In search of the middle ground
Op zoek naar de gulden midden weg

Ken Giller

Rector honoured guests, friends and family (in particular my mother)

I hope you will forgive me for speaking in English, and accept it as a celebration of the international flavour of our University. Although most of our day-to-day business within the University is conducted in Dutch, I often feel that my ability to express myself is pre-school level compared with my mother tongue!

I am sure that many colleagues would be surprised to see my name attached to this title – given that I am well know for having strong views on most topics! Perhaps this is a reflection of age simply dampening extremism, but I hope also an indication that reflection on the progress in many fields of research seems to be limited by the inability or lack of willingness of many scientists, and indeed members of society from all sides of different divides, to accept that other disciplines and approaches can contribute significant insights to debates. This is a theme I would like to develop today.

Some personal history
After a hugely stimulating and enjoyable period of PhD research examining environmental and management effects on conservation of rare orchids in the fens surrounding the Norfolk Broads in England, I moved to work at Rothamsted Experimental Station. On announcing my move I immediately felt the scorn of the 'pure' ecologists for the 'applied' agronomist – clearly regarded as a lower form of being. After dealing with the complexities and uncertainties of vegetation science I soon discovered the happy and seductive release of reductive science – what a pleasure to be able to control multiple variables so that effects of single parameters on growth and yield could be examined! This was when I discovered the delights of the precision of mass spectrometry and using stable isotopes to track processes of nitrogen cycling in the field and fascination of the N_2-fixing symbiosis in tropical legumes.

I soon discovered that science was not that simple! A chance discovery together with Steve McGrath at Rothamsted that heavy metals present at small concentrations in soil could lead to massive loss of yield in white clover, due to suppression of N_2-fixation, threw our research into the public arena with articles in the popular press. The implications of this research for the recycling of sewage sludge to land, and the potential increase in costs of sewage sludge disposal, drew strong attack from scientists within the water industry. Presentation of our results at scientific conferences resulted in attempts to negate our research at every opportunity. Surprisingly, it was only when we published an article in a popular scientific magazine New Scientist, that the establishment appeared to start to take us seriously. A succession of European Union collaborative research projects over the following 10 years contributed to the revision of European Guidelines for application of heavy metals in sewage sludge to land. Unfortunately the desired effect of cleaning up the sludge so that it could be used in agriculture was not the result, instead the response was to incinerate what is potentially a valuable resource for recycling in agriculture.

This brush with industrial scientific opposition led to a personal realisation that science was not so hard and objective as I had naïvely thought, but rather corruptible depending on vested interests of the practitioners. About this time I met Jerry Ravetz whose insights into the social responsibilities of scientists (Ravetz, 1996) had a profound influence; confirming my growing personal desire that my science should be both relevant and useful to society, but raising my awareness that science was rather less straightforward than we had been taught.

Scientific stereotypes

Various adjectives are used to describe science and are often set up as opposites, for example:

Pure *vs.* Applied
Blue-skies *vs.* Near-market
Positivist *vs.* Constructivist
Reductionist *vs.* Holist
Natural (*β*) *vs.* Social (γ)
Hard *vs.* Soft

… and these result in a series of stereotypes, that are often used as derogatory terms in academia. Further terms are also be used to describe science or scientists, for example:

Quantitative *vs.* Qualitative
Experimental *vs.* Modelling
Specialist *vs.* Generalist

….terms often applied with a certain 'venom' as if to damn the opposite camp for the weakness of their approach. In this regard I must admit to having taken some personal amusement from the rather large divide at times expressed between some of our colleagues in social sciences at Wageningen over the past year. In the biological sciences the impression often given by the funding councils and reviewing bodies over the past 20 years is that the only science of any value is that which focuses on the molecular or cellular scale. Anything concerned with whole organisms or with the broader agro-ecosystems in which they live was regarded as second division at best. There are signs that this is changing somewhat, and certainly I find a refreshing attitude within Wageningen to the importance of research concerned with integration at larger scales.

I question whether our intolerance of different approaches really assists us in our search for general laws and rules that can help in developing our understanding. I still see science as a noble pursuit, even if it is rather shrouded by the uncertainty and complexity of our rapidly changing world. This is a theme to which I will return later on.

What is meant by 'Plant Production Systems'?

Having introduced some of the ways in which I interpret the title of my lecture I now turn my attention to my new title in the group where I work together with a distinguished group of researchers based at the Haarweg in Wageningen. I am often asked what does 'Plant Production Systems' mean? We have summarised our 'leeroopdracht' in the following paragraph:

"Our key domain is the integration of knowledge to allow analysis and design of new approaches to the dual goals of sustainable production systems: optimal production of crops and livestock combined with optimal management of natural resources in

their broadest sense. We develop tools and methodologies that allow analysis and design of alternative future scenarios at local (farm), regional, national, international and global scales."

In the past year we have toyed with a number of alternative names, such as 'Natural Resource Management' that may convey the essence of our work to others more easily. Much of our analysis is based around the carbon and nitrogen cycles as indicators of trajectories of change within systems that can be measured and have strong relationships both with productivity and with the positive or negative environmental effects of land use change. With a specialisation and focus on agricultural production systems, we address natural resources and the 'ecosystem services' that these confer in their broadest sense. The beneficial functions that we derive from ecosystems range from food production to recreation, from the aesthetic pleasure of the landscape to nature conservation and designing of land use systems must take full account of the competing demands within multifunctional landscapes. This leads to the need for understanding of the major drivers of change – population and poverty, global climatic change etc and the impacts they have. One large project (the ATEAM project) in which we participate focuses on determining the sensitivity of European ecosystems so that the vulnerability of different areas can be mapped and potential for adaptation and responses evaluated. As with much of our work an explicit aim is to link our analysis to understanding the links to policy, leading to strong collaborations with colleagues from the social sciences.

One of the most simple examples of the power of systems analysis comes from analysis of nutrient cycles. At the field or plot scale we can think of removals of hay for fodder or grazing by livestock as being losses from the system, and return of manure to the field as an external input. However, if the scale of consideration is taken to be the whole farm, then many inputs and losses become internal transfers and the system can be viewed as a much more closed cycle. Although a very simple example, there are numerous other examples where extrapolation of data from small plots to the scale of the landscape for soil erosion, or infiltration and runoff of water result in huge errors.

Pursuing the nutrient example further, analysis of the problems at different scales can give insights into the root causes of problems and inefficiencies within the systems. Moving up to the farm scale, a primary goal is export of plant and animal products and which must be replaced to maintain the nutrient balance, but where excessive import of nutrients leads to accumulation of excessive concentrations in parts of the farm and leakage that can cause pollution. In the Netherlands the specialisation of farming that has led to crop and animal production being largely-separated into different enterprises leads to difficulties in recycling of animal manures to land, the need for larger imports of fertilizer and feed and imbalance in the nutrient cycles. There is a disjunction between different parts of the system at a broader scale. Simply redrawing the system boundaries to ensure the integration of livestock and cropping within the same enterprise can enhance the efficiency of recycling. If only life were so simple! At an international scale the import of nutrients as feed into the Netherlands leads to a huge disbalance, and suggestions of solutions such as freeze drying manure and dropping from planes over the Sahel, or shipping by sea to Africa. However crazy this must seem, such potential solutions to the problems have been the subject of serious analysis.

To borrow an example from my colleague Rik Leemans, we can recognise that analysis must address a variety of ecological and environmental scales and policy and socioeconomic scales. However, direct influence in terms of action and effect generally takes place at the lower integration levels as this is the scale at which direct management results in changes in land use. Although decision making for policy takes place through governments and international negotiations, such policy has to feed down through the various levels to influence those involved in land management at local scales. Changes in management feed back to influence, and hopefully assist in solving, the problems at the higher scale. One relevant example is the declaration of national and EU policy designed to ensure the quality of water resources through the 'nitrate directive'. This is interpreted in the Netherlands through the MINAS (MINeral Accounting System) scheme which is implemented at farm scale. Reductions in the use of nutrients at farm scale then feedback to overall reductions in the 'Mest Probleem' at a regional and National scale.

As methodologies for this type of complex analysis do not necessarily exist we have a strong emphasis development of tools and approaches. One initiative within the European Union that we are leading through the graduate school PE&RC on behalf of WUR is the design of a large integrated project to develop tools for analysis of impacts of policy on land use across different scales in a System for Environmental and Agroecological Modelling – Linking European Science and Society (SEAMLESS). This work is still in the design phase. We anticipate a submission to the EU for funding within the next six months and have interest from over 80 potential partners both within and beyond the boundaries of Europe. Two of the case studies that will be developed in this work are the expansion of the EU eastwards and effects on future land use in both current and accession countries, and the effects of conversion of from conventional to organic farming on land use and the environment.

The essential part of the analysis when we address land use systems as a whole is to seek optimal forms of management for many competing goals. Such analyses are inherently complex and carry with them a large degree of uncertainty. There is no single answer, but multiple outcomes to every question, trade-offs between goals are inevitable and that the topics are open and of general interest so that everyone is a stakeholder and has a right to an opinion. Scenarios can be explored that will give insights into many possible future trajectories and can aid in clarifying how best these can be influenced. Given the uncertainty surrounding such explorations all realms of science appear to be remarkably 'soft', and we need to make use of all lines of enquiry.

Pessimistic vs. optimistic views of the world: Famine vs. Plenty

Over 20 years ago I began working on N_2-fixation as a source of 'cost-free' nitrogen for smallholder farmers in the tropics. Research on symbiotic N_2-fixation in legumes remains a topic of intense research interest and one that has been highlighted as a potential solution to the alarming soil fertility decline in African smallholder farming systems, in which the research of colleagues in Wageningen has played a major role in highlighting the severity and extent of the problem (Stoorvogel and Smaling, 1990).

However this is another example of where science and scientists appear to be divided into opposing 'camps'. One camp, which is generally portrayed as the widely-accepted, conventional view states focuses on the problem of ever-increasing population pressure. This has led to reduction in the time the land lies fallow and preventing the natural regeneration of soil fertility. When compounded with overgrazing on the common lands and the resulting effects on soil erosion, this leads to a scenario within which prospects of mass-starvation loom high on the agenda for sub-Saharan Africa.

The alternative view, portrayed as a more-enlightened insight is that the extent of the impending disaster has been overplayed, that farmers have responded to the new challenges of intensifying land-use and will continue to do so in the future (e.g Scoones, 2001). What is needed is greater attention to understanding the farmers, and their methods for managing the environment. From this base solutions to the problems will inevitably emerge. In essence these two views can by typified as rooted in the "doom and gloom" of Malthus contrasted with a optimistic or Boserup-ian view of the world.

But to what extent do these opposing poles of opinion exist? Who are the blinkered reductionists (a term often used with much associated venom) who proclaim the total immediate environmental devastation in Africa? I question whether the 'conventional', simplistic and obviously-flawed view of environmental degradation is actually a convenient construct of writers. Against this stark backdrop, presentation of an alternative, more perceptive, innovative and environmentally friendly discussion that gives the reader a "warm" feeling is all the more easy. In fact, this is precisely what Herman van Keulen and I have been criticised for in the Noorderlicht programme that was screened on Dutch TV in August (though the final product was actually rather more positive than originally intended due to the editing rather than by design). The danger for us as scientists involved in research on these topics is that stories of poverty, famine and land degradation, or conversely the positive, local-based biological farmers' solutions make a strong impact in the popular media, whereas a more nuanced view is often deemed as too complex to communicate readily to the public at large.

And which of these two views is correct? The uncomfortable truth is that both stances can be justified based on interpretations of the available information. The confusion arises largely due to extrapolation from localised studies. Both views fall into trap of ignoring issues of scale in both space and time in which vastly different settings can be true within relatively small areas. Many smallholder farmers, and often those that are relatively well-endowed or have family members working in the cities, are managing their land productively, investing in their future and enhancing their environment. A widely-cited example is the study of Tiffen *et al.* (1994) where access to the market and employment potential of Nairobi plays a major role. We can learn much from such farmers in our analysis of opportunities for others. But many farmers have little opportunity or incentive to invest in their agriculture. A good example of the difference in analysis leading to different conclusions is the study of Mazzucato and Niemeijer in West Africa which leads the authors to question whether land degradation is a widespread phenomenon (Niemeijer and Mazzucato,). A broader analysis of colleagues from my group indicates that Mazzucato and Niemeijer have described one stage in a pathway of development as population density increases, a stage before land pressure is acute (de Ridder *et al.*, 2002). There is also strong evidence for increase in land pressure, declining soil fertility and land degradation in similar agroecological environments in West Africa. As I stated earlier, in essence highly differing interpretations can be supported depending on the scale of analysis, the point in time on a trajectory of development that the system is studied, and the linkage to external factors such as urban markets.

Such analyses of positive or negative environmental trends and differing views of poverty can have broad influence on development policy for rural communities. The outputs of research are rapidly communicated, with the studies that show more extreme positive or negative trends having the most impact. Scientific analysis has a strong role to play in assisting in the design of policies, but to what extent should we simplify outcomes and the messages that arise from them in order to influence public debate? This is a clear example where scientists have a strong social responsibility to the communities under study, where science can play a highly important role but the onus is on being clear in communicating the context under which our analyses are robust.

With reference to my title this is an example where the generally accepted view among the scientific community as a whole perhaps *is* the 'middle ground', although this is far less likely to capture the headlines.

The problem of poor soil fertility in Africa

Poor soil fertility is widely accepted to be the factor which most severely limits agricultural production in Africa. If soil fertility is badly depleted then no matter how efficiently resources are recycled the gains will be minimal. The options for managing that are within the reach of farmers are often labour-demanding and yield little return – in essence this is what Rudy Dudal termed the drudgery of 'recycling poverty'. Under such circumstances some form of inputs external to the farm – whether due to the use of livestock to harvest nutrients from larger areas or other forms of inputs such as mineral fertilizers are necessary to lift the productivity of the system.

In such situations, legumes can play a special role as a 'free' source of nitrogen, given the acute problems that farmers face in accessing nutrient inputs in the form of mineral fertilizers. A large body of research has shown the immense potential of legumes in contributing nitrogen from N_2-fixation to tropical cropping systems. Benefits are realised directly in highly nutritious, protein-rich food for the family, through high-quality fodder for livestock, through soil fertility by the addition of plant residues to the soil or by the direct use of green manures or agroforestry trees for soil improvement. However, despite the numerous demonstrations of their potential, farm surveys show that the actual inputs of N fixed by legumes within smallholder farming systems are often limited due to the poor growth of the legumes in bad soils on the one-hand and the small area planted to legumes on the other.

Legume residues and other organic resources can contribute to soil fertility in two ways: by contributing nutrients directly for plant growth; and by contributing to soil organic matter for sustainability for the long term. Unfortunately few approaches can achieve both at the same time! The ability of plant residues to contribute nutrients for crop growth depends on the nutrient content of the materials and other aspects of the residue 'quality' (Cadisch and Giller, 1997). In legume residues the most important parameters that influence release of N are the N content (and hence the C:N ratio), and the content of complex molecules lignin and tannins or polyphenols that retard decomposition. These parameters have been summarised into a form of decision tree that can be used to facilitate discussion and understanding with farmers as to the utility of organic resources within the farming system (Figure 2).

The residues that are not particularly good at providing nutrients for plant growth can be useful for improving soil fertility in the longer-term. Soil fertility is seen as a 'slow' ecological variable through its intricate relationship with soil organic matter. This means that there is often a fairly long phase before changes in management result in noticeable or measurable differences in 'building-up' of soil fertility. Soil organic matter contributes to soil fertility in many ways, ameliorating otherwise hostile chemical conditions, enhancing the ability of soil to hold other nutrients (through enhanced cation exchange capacity), by improving efficiency of water capture and use by crops due to effects on soil surface and water-holding capacity. Improvements in soil organic matter status can thus have major interactive effects of enhancing the efficiency of use of resources such as nutrients and water. This is one of the few 'win-win' situations where enhanced resource use efficiency can both improve productivity and decrease unwanted losses that can contribute to pollution. The role of soil organic matter in nutrient provision is largely over-ridden in agriculture through the use of inputs (fertilizers, manure and legume residues).

So if legume-based approaches show such promise, why are they not used more widely by farmers? Indeed there are interesting examples where new legumes have been introduced, such as the rapid adoption of soyabean as a smallholder crop in Zimbabwe and Nigeria where both strong technologies in the form of well-adapted varieties and strong links to markets have been developed. There are also examples in Central America and in Benin where green manure legumes, such as the velvet bean (*Mucuna*) have been rapidly adopted by smallholder farmers, though more for weed control than simply for their soil-improving properties as such approaches are often very labour demanding. The successes of legume-based technologies are relatively rare and localised compared with the widespread interest of researchers and NGO's. The productivity improvements achieved through legume N_2-fixation may also be limited compared with what is achievable using mineral fertilizers, or combinations of organic resources. This is another case where a 'middle ground' of 'integrated soil fertility management' is a more appropriate view than purely biological or organic approaches. If well managed, fertilizers can be much more efficient in their use than organic sources of nutrients.

***The NUANCES** (**N**utrient **U**se in **AN**imal and **C**ropping systems – **E**fficiency and **S**cales) Framework*

In the past year we have launched an integrated analytical framework with the aim of embedding analysis of the potential for the different potential soil improving technologies within the wider livelihood strategies of farmers. Essentially research in this area has been driven by a 'commodity' based, plot or field scale approach, despite the increasing realization that natural resource management has to be tackled at the system scale. Virtually no studies exist where the potential of grain legumes, herbaceous green manures, multi-purpose trees in agroforestry, management of animal manures, or of mineral fertilizers for improving soil fertility have been compared within a single study or target area. Other aspects of farm and land management such as labour use, water use, weeds, pest and disease control, mechanization, etc. are of great importance in determining productivity and land qualities. The livelihoods of farming families depend on complex interactions between competing demands for investment of cash and labour both within and beyond the farm boundaries. Livelihoods of smallholder farmers are also strongly influenced by opportunities for off-farm earnings through markets for produce and employment both locally or in urban centres. The basic scheme in Figure 3 summarises the complexity of smallholder farming systems in a relatively simple way, which is still complex to address given the number of components under consideration. A common reaction from scientists is that the analysis is far too complex to attempt! However, given that this is a gross oversimplification of the context within which farmers have to make decisions on a day to day basis the conclusion that we cannot attempt such an analysis would be fairly damning for the power of science. It is clear that we can learn much from farmers who manage their resources in a complex way, investing most in small areas of the farm and creating or reinforcing existing gradients of soil fertility. We seek a better understanding of the choices and trade-offs where immediate needs of the family may often override the possibilities of investing in the longer-term sustainability of the farm as a whole.

The NUANCES framework aims to build on what I consider to have been major advances in our understanding African smallholder agriculture over the past 15-20 years. These advances have come from many types of studies: from the farmers themselves through various forms of spontaneous innovation and participatory research; through studies of nutrient cycling on African smallholder farms with particular attention to soil biology; through economics at farm, country and international scale; through understanding of weed control and other management operations, to name just a few. We hope to integrate the available knowledge by conducting comparative studies of farming systems in countries in Africa, and through this integrated analysis to understand the linkages to policies at broader scales.

From the outset we do not envisage invention of magic or universal solutions to these complex problems. We do believe it is possible to identify the conditions from both socioeconomic and agroecological perspectives that can provide windows of opportunity in both time and space that will favour particular forms of management. Thus we recognise from the outset that the attractiveness of technologies will grow, and wane, as intensity of land use and links to urban markets for both produce and employment develop. Insights from 'New Institutional Economics' highlight the need for strong technologies, supply chains, markets, information flow and all other components for successful changes in systems of agriculture (Dorward *et al.*, 1998). There are also clear effects at the global scale of trade-agreements and of European and American agricultural policy on profitability of farming in Africa (Bigman, 2002; Koning, 2002). Through a better understanding of the context under which the farmers are operating, and how this influences their management decisions, we hope to contribute fully to debates surrounding policies for enhancement of food security and livelihoods rural communities in sub-Saharan Africa.

Searching for the middle ground

I have discussed a number of examples of the directions we are taking in research and teaching around the general theme of plant production systems and analyses of systems at different hierarchical scales. It is clear that this is a highly complex field of science which involves two key aspects. Firstly we have to deal with huge uncertainty as we try and understand the likely effects and impacts of changing policies and management. Secondly, as we deal with topics that are central to society at large, and because we deal with these at scales that can be readily recognised by all it is an area of analysis where there are many views and stakeholders whose views must be taken into account.

This is not an area of science where single optimal solutions or fixed outcomes exist. There is are multiple responses and outcomes to virtually all of the questions we are likely to pose which involve balancing trade-offs between goals. Planning for the future involves choice where the costs and benefits arising from decisions may accrue to different members of different societies with conflicting interests.

As a relatively new convert to the challenging and uncertain science of systems analysis at higher integration scales, I recognise the need to escape from the stereotypes embedded in our descriptions of science that I allude to earlier. One response is to retreat to the comparative safety of science at scales where variability can be controlled, and there is indeed still a huge amount to learn from such science, but simply because it is difficult is no excuse not to embark on explorations of higher scales. We need to gain insight and strength from all disciplines and lines of scientific enquiry and recognise the value of generalists who can assist in the integration of knowledge. My personal search for this elusive middle ground is not an argument or plea for mediocrity but acceptance that no single discipline can lay claim to the 'truth'. The insight of 'post-normal science' (Ravetz, 1999) in which the views of stakeholders are fully integrated I find especially useful on conceptualising our role.

Implications for teaching

I believe the analysis I have presented has important messages for our teaching in Wageningen. The next generations of scientists will face even greater challenges, as we can see by the unpredictable trends in global politics. We need to ensure that our students gain broad skills to integrate and question - even for those following more specialised or narrow lines of study. Some time ago Ray Ison (1990) wrote a paper entitled "Teaching threatens sustainable agriculture" in recognition of the poor structure and lack of integrative thinking in most educational programmes. During long evenings solving the world's problems together with Malcolm Blackie in Malawi, we came to the conclusion that commodity-based research threatens agriculture in most developing countries for the same reasons. Through ensuring delivery of courses with a strong-emphasis on 'systems thinking', Wageningen can produce professionals well equipped to engage in wider debates on the role of science in society and to contribute to a brighter future.

Concluding remarks

To conclude I would like to reflect on my appointment to this position and on my experience of my first year in post as Professor of Plant Production Systems.

Rector Magnificus, Professors of the University

I acknowledge the trust put in me by colleagues and the Rector involved with the selection process for appointing me to this Professorship in a school of highly distinguished tradition. I pledge that I will do my utmost to uphold and extend that tradition and academic tradition and to contribute to the understanding of Plant Production Systems in their widest context. Status as an academic (at least in the English tradition) with the (former) system of career-long tenure was designed to ensure the freedom to speak one's mind without fear of immediate dismissal (or a knife in the back) – a tradition that goes with the rather quaint clothes! I am indeed honoured to join your ranks and the type of science that we pursue means that I have already, and will in the future, be seeking close collaboration with many groups from both the social and natural sciences within Wageningen.

I consider it to have been a very exciting year in terms of my own learning and many of the scientific debates in which I have participated. This gives me great confidence in my own decision to join Wageningen University and in the future role of Wageningen both home and abroad. However I have been equally disappointed to see over the past year that Professors are regarded as somewhat insignificant middle managers who are expected to implement questionable policies that are presented for discussion, but for which the manner of implementation has clearly been previously decided. My perhaps naïve but persistent view is that the role of administration and management within the University is to give academics the space and time to innovate and develop their science rather than to keep us busy with infinite streams of electronic communications and paper. I am not arguing for a return to a role of university academics casting pearls of wisdom from their 'ivory towers', as I hope has been clear from my presentation today. I acknowledge that the funding base for Universities is something for which we have to strive rather than a 'given'. But I cannot help but conclude that the current 'business' and 'market-led' focus that we repeatedly hear is an extremely short-term view for a University to adopt as a driving force for University policy. I suggest, Rector, that there should be a stronger leading emphasis on the quality of science and its relevance to society, and that high-quality science will guarantee the University a long and valuable contribution to knowledge, to education and to society at large, and a future in which I hope to play a major role.

Colleagues and students at the Haarweg
I thank you all for the welcoming and relaxed atmosphere that prevails where we work. I hope that I can both add to cultural diversity and help to maintain a stimulating and pleasant working environment. After all, given the time and effort we all invest in our work it should not only be of good quality and of broader relevance, but also enjoyable! We have a number of exciting new initiatives, and a healthy flux of students and visiting researchers from all parts of the world. I am confident that we will make significant contributions through our science towards building a better world in the coming years.

Ladies and Gentlemen
Thankyou all for your attention.

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I thank all of those with whom I have worked in research and from whom I have learned so much. I also thank Jerry Ravetz, Malcolm Blackie and Richard Thompson for inspiration.

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