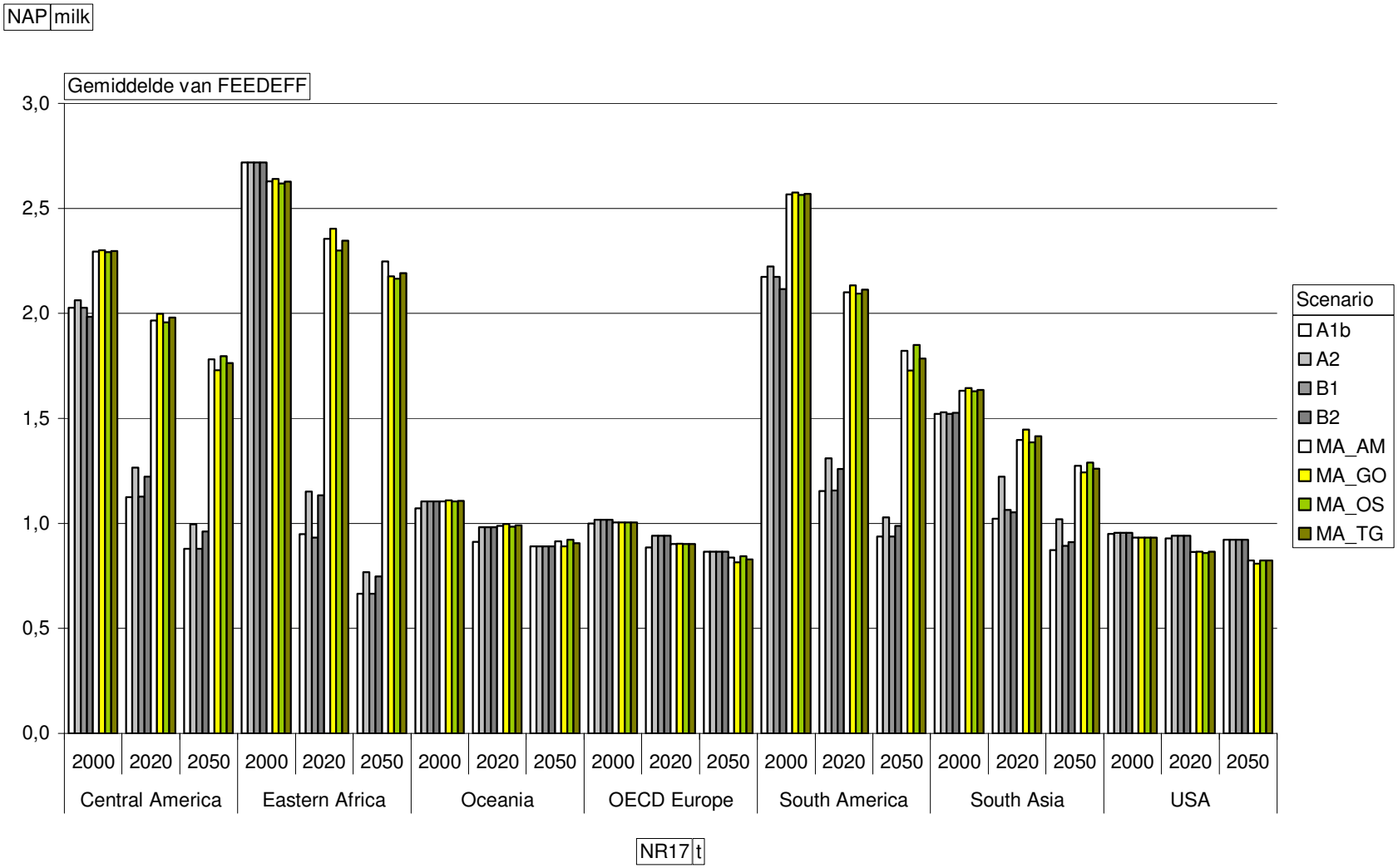

Figure 4.15 Feed efficiency for milk production

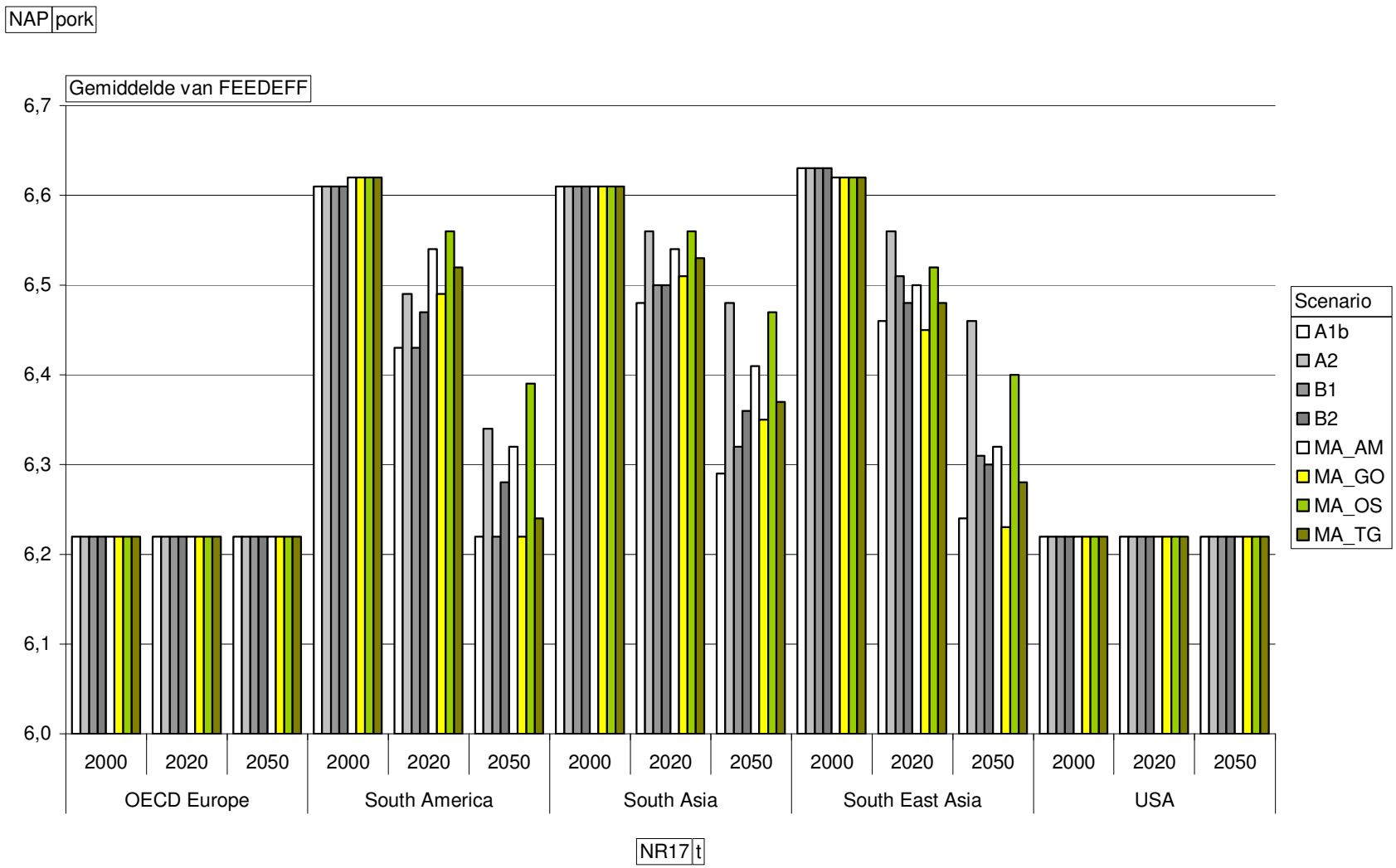

Figure 4.16 Feed efficiency for pork

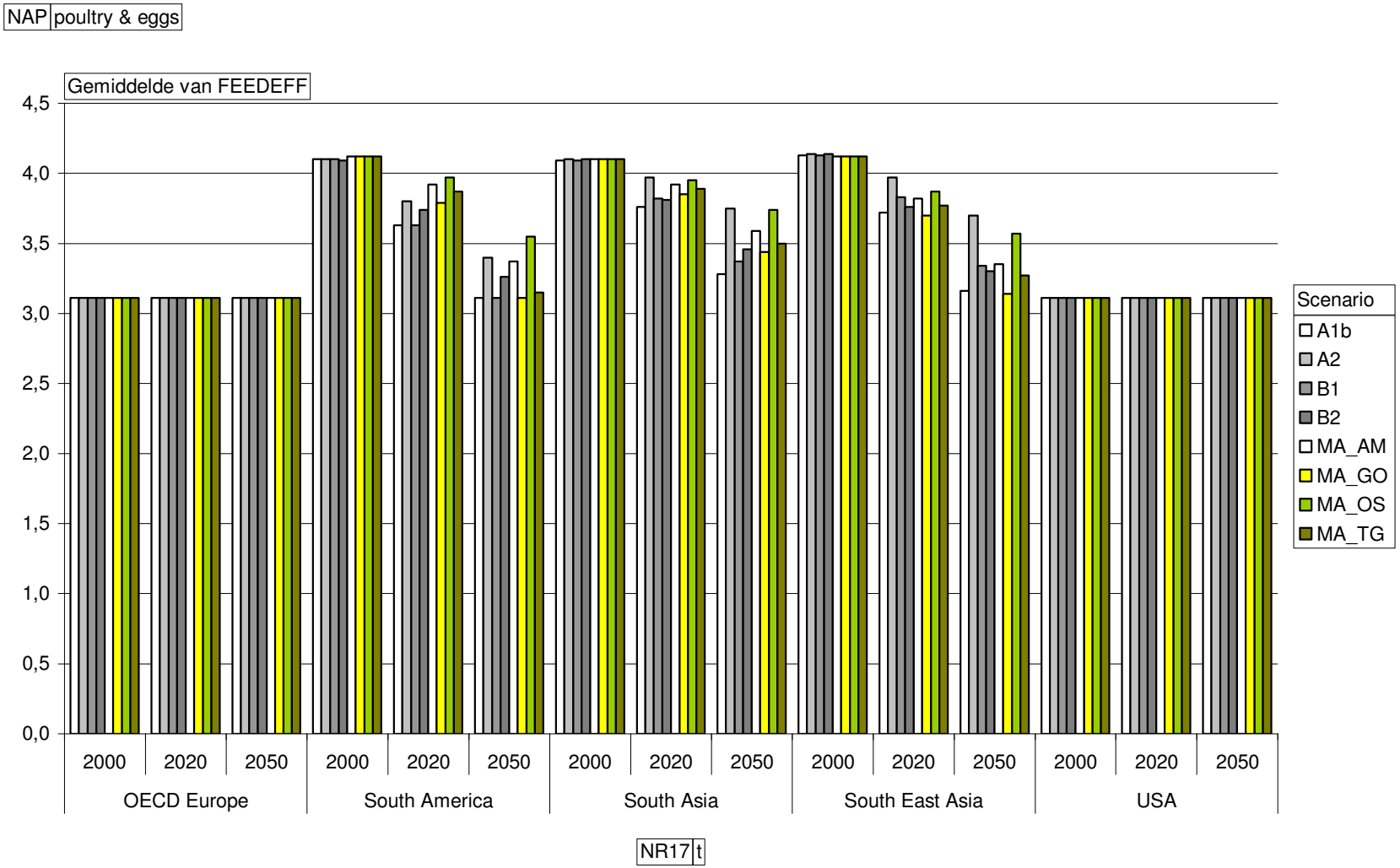

Figure 4.17 Feed efficiency for poultry and eggs