AMBIENTA
Environmental Investments

Vucciria, Renato Guttuso, 1974
Palazzo Steri, Palermo

Fabio Ranghino

Is a protein rich diet an affordable bill for the planet?

For most of the 2.5 million years of human evolution little has changed in our diet. We know that primitive humans were exclusively hunter-gatherers. They consumed only raw food before discovering fire. But over the last 10,000 years our diet has changed along with our ability to shape the world according to our tastes and food preferences. Developments like agriculture, animal husbandry, mechanization and fertilization have allowed humans to build a $5 trillion industry that provides an increasingly sophisticated and rich diet for 7 billion people, even if foodstuffs are unevenly distributed across the globe. Recently we have come to know the cost of this transformation: 1.5 billion cows graze on pastures that used to be wilderness, fish populations are drastically reduced and soil quality is declining. While 63% of Americans are overweight, hunger still affects almost 800 million people around the world, despite a slightly improved trend.

Finding the right balance between better diet demanded by a growing population and the effect that has on the environment is crucial for us today and as such, it is a compelling global trend for environment-focused investors. This newsletter provides tools to navigate this complex subject and its current investment opportunities.

Dietary changes and the food demand gap: the protein issue

One of the first mechanical ploughs by John Deere & Co, 1867

Ten thousand years ago, less than 10 million people lived on this planet. By the time of the Roman Empire, this figure grew to around 300 million people. In the next 2,000 years, the population grew to 1.3 billion people by 1850, rapidly doubled to 2.6 billion by 1950 and then tripled to 7.3 billion by 2015. Forecasts now point to 9-10 billion people by 2050. How has this acceleration in population growth happened? How was it possible?

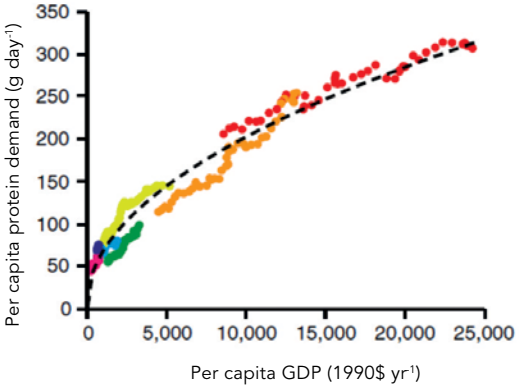
The availability of food has been one of the factors driving this rapid growth. It was probably the only factor for million years preceding the introduction of agriculture and animal husbandry. Diet was limited to available food supplies that varied over geography and time: wild plants and wild animals whenever they could be caught. The introduction of agriculture and animal husbandry around 10,000 years ago increased the availability and reliability of food supplies and drove the very first demographic boom. Two other more recent developments, the mechanization of agriculture in the 19th century and chemical fertilizers in the 20th century, spurred an enormous increase in agricultural yields, key to the demographic boom from 1850 to this day. Over this period of time agricultural land and pastures expanded enormously to the expenses of forests and wilderness.

Will we be able to feed the next 2-3 billion people expected to populate the planet by 2050? Will we manage to eradicate hunger as established by the UN in 2015 through its Sustainable Development Goals?

It is no easy task, as we can observe by the media's constant coverage of the question. The demand for food is expected to grow faster than the population for a very simple reason: not only is the population growing but the caloric intake per person is growing along with economic development. In the 1960s the average global per capita food consumption was around 2,350 kcal/day, it is now about 2,900kcal/day and will exceed 3,050 kcal/day by 2050. The combined effect of population growth and increased daily caloric intake will turn into a food demand gap of about 50% by the middle of the century.

Merely closing this gap would be challenging enough, given the limited availability of land. But there is more to the issue: caloric intake is just one side of nutrition; nutrition is also about food types.

Widespread economic development since the industrial revolution has allowed an increasing share of the world's population to exercise choices about what type of foods to consume. In developed economies this preference is quite clear: protein-rich and processed foods have emerged as winners, taking the largest share of daily caloric intake. In some cases, per capita protein consumption in high income countries is 4-6 times that of low income countries, with growth in the demand resulting as a function of increasing economic development. This is why the protein gap is expected to be higher than the mere caloric gap over the next decade.



Annual dependence of per capita demand of protein on per capita real GDP

The origin of proteins is another fact to consider. This micronutrient is critical for any balanced diet; and it is present in a higher per-kilo level in animal-based foods, such as meat and fish. Typically the protein content of meat or fish can be as high as 30-40% as compared to 2-10% in grains. In developed economies the protein demand is primarily satisfied by animal-based foods. Unfortunately, grains and meat products do not have the same effect on the environment. As we will see, the production of meat-proteins is particularly resource-intensive and has a significant impact on the environment.

So, there is a question about the long-term sustainability of our protein consumption and production model. It is a complex matter which encompasses large industries, shifting consumer preferences and long-term eco-sustainability.

In the next section we will guide you through the environmental challenges posed by protein production.

Environment and proteins: "no such thing as a free lunch"

Proteins have always been a part of the human diet. Animal proteins represented more than 50% of caloric intake before the arrival of agriculture and animal husbandry which introduced cereals and dairy products. While it's true that today 70% of our caloric intake comes from foods that were not available before agriculture, we still rely on the same three main sources of protein: 1) animal proteins including dairy, fish and insects; 2) plant proteins (pulses, soy, nuts, grains etc); 3) alternative proteins which include algae and bacteria.

Our focus here is on animal proteins and plant-based proteins which represent the vast majority of the global protein supply. To understand the environmental issues and the investment opportunities of each product family we need to understand the respective product value chains. While the value chain for fish is a separate case, the plant protein and animal protein value chains are significantly interconnected. Each value chain drives demand for different resources and consequently has varying levels of impact on the environment.

Overview of high protein content products: dairy, meat, fish, beans, pulses, eggs, nuts

Fish value chain

Fish is the major source of protein for around 3 billion people and its consumption has grown seven-fold since 1950. Unfortunately, the volume of fish caught in the wild has barely grown over

Foto ©Stefanos Kyriazis/123rf

Aquaculture in Northern Greece

the last 20 years due to diminishing supply and all additional demand has been supplied by aquaculture which has grown fourfold in the same 20 years. Aquaculture now supplies almost 50% of all fish and is set to grow further, since 90% of fish stocks in the oceans are overfished and expected to collapse soon. The fish protein value chain is highly inefficient. Around 40% of wild-caught fish has no commercial value and is discarded despite being high quality protein. Moreover wild-caught fish is also used as an ingredient for fishmeal and as feed for land animals thus strengthening pressure on fish stocks. Ultimately, high density aquaculture produces waste effluents that, if not properly managed, produce an excessive biological load that pollutes the water. There are severe supply constraints and wastage issues caused by the production of fish protein.

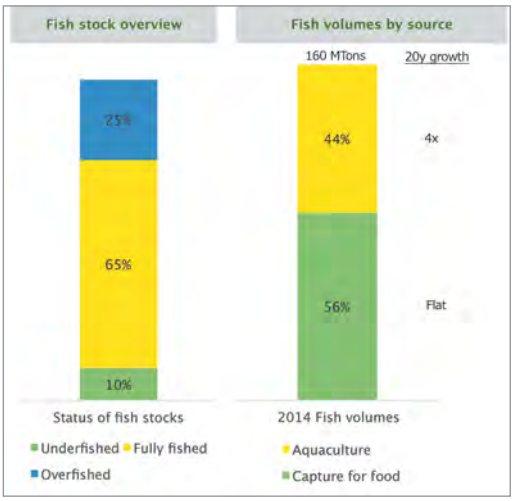
Land sourced proteins

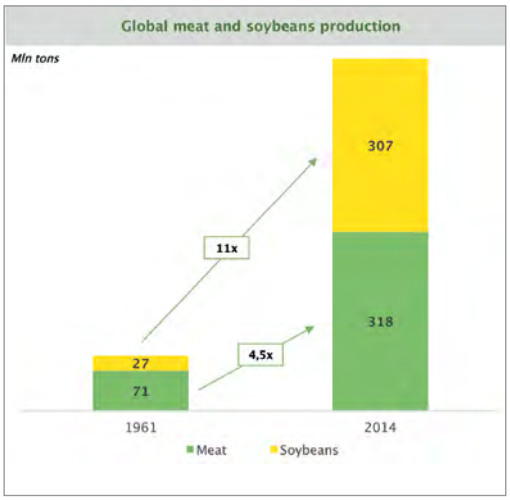
For land-grown proteins, including both plant- and animal-based, the environmental issues are significantly more complex and relevant on a global scale. Today there are more than 27 billion live animals in the world -- four times the amount in 1961 -- and annual meat production has grown almost 5 times in the same period. Not by chance, soy production has grown almost 11 times as its main application is animal feed (representing 75% of total global production). The increased number of animals require pastures for grazing for which humans have cleared forests resulting in one-third of overall global deforestation.

Assessing the resource intensity and environmental impact of the production of each type of protein is not a simple task, a summary of a few of the major contributors to the negative effect on the environment are outlined in the table in the next page. Land and water demand are the two major areas of impact in terms of pressure on natural resources and thus represent the opportunities for resource efficiency driven businesses. In terms of pollution, the impact of protein production is broad. In particular, protein production is definitely a major contributor to land degradation, greenhouse gases emissions, water pollution and growing antibiotic resistance. Therefore, any product and service, reducing or avoiding these impacts, represents a pollution control investment opportunity.

Left: overview of fish stocks and production by origin (2014)

Right: overview of livestock related products: meat and soybeans





Environmental Impact of land sourced protein value chain

	ENVIRONMENTAL IMPACT	DESCRIPTION
RESOURCES	Land utilization	- 26% of global land utilized for animal protein production - Peaks of demand on a country basis can be up to 50% (i.e. 45% in UK)
	Water demand	- 8% of global water demand, including feed production - almost equivalent to global domestic water usage
POLLUTION	Land degradation	- Main cause of both habitat loss and soil degradation - Responsible for 1/3 of global deforestation - Overgrazing is the main cause of desertification
	Greenhouse gases emissions	- Responsible for ~15% of all global greenhouse gases, similar level to global transportation - Deforestation and emissions of GHG gases from ruminant digestive systems and manure are major contributors
	Water pollution	- Livestock effluents and fertilizers from feed production has a negative impact on water quality - In the US, fertilizers are the single largest contributor to water pollution
	Antibiotic resistance	- Extensive use of antibiotics on animals is contributing to the development of antibiotic-resistant infections - 45% and 70% of antibiotics, in UK and US respectively, are used for livestock and not humans

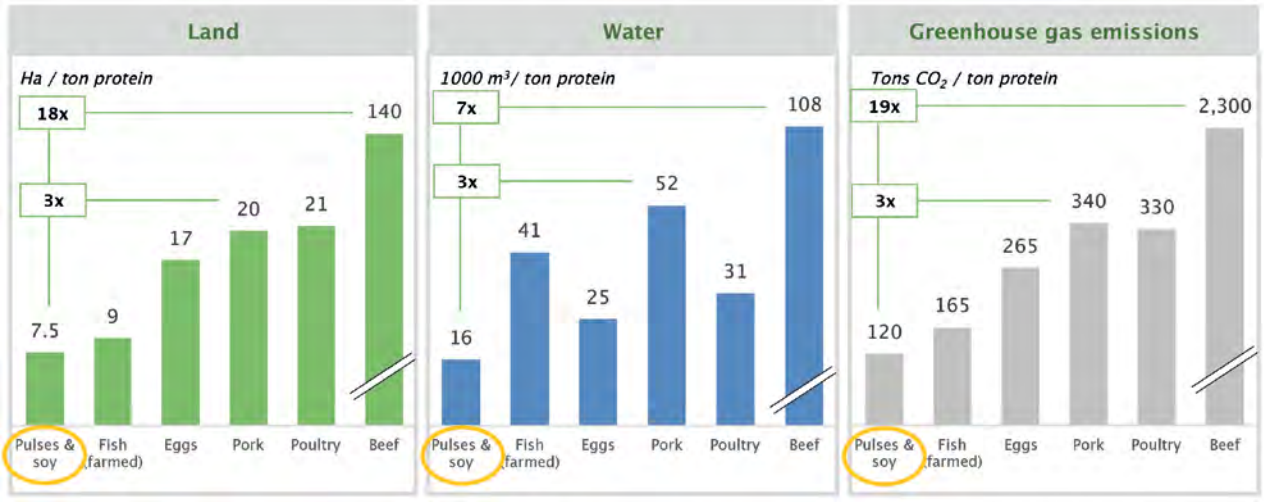
There is no doubt that we need proteins, so ranking each protein source by its relative intensity or impact on the environment per ton of protein produced is a useful exercise. Plant based proteins have a much lower impact and resource intensity than animal based proteins. Beef, for example, can be more than ten times more resource-intensive than pulses and soy.

In summary, rationalizing the protein value chain represents a major global environmental issue because of its heavy resource and pollution footprint, making it at least as significant as finding alternatives for fossil fuels.

It is clear that uncontrolled growth of protein production, both non-animal and animal, under current business practices will continue to significantly harm our eco-system and ultimately hinder future generations' ability to produce food.

When the free-market economist Milton Friedman popularized the phrase "there is no such thing as a free lunch", he emphasized the concept of opportunity cost. The concept couldn't be more appropriate for discussing the production of protein. It is not about good or bad proteins. It is about the opportunity cost of using resource inputs and outputs for one purpose or another. Growing plants for consumption or for animals to graze. Feed humans or animals. To waste or recover. Since an opportunity cost usually highlights a business case, we believe this global concern can lead to significant investment opportunities - as long as you know what you're looking for.

Overview of major environmental issues by origin of protein (per ton of protein)



Investing in a large problem through small solutions

Sustainable protein production for 9 billion people is going to be a major global challenge. We can foresee a time when the environment is pushed to a critical limit and when choices about food will no longer be made by consumers based on preference or buying potential, but relegated to the realm of politics and regulation. If fish stocks collapse, we will have to abandon fishing. If soil fertility becomes too degraded or water becomes too scarce, we will no longer be able to grow or breed plants or animals. The scenario is not so farfetched. It has already begun. An example: last year in China thousands of swine farms were forced to shut down because of excessive water pollution, reducing global pork meat supply by 5-6%.

And yet, there are still many reasons for optimism. There are several areas of improvement in protein production value chains that can lead to significant productivity gains. It is here that the sound investment opportunities lie. Historically, agriculture and food production have not been fertile investment ground for private equity: a marginal 1-2% of deal volume is usually dedicated to this segment. Moreover, investment has been mainly in downstream food production, closer to the consumer. Unfavourable working capital cycles, capital intensity and dependency on commodity pricing, are just a few of the reasons why the upstream segment has not attracted private equity capital. In light of undeniable trends, we expect this to change and the percentage of investment in the upstream segment to undoubtedly increase.

German Bay. Full net of herrings caught on a Trawler in the North Sea

Foto ©attaintc-kid/iStockphoto

The interest generated by this trend is on the rise and it involves different types of investors. It is gaining attention not only by private equity investors but also by early stage investors and through to listed equities. Some representative examples:

Goldman Sachs and Altor acquired Hamlet Protein in 2015. This company has found a way to produce animal feed that improves nutrient absorption so farmers can raise animals with less feed. As a leader in high value-added feed for young animals, Hamlet's innovation drives more efficient bio-convertion of feed into valuable protein, for an optimization of the protein value chain. A second feature of this this feed is that it allows for a reduction in the use of antibiotics. This responds to consumer demand and at the same time reduces costs for the farmer.

On the listed equity side, Novozymes, a listed Danish bio-technology company, has become a global leader in the development of enzymes used as additives for animal feed. These enzymes are natural products that improve digestibility and nutrients absorption thus improving feed conversion ratios. Other products influence the excretion level thus reducing both air and soil pollution while reducing feed cost. Novozymes, which grows both organically and through M&A, is a clear example of both disruptive and marginal innovation in the sector.

Aquaculture is the key to addressing the growing demand for fish, making it a double-digit growth sector. Many transactions, in both private equity and in the listed space have occurred that exemplify this. For example,

in 2015 KKR invested nearly $100 million in a significant minority stake in a Chinese aquatic feed producer. Similarly, Benchmark Holdings, a UK based listed company active in aquaculture and agriculture, acquired INVE Acquaculture in the Netherlands for more than 12 times EBITDA.

We see this trend is significant and is probably represented best by the Nutreco auction feud contested by Cargill and SHV Holding in 2014. Nutreco is a global animal nutrition and fish feed leader based in the Netherlands which was listed in 1997. Supported by the long-term protein demand trend, it delivered an impressive annual total shareholder return of 13% over an 18 year period [*source: Nutreco press release*] before the family-owned investment holding SHV overbid Cargill and delisted Nutreco. SHV, a long-term oriented investor, successfully bid a 10.5 times EV/EBITDA multiple and around a 40% premium on the stock price to obtain the control of the global leader, with its long-term story of growth.

Last but not least, an emerging area of interest for both venture capitalists and corporate and private equity players is in insect-based proteins. Despite an instinctive repulsion to the concept of human insect based nutrition, this is a segment of the value chain that is set to grow globally. Insects are an integral part of the food value chain in nature. Fish, animals and even humans eat insects, which are very rich in proteins. Insects offer several environmental and economic advantages compared to alternative animal protein sources. Insects have an extremely high ability to convert feed into edible proteins, higher than any other animal, and can be fed with organic side streams like post-consumer organic waste, they require little water and produce minimal emissions. As such, insects are a credible low-cost source of protein which will someday be a new branch of the global food industry. Technology, bio-tech, industrial businesses, both at start-up and SME level, are already active in this space providing new small solutions to a global problem.

Thai food: fried and baked scorpions and grasshoppers

©Alexander Podshivalov/123rf

There are four environmentally relevant themes which we believe will play a major role in this potential trillion-dollar industry transformation:

- **Plant based protein products:** plant based proteins are less resource intensive than animal based protein, therefore any relative increase in consumption leads to improved sustainability. Pulses in particular are a great example. Pulses drive both significant environmental benefits and satisfy consumers because they are highly nutritious and environmentally friendly. Pulses naturally take nitrogen from the atmosphere and fix it into the ground, promoting a more efficient use of fertilizers and thus reducing greenhouse gas emissions.
- **Animal feed innovation:** feed is the major driver of the environmental impact of livestock and aquaculture production. Feed is transformed into meat at different rates of efficiency and has an influence on animal health. For these reasons, business models that improve the conversion effectiveness of feed into valuable proteins for human consumption are particularly interesting. They represent an economic advantage for farmers and reduce pressure on scarce resources such as fish for fish meal. Feed

Foto ©artisteer /iStockphoto

additives used to improve the absorption of nutrients are an example of this conversion effectiveness: with them, animals need less food per weight of meat produced. Other examples include instruments and monitoring equipment that are used to control feed quality. High quality feed, with the right humidity content for example, leads to healthier animals which convert feed more effectively and require fewer antibiotics.

- **Services and businesses that close the protein loop:** useful proteins are wasted along value chains and often we do not even know it. Sludge from starch companies is rich in proteins but it is usually turned into waste whereas it could be used as animal feed. Sugar beet leaves, extremely rich in proteins, are typically left in the field. Fish of low commercial value is wasted or at best used as fishmeal or animal feed. Retail wastage of proteins is also significant. Several businesses are emerging that could scale smart solutions to close these loops of protein waste beyond simple commercial agreements between two or more businesses. In this area, logistic platforms or treatment machines to reclaim valuable proteins are an example of food recycling value chains at the post-consumer level.
- **Information and data services:** we often miss the critical information that can enable productivity gains in animal health and resource utilisation. We give animals antibiotics to prevent illnesses rather than as a cure. We fish without considering the status of stocks. We fertilize to grow crops for animal feed without a clear understanding of the timing and quantity to be used. Several technology-enabled solutions are being developed that facilitate improvements in these practices. Information services facilitate improved fertilization techniques or monitor the conditions of the land and fish stocks in the oceans via satellites.

In conclusion, we believe that products and services focused on addressing sustainable protein production will emerge as strong growth stories, supported by macroeconomic and resource efficiency drivers. Planet Earth cannot afford the cost of current practices. Marginal and disruptive innovation are required to make production affordable and sustainable. This trend is here to stay for the long-term and will generate a growing number of opportunities for sustainability-focused investors. Protein value chain questions are part and parcel of the one of the most important environmental issues of the century. Solving these questions means keeping us free to choose about food we consume in the years to come.