European Journal of Sustainable Development (2017), **6**, 4, 538-550 ISSN: 2239-5938
Doi: 10.14207/ejsd.2017.v6n4p538

The Agriculture and Livestock Sectors' Contribution to the Peruvian Economic Growth's Green Classification Between 2005 and 2014

By Alfredo Villavicencio[1], Marta Tostes[2]

Abstract
As shown in the last NIGGE (2010), the agriculture and livestock sectors are the third most pollutant economic activities (meaning 15% of Peruvian GHG emissions), after forestry and energy. This investigation aims to provide quantitative support to the contribution of this sector to Peruvian economic growth's green classification that can be seen through three groups of variables, applied through Ordinary Least Square regressions of data found at the Agriculture and Livestock Monthly Bulletin. As preliminary results, even though there is a positive and significant correlation between the considered Peruvian GDPs and the Environmentally Preferred Agriculture Goods, the Environmentally Non-Preferred Agriculture Goods have a higher and more significant correlation, reflecting an unsustainable trend. Moreover, Environmentally Non-Preferred Livestock Goods have a significant but reduced negative correlation with the Peruvian GDPs. On the other hand, biotrade appears as a strategy for achieving green growth due to its positive and significant correlations with the Peruvian GDPs. Finally, pesticides, fertilizers and farmed land area show non-significance in almost every result. In conclusion, through policies that reverse those trends and that foster biotrade as a green growth alternative, a significant contribution from the agriculture and livestock to the Peruvian green growth could be ultimately achieved.

Keywords: Agriculture, livestock, green growth, biotrade, GHG emissions

1. Introduction

From 2005 to 2014, Peru experienced sustained economic growth with an annual average of 6.39% and a cumulative total of 74.5% (INEI, 2015). However, has this economic growth also been a green growth? Through greenhouse gases (GHG) emissions' measurement, Peru formally did have a green growth within that period: from 2007 to 2010 (MINAM, 2012). In this regard, the question stands: what happened between 2005 and 2007 and between 2010 and 2014 in order to have "non-green" growth while in the remaining four years Peru did have a green growth? Did agriculture and livestock sectors contributed to it?

That last question is what this research seeks to answer: how the agriculture and livestock sector contributed (or not) to the green classification of the Peruvian economic growth during that period. From this, the present investigation aims to answer to what extent and from which variables this sector contributed to this characteristic of Peruvian economic growth. The sector's choice is based on two main reasons: its structural relevance in the Peruvian and global context of green growth and the accessibility to data on its evolution. Even though from 2005 to 2014 agriculture and livestock production

[1]ExceDesa's Senior Investigator, , is a graduated Economist from Pontificia Universidad Católica del Perú (PUCP)
[2]Main professor at Pontificia Universidad Católica del Perú (PUCP) in the Management Science Academic Department

lost share in total GDP, from 6.2% to 5.1%, it maintained an average annual growth of 4.8% and a cumulative variation of 44.70%. As for its share in GDP, such is relatively low when compared with that in the last decade of the economically active population (EAP) from this sector accounted for around 29% of the total (INEI, 2015).
On the other hand, it is important to consider that the agriculture and livestock sectors are some of the most vulnerable and the most affected by climate change (FAO, 2014). For that reason, studies about the impact of these sectors can help determine whether control policies and environmental management should target more this activity. From a GHG emissions perspective, the Peruvian National Inventory of GHG Emissions showed that the activities in the agriculture and livestock sectors are the third ones to produce more GHG: after forestry and mining: agriculture and livestock represented 19.5% of the total (MINAM, 2010). A study by the Food and Agriculture Organization (FAO, 2014) disaggregates the ten billion tons of CO2 emitted by the agriculture and livestock sectors worldwide: 63% is related to fermentation and animals' manure management, 13% to the use of synthetic fertilizers, 10% to the sowing of rice, 5% to the burning of agricultural land, among others. However, the amount of comprehensive research examining the relationship between agriculture, livestock and green growth is quite small and fragmented. In that sense, this research seeks to partially fill that gap through the Ordinary Least Square (OLS) regressions between the three GDP (total, agriculture and livestock) and three groups of variables: productive specialization in environmentally preferable and not preferable agriculture and livestock goods, agriculture and livestock inputs, and biotrade.

2. Literature Review

To understand the concept of green economy and its empirical application for Peru, it is essential to observe the evolution of related concepts. As a consequence, in chronological order of introduction into the academic debate, the definitions of the following terms (the ones used throughout this investigation) will be provided: sustainable development, biotrade, and green growth. First of all, sustainable development was introduced in 1980 within the World Conservation Strategy developed by the International Union for Conservation of Nature (IUCN). Since its introduction, the concept has been related to the natural resources administration. Seven years later, the Brundtland Report (1987), prepared by a group of UN experts led by the then Prime Minister of Norway, Gro Harlem Brundtland, introduced the notion of sustainable development, as *"development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs"* (Brundtland, 1987: 1).
Moreover, at the Sixth Conference of the Parties to the United Nations Framework Convention on Climate Change (COP) in 1996, the UN Conference on Trade and Development (UNCTAD) first developed the concept of biotrade. Although this is not the result of the concept of bio-economy, its relationship with that concept is undeniable. Fairlie (2013) collects the best known definition of biotrade developed by UNCTAD in 2007:
"Within this framework the term BioTrade is understood to include activities related to the collection or production, transformation, and commercialization of goods and

services derived from native biodiversity (genetic resources, species and ecosystems) according to criteria of environmental, social and economic sustainability" (UNCTAD, 2007: 1).

After contextualizing some basic green growth related concepts, the concept of green growth itself has been nominated for several decades, and it is the OECD, in the words of Fairlie (2013), which defines the objective of green growth as: *"to increase production through administration of scarce natural resources, which results from the reduction of carbon intensity and adverse environmental impacts arising from the process of the food chain and the improvement of the presentation of environmental services"* (Fairlie, 2013: 7). Likewise, green growth focuses on generating or accelerating economic growth by reducing environmental costs, which may be measured in different ways: ecological footprint, GHG emissions, share of organic inputs, among others. For this particular investigation, it is interpreted as having an economic growth that goes hand by hand with a productive specialization in environmentally preferable goods.

3. Stylized Facts

3.1 Peruvian Agriculture and Livestock Sectors

Peru had a decade of sustained economic growth: from 2005 to 2014, the Gross Domestic Product, measured at constant 2007 prices, grew by an annual average of 6.39% and a cumulative 74.5%. The highest growth in annual average rates during the period studied economic activities were: telecommunications and other information services (12.5%), construction (11.0%) and financial services, insurance and pensions (9.1 %). However, the sectors that grew the least were the extraction of oil, gas, minerals and related services (3.5%), fisheries and aquaculture (3.7%) and agriculture, livestock hunting and forestry (4.1%) (INEI, 2015).

Furthermore, from 2005 to 2014, agriculture, livestock and hunting had an average annual growth of its gross domestic product, at constant 2007 prices, of 4.1%. Such GDP steady growth in the sector is due to reasons such as the 6.2% growth from 2005 to 2012 of the farmed area, the increase of around 2% of foreign investment in this specific sector, the tripling of multiple placements of banks and rural banks, the 68.2% rise in indexes of products' prices in the sector, among others. Quite similar to the mining activity, from 2005 to 2009, the average annual variation rate of the agriculture and livestock was 5.9%, while that from 2009 to 2014 annual average growth rate was 3.0% (INEI, 2015). In this scenario, one of the reasons is also in reducing external demand for agricultural products due to the international crisis lived in the last years of the past decade. Even though non-traditional agricultural exports were gaining a greater share of total exports at the beginning of the period, the reduced foreign demand and increased agricultural imports due to the increased trade openness slowed the sectors' growth (Mendoza & Tello, 2011; COMEX, 2013).

From the data presented by the Ministry of Agriculture and Irrigation (MINAGRI, 2015), some differences in the growth of the agricultural sector and livestock appear. Even though both sectors are clearly seasonal variables, their differences in variation have dissimilar origins. For example, the agriculture GDP at constant 1994 prices grew by 113% from January 2005 to November 2014, while livestock grew less, 95.27%

(MINAGRI, 2015). Both GDP have grown prominently; however, the faster growing agriculture sector shows that the livestock sector has been losing presence in the sector. Indeed, it can also be seen in the disaggregated data of studied sector on its GDP, where the livestock sector has grown only 55.26%, compared to the 113% of the agriculture sector (MINAGRI, 2015).

3.2 Peruvian Green Growth

By 2050, without strong environmental policies and regulations, Peru could lose between 10% and 15% of its plant species (SERNANP, 2015) and, until 2012, already had 301 species in danger of extinction (Peru Ecológico, 2012), and by 2030, a loss of more than 22% of the glacier area since 1980 could be reached (Vargas, 2009). Because of the huge risks around climate change in Peru, the United Nations Industrial Development Organization (UNIDO, 2012) details a list of indicators of industry and green growth. In this regard, the Ministry of Environment (2012) applied these indicators to monitor the performance of green growth for Peru from 2000 to 2010. Within these, results can be seen only in the period from 2007 to 2010 there was green growth in Peru (higher economic growth than changes in GHG emissions). The application of the Ministry of Environment (2012) to UNIDO's indicators suggests that the reasons are linked to the drop in the percentage of households using solid fuels to cook 18% in 2007 and half (9%) in 2010 ; forestry production fell from 9,367 m^3 in 2007 to 6.258 m^3 in 2009 (since 2003, when there was only accelerated deforestation); the metal mining production had a slight slowdown in 2007 and 2008; there was a public environmental expenditure above average from 2009 to 2012; the slowdown in the production of fish between 2006 and 2009; among others.

Also, when the share of agriculture on the green growth is observed, it cannot be left aside to analyze changes in productive specialization through those agriculture and livestock products that affect positively or negatively the environment. To do so, the list of Environmentally Preferable Goods presented by Garcia (2008) is taken into account, from which the following Environmentally Preferable Agriculture Goods are taken into consideration: cocoa, tea, hard corn, flour corn and cotton. Regarding these products and comparing December 2005 with December 2014, the volume of corn starch grew by 563%; the Cocoa, 200%; and hard corn, 28%; while the volume of cotton was reduced by 83% and tea by 63% (MINAGRI, 2015). On the other hand, Environmentally Non-Preferable Agriculture Goods (ENPAG) are studied through just a one product proxy: rice. In both cases, it is due to the strong impact they have on methane emissions and GHG broadly. Thus, between December 2005 and 2014, the volume of rice production grew by 39% (MINAGRI, 2015). As for Environmentally Non-Preferable Livestock Goods, its production approximate will the sum of the volumes of cow, sheep, poultry and pork meat production increased significantly by 74.75% (MINAGRI, 2015) during the studied decade.

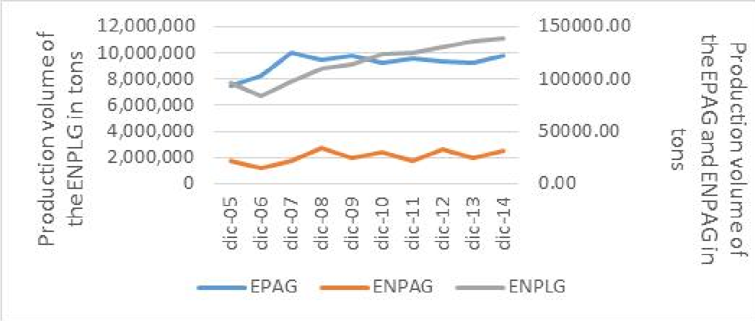

Figure 1. Production volume (tons) of EPAG, ENPAG, and ENPLG, 2005-2014 (Decembers)
Source: Agriculture and Livestock Monthly Bulletin – MINAGRI.

Furthermore, within the agricultural sector and its link with the green growth potential, it should be studied what have been the changes in the volume of inputs that the sector requires (most notably farmed land, fertilizers and pesticides). Thus, first, the area planted is a variable that has a clear seasonality, as the months being compared. Therefore, when compared the months of January 2005 to 2014, a growth of 13.52% is observed; this month is also close to the average growth of other months (MINAGRI, 2015). Nevertheless, Peruvian fertilizer production is quite low; in average, 95% of the volume is imported throughout the decade studied. Even though both the volume of imports of fertilizers such as pesticides have been variable without a particular seasonality and irregularity, their imports will be used as a proxy due to their high share in the amount located in the market. In the case of import of fertilizers, an increase throughout the period of around 60% can still be seen (with a few variations), while pesticides have in fact quadrupled their volume in this decade (MINAGRI, 2015).

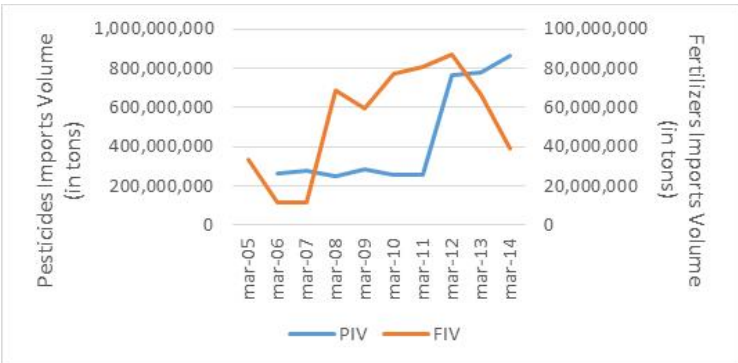

Figure 2. Pesticides and Fertilizers Imports Volume in Peru
Source: Agriculture and Livestock Monthly Bulletin – MINAGRI.

In addition, few authors have written about green growth in Peru and other related topics (such as biotrade, green economy, among others) that have direct implications on green growth. Among them, Vargas (2009) shows some ways in which climate change has affected and continues affecting the Peruvian economic growth, which has influenced so far in its recent slowdown. From this author's research, it can be concluded that the Peruvian green growth has recently characterized not only by the undesirable trend of high GHG emissions but also by the fact that the same economic growth is endangered due to the consequences of climate change (e.g. the increasing frequency of the El Niño phenomenon and its livestock, fishing, agricultural and tourism consequences). Moreover, Orihuela (2014) studied the question of whether the resource-based growth can be green and particularly inclusive in the Peruvian case, finding that both answers have been historically answered negative. Moreover, Fairlie (2013) notes that biotrade is one of the best alternatives for Peru to achieve green growth, through the sustainable use of Peru's biodiversity. Even though native biodiversity in 2014 represented 1% of exports to the United States (Fairlie, 2013), there is still plenty space for boosting it (from both the public and private sectors) within the Peruvian exports' structure in order to encourage green growth. In this regard, Garcia (2008) elaborates a list of environmentally preferable products for Peru (based on suggestions made by UNCTAD), which, while not belonging to the concept itself of biotrade, may foster Peruvian green growth.

4. Theoretical Framework

In the academic debate about green growth, models including ecological footprint cannot be left aside due to its intrinsic relationship to sustainability and green growth. Thus, Dobos and Csutora (2010) calculated the ecological footprint through an input-output model on an open economy. After that, they describe a Leontieff model represented economy in the Equation 1[1], with their imports described by the Equation 2[2].

Equation 1: $x = Ax + e + c$

Equation 2: $i = C_A x + c_i$

Then, to include the concept of ecological footprint, the authors represent goods (demand, production, exports and imports) depending on the amount of land (natural resources). Therefore, the productive function will be based on a natural resource based factor: the land. Clearing that natural resources' proxy, Dobos and Csutora find the ecological footprint in terms of production, exports and imports included in the matrix described by the Equation 3[3]. When this equation is expanded according to the equivalencies presented in the model, they found that in an open economy, the ecological footprint will depend on how land intensive are the final demand, capital accumulation, exports and imports.

Equation 3: $FP_{do,t} = l_1 x_t + l_1 (I - A)^{-1} i_t$

[1] Where "x" is an n-dimensional vector of brute products, "c," an n-dimensional vector of consumed goods, "A," an nxn inputs matrix that includes the self-produced goods needed for the production of every unit, and "e," an n-dimensional vector of exported goods.

[2] Where "i" is an addition of a vector of imported goods, "$C_{A,}$" an nxn matrix of imported inputs needed to produce every unit, and "c_i," a vector of imported goods that satisfy the final demand.

[3] Where $l_1 x_t$ is the multiplication of the land requirements for every exported good times every exported good, and $l_1 (I - A)^{-1} i_t$ is the multiplication of the land requirements for every imported good times every imported good.

However, it notes that there is no single methodology for measuring the ecological footprint, so every model can use different measurements. It states that the first to define the ecological footprint were Wackernagel and Rees (1996), who found it as demand of humans on nature, depending on the planet's capacity to produce and recover these natural resources. For example, Constanza defines the ecological footprint as *"the area of productive land and aquatic ecosystems required to produce the resources that the population consumes and to assimilate the wastes that the population produces, wherever that land and water are located"* (2000: 341). On the other hand, some institutions and academics (Quesada, 2007; SAS, 2009) measure the ecological footprint and carbon footprint, or the total emission of carbon dioxide through specific patterns of consumption and/or production. Finally, other models around sustainable development, natural capital and green growth are the Dasgupta-Heal-Solow-Stiglitz model (1974), the Asheim et al model (2007), the Benchekroun and Withagen model (2011), among several others.

5. Methodology

Throughout this research, as a summary, the methodology aims to study the relationship between GDP (constant values at prices of 1994; of the total, agriculture, and the sum of agriculture and livestock GDP) with three groups of variables related to green growth: productive specialization, measured by production volumes of Environmentally Preferable Agriculture Goods (EPAG), Environmentally Non-Preferable Agriculture Goods (ENPAG), and Environmentally Non-Preferable Livestock Goods (ENPLG); inputs (measured by fertilizers imports volume, the pesticides imports volume and farmed land by main agriculture products); and a biotrade proxy, by OLS regressions.

In this regard, we have as endogenous variables of research to total GDP, the agriculture GDP and complement (some sections), the sum of the agriculture and livestock GDP (the three values at constant 1994 prices) due to the impact that is usually generated within productive specialization of countries. As a contrast, each of the exogenous variables detailed below has been seasonally adjusted to 12 months in order to remove the effect of annual averages and allow a comparison of a month to its equivalent in the previous year, which is compatible with the characteristics of the agricultural sector. In addition, these data have been placed on the value of natural logarithms to reduce differences generated by the magnitudes of the variables and by measurement units. After that data processing, some econometric OLS regressions (Equation 5)[4], corrected by some tests of heteroscedasticity and autocorrelation.

Equation 5:

$$\ln(\mathrm{GDP_i})_\mathrm{d} = \alpha_\mathrm{i} + \beta_{\mathrm{i}_1}\ln(\mathrm{EPAG})_\mathrm{d} + \beta_{\mathrm{i}_2}\ln(\mathrm{ENPAG})_\mathrm{d} + \beta_{\mathrm{i}_3}\ln(\mathrm{ENPLG})_d + \beta_{\mathrm{i}_4}\ln(\mathrm{FLA})_d + \beta_{\mathrm{i}_5}\ln(\mathrm{FIV})_d + \beta_{\mathrm{i}_6}\ln(\mathrm{PIV})_d + \beta_{\mathrm{i}_7}\ln(\mathrm{BT})_\mathrm{d} + \mathcal{E}_i$$

[4] Where "i" could be the total GDP, the agriculture GDP or the sum of the culture plus livestock GDP, "EPAG" are the Environmentally Preferable Agriculture Goods, "ENPAG" are the Environmentally Non-Preferable Agriculture Goods, "ENPLG" are the Environmentally Non-Preferable Livestock Goods, "FLA" are the Farmed Land Area, "FIV" are the fertilizers import volume, "PIV" are the pesticides import volume, "BT" is the biotrade volume exports, and "Ɛ" is the statistical error.

Then, the selection of agriculture and livestock variables, whose correlations with the three GDPs will be sought in this study, is based on three criteria: accessibility to data by the Agriculture and Livestock Monthly Bulletins (MINAGRI); the willingness to gather existing research; and finding an econometric support for such relationships. Furthermore, in terms of agricultural activity, the definitions of EPAGs are taken from UNCTAD (1995), and landed to South American reality from Garcia (2008). As for the study of the impact of the ENPAGs, considering the limited data by the Agriculture and Livestock Monthly Bulletin, the only agriculture product which is considered as a proxy is rice. The choice of this product is based on its international recognition as the most environmentally harmful agricultural good for two reasons: with 10% of total emissions of GHG in the agriculture and livestock sector worldwide (FAO, 2014). But in the agriculture and livestock sector, rice is not the only non-preferable good; meat production is often closely linked to the "gray growth" or "non-green growth", due to the enormous production of GHG emissions (63% of the sector) that carries the manure of these animals (especially cow). Likewise, other variables to be studied are the agriculture sector's inputs because of their direct negative consequences: farmed land of the main agriculture products (FLA), the imports volume of fertilizers (IVF) and the imports volume of pesticides (IVP). Finally, for this research, the list of agriculture products used as biotrade offered by Fairlie (2013), is available in the monthly Agriculture and Livestock Monthly Bulletin. In that sense, the sum of the volumes of export of six products is the proxy that will be taken for the variable biotrade: cocoa, quinoa, cochineal, coca leaves, cat's claw and tare.

6. Results

6.1 Peruvian Agriculture and Livestock Productive Specialization

Agriculture and livestock sectors can contribute or not of in different ways to green growth. For the Peruvian case, as previously discussed, the variables that are taken into account are productive specialization in Environmentally Preferable Agriculture Goods (EPAG); Environmentally Non-Preferable Agriculture Goods (ENPAG); Environmentally Non-Preferable Livestock Goods (ENPLG); inputs whose use is not environmentally sustainable (farmed land, fertilizers and pesticides); and biotrade. The choice of these variables is based on multiple individually collected research works and on the availability of data obtained through the Agriculture and Livestock Monthly Bulletins done by the Ministry of Agriculture and Irrigation (MINAGRI). In addition, understanding the methodological requirement to include GHG emissions within the economic growth (Fairlie, 2013), this choice of variables has this approach too. For example, FAO (2015) evaluates the databases of the variables on the agricultural sector that produce higher GHG emissions and then suggests public policies related to them. Each of these policies may impact differently on a case-by-case analysis shown in the chart below.

OLS	ln_GDP	ln_agr+livest.	ln_agr
ln_EPAG_d	-0.0191	0.144**	0.210*
	(0.0429)	(0.0608)	(0.117)
ln_ENPAG_d	0.0654**	0.213***	0.337***
	(0.0288)	(0.0422)	(0.0756)
ln_ENPLG_d	-0.0549***	-0.0176	-0.0330
	(0.0135)	(0.0203)	(0.0311)
ln_BT_d	0.225***	0.165***	0.209**
	(0.0153)	(0.0282)	(0.0773)
ln_PIV_d	0.00626	-0.0266	-0.0242
	(0.0141)	(0.0206)	(0.0272)
ln_FLA_d	0.00921	-0.0226***	-0.0142
	(0.00638)	(0.00829)	(0.0218)
ln_FIV_d	0.00109	0.0225	0.0441
	(0.0141)	(0.0203)	(0.0298)
#observations	116	116	116
R2	0.696	0.650	0.482

* p < 0.1
** p < 0.05
*** p < 0.01

Chart 1. Results from the OLS Regressions

Through those results, it could be concluded that the correlation coefficients of the ENPAGs are also positive and significant. Not only does this "coincidence" occur but these goods are also highly significant (less than 5%) for the regressions with the sum of the agricultural and livestock GDP is observed. Consequently, the economic growth of the last decade is one of the reasons why Peru also has specialized in ENPAGs, because the relationship is pro-cyclical. Moreover only one significant correlation coefficient (5%) is obtained with the ENPLGs, a negative one, due to the fact that the livestock imports grew strongly in the studied decade (MINAGRI, 2015). For example, imports of poultry meat have increased from 299,9 tons in January 2005 to 1.622,8 tons in December 2012.
In order to achieve a general conclusion about the productive specializations in EPAGs, ENPAGs, and ENPLGs, all the results have to be considered simultaneously in terms of: significance, magnitude and sign. In this regard, it can be seen how the correlation coefficients between ENPAGs are always bigger and have greater significance than EPAGs do, for the three considered GDPs. This indicates that although both variables are pro-cyclical growth of GDP studied, economic growth is being "non-green" by the bigger magnitude of the coefficient of the EPAGs in comparison to the ENPAGs. Therefore, from the perspective of agriculture production specialization, economic growth of the last decade has been less green, given the higher correlation in ENPAGs, which is complemented by observations in the ENPLGs.

6.2 Agriculture and Livestock Sectors' Inputs Consequences on Peruvian Green Growth

To make possible the agriculture and livestock sectors production, there is a large amount of inputs used, among which are the following: agricultural machinery, equipment and irrigation systems, veterinary products, seeds, among others. Nevertheless, between agriculture and livestock inputs, there are three usually considered as the most controversial due to their environmental consequences: farmed land (extensively speaking), fertilizers and pesticides. This is why the FAO (1997) states that the highest negative consequences on this sectors' pollution is due to inputs such as fertilizers and pesticides on water, air and soil where they are used. Finally, because of the data accessibility by the Agriculture and Livestock Monthly Bulletin, the econometric analysis regarding the relationship between agricultural inputs and the GDP is restricted to farmed land, fertilizer imports volume, and pesticides imports volume. For these three cases, OLS regressions were made with three seasonally adjusted series with natural logarithms amounts.

The results are clear: only in the case of agricultural GDP there is a highly significant correlation (less than 1%), while in the other two cases there are non-significant results. Nonetheless, the result might seem surprising, because the relationship between the two variables is negative. How is it possible that a smaller planted area generate a higher GDP? After clarifying that also the correlation coefficient is quite small, this negative relationship may be due to different reasons, such as the facts that the Peruvian agriculture and livestock sector, for several decades, is far from being the most productive economic activity (Verdera, 2007), and because of the increasingly high number of agricultural products imported and irregular agricultural trade balance (INEI, 2015) generated strong competition with the local agricultural sectors and simultaneously involved lower costs of foreign inputs from this sector.

As previously announced, the Peruvian fertilizer production is quite low while imports of these inputs exceeded 95% from 2005 to 2014 as an average (MINAGRI, 2015). Therefore, for this investigation, fertilizers import volume is taken as the proxy variable of fertilizers production. However, none of the three regressions linking that variable with the GDPs (although relevant to both cases of the agriculture GDP and the sum of agriculture and livestock GDP) has significant results. This raises at least two conclusions. First, the absence of these correlations does not imply that the import of fertilizers has not increased from 43.113 tons in January 2005 to 69.597 tons in December 2014 (MINAGRI, 2015). Unlike other variables, fertilizer imports have been quite irregular in their variation, without a clear cycle. Therefore, even taking away the seasons statistically influenced in these series, no significant results were obtained. As a consequence, the second conclusion is that maybe there should be another methodology that demonstrates the negative impacts of agriculture and livestock sectors to green growth through such inputs.

At last, in Peru, between 2007 and 2012, from the five most common types of pesticides, the use of three rose sharply, one maintained and the last one dropped. Thus, comparing 2007 with 2012, imports of acaricides quadrupled, rising from 133,1 to 579,8 tons; fungicides increased from 3.464,5 to 3.829,1 tons; pesticides and almost tripled (becoming by far the most widely used pesticide), reaching 8.987,9 tons. Moreover, during the same period, the use of insecticides was reduced by approximately 15%, while rodenticides were maintained in about 45 tons (INEI, 2014). However, OLS regressions made with the seasonally adjusted series do not provide significant results. That is why there is no clear relationship between the pesticides imports volume and the three GDP studied (although, just as with the above variables the two relevant to this case are the agricultural and the sum of agriculture and livestock).

6.3 Biotrade as a Green Growth Option

"We propose Biotrade as a green growth option", stated Fairlie (2013: 1), to which he adds that, therefore, *"creates the need to work on the issue at different levels: in the proposals that arise in international forums, in the valuation of biodiversity and systematization of successful experiences".* In this statement, lies the relevance of questions to biotrade as a strategy to achieve green growth. To this end, then, it is essential to observe whether such activity has had any relationship with any of the three GDPs (total, agricultural and the sum of agriculture and livestock) and its explanations.

As shown in the econometric results, biotrade is positively correlated to a large extent and big significance with the three GDPs. In the first instance, it is observed that its significance increases (although its value decreases) when compared from agriculture to the sum of agriculture and livestock, which occurs for obvious reasons: the Peruvian biotrade is mainly agriculture (Fairlie, 2013) and no livestock is found on it (although there could be a great potential in this subsector). One of the surprises is that the biotrade generates a greater impact on total GDP that on agricultural GDP, in both cases with less than 1% significance. This situation may be because bio-products have been losing share compared with agricultural GDP (MINAGRI, 2015), but still have a positive and significant impact on total GDP.

Then, once found the pro-cyclical relationships between GDPs and biotrade, it is understandable that in fact biotrade can be taken as an option to obtain green growth. Acknowledging that it includes the concept of sustainable production itself, biotrade should be encouraged because it also increases economic growth. Exports of agricultural goods as cat's claw, tara, quinoa, cocoa, cochineal, the coca leaf, among others, should be exploited with sustainability criteria to promote long-term growth in Peru. Several scholars support this statement and complement it from different angles. For example, as argued by Fairlie (2009; 2013), it is essential to include sustainable agricultural development and biotrade as specific points within the agendas of the FTAs to be signed and that Peru is currently negotiating.

7. Conclusions and Final Remarks

Throughout this research, from different variables, the contribution of the agriculture and livestock sectors to green growth in Peru from 2005 to 2014 was extensively studied. Thus, it was essential to analyze first the economic growth during that decade and then how much the third activity with more GHG emissions contributed to it: agriculture and livestock (MINAM, 2010). To do this, through OLS regressions with seasonally adjusted variables and logarithms, the relationships were studied (one by one) between economic growth and three groups of variables: productive specialization (in agriculture and livestock goods), environmentally preferable inputs, and biotrade.

In conclusion, there are several variables that may be used to study the agriculture and livestock sectors contribution to Peruvian green growth between 2005 and 2014. On the one hand, EPAGs and biotrade found a procyclical relationship, which demonstrates an important contribution to green growth. On the other hand, ENPAGs (to a greater extent than EPAGs) also found a pro-cyclical relationship; however, the higher

significance and magnitude of these latter variables could determine that Peru's economic growth has been less green than before and is not sustainable over time. Finally, some variables found no greater significance through this methodology, such as inputs in the agriculture and livestock sector. In other words, the agricultural sector has variables that contribute positively and negatively, but currently the latter are the ones that have larger impacts on the sector.
Because of these observations, it is essential to promote biotrade as an alternative to green growth, and enhance the EPAGs through different incentives. In this sense, there are already public and private initiatives, including adherence to the Andean Biotrade Program, the BiodiversePerú Project, PerúNatura, the National Biotrade Promotion Program, among others. However, in Peruvian academic literature, there has been very little research on biotrade and about the impacts of such policies on bio-building, and in general on green growth. Therefore, the main suggestion for this case is to promote studies involving sustainable trade of different native products due to their positive impacts on green growth.

References

ASHEIM, BUCCHOLZ, HARTWICK, MITRA, & WITHAGEN. (2007). Constant savings rates and quasi-arithmetic population growth under exhaustible resource constraints. *Journal of Environmental Economics and Management 53*, 213-229.

BENCHEKROUN, & WITHAGEN. (2011). The optimal depletion of exhaustible resources: A complete characterization. *Resource and Energy Economics, Vol. 33 no. 3*, 612-636.

Brundtland, G. H. (1987). *Our Common Future: Brundtland Report.* Ginebra: ONU.

COMEX. (2013). La agricultura peruana impulsa las exportaciones no tradicionales. *Semanario COMEX Perú. Del 16 al 22 de diciembre de 2013*, 7-8.

CONSTANZA, R. (2000). The dynamics of the ecological footprint concept. *Ecological Economics, vol. 32*, 341-345.

DASGUPTA, & HEAL. (1974). The optimal depletion of exhaustible resources. *Review of Economic Studies, Symposium on the Economics of Exhaustible Resources*, 3-28.

Dobos, & Csutora. (2010). *The calculation of dynamic ecological footprint on the basis of the dynamic input-output model.* Budapest: Corvinus University of Budapest, Norway Grants.

Fairlie, A. (2009). *La importancia creciente del desarrollo sostenible en la agenda comercial de Perú.* Lima: CISEPA.

Fairlie, A. (2013). *Crecimiento verde y biocomercio: una mirada andina.* Lima: PUCP.

FAO. (1997). *Lucha Contra la Contaminación Agrícola de los Recursos Hídricos.* Ginebra: FAO.

FAO. (2014). Main contributors to GEI emissions.

García, J. (2008). *Hacia Una Lista Potencial De Bienes Ambientales Para Sudamérica: Criterios Para Una Perspectiva De Desarrollo Sostenible.* Ginebra: ICTSD.

INEI. (2014). *Perú: Anuario de Estadísticas Ambientales 2013.* Lima: INEI.

INEI. (2015a). *Compendio Estadístico, Perú 2015.* Lima: INEI.

Mendoza, & Tello. (2011). *Industrias extractivas y cambio climático en el Perú: vínculos y preocupaciones.* Lima: CEPES.

MINAGRI. (2015). *Boletín Agropecuario Mensual. Diciembre 2014.* Lima: MINAGRI.

MINAM. (2010). *Inventarios Nacionales de GEI 200-2009.*

MINAM. (2012). *Indicadores de industria y crecimiento verde.* Retrieved from http://www.plataformadeconocimientoindustrial-lac.org/fileadmin/unido/files/projects/SERE_2/4.7.1_Peru_presentacion_informe_Per%C3%BA.ppt.

Orihuela, J. C. (2014a). El crecimiento basado en recursos, ¿puede ser verde e inclusivo? El caso de Perú. In QUILLICONI, & PEIXOTO, *Los desafíos del crecimiento sustentable con inclusión en América Latina* (pp. 201-222). Buenos Aires: Editorial Teseo.

Perú Ecológico. (2012). *Extinción... cara a cara.* Retrieved from http://www.peruecologico.com.pe/extincion.htm

QUESADA, J. L. (2007). *Huella ecológica y desarrollo sostenible*. Lims: Aenor Ediciones.
SAS. (2009). *Best practices in carbon footprint modeling: going beyond inventories and calculations*. EEUU: SAS.
SERNANP. (2015, 03 31). *Nuestros ecosistemas*. Retrieved from http://www.sernanp.gob.pe/sernanp /contenido.jsp?ID=650
UNCTAD. (1995). *Environmentally Preferable Productos (EPPs) as a Trade Opportunity for Development Countries*. Ginebra: UNCTAD.
UNCTAD. (2007). *Iniciativa BioTrade. Principios y Criterios de Biocomercio*. Nueva York & Ginebra: UNCTAD.
UNIDO. (2012). *Indicadores de Crecimiento Verde*. Retrieved from http://www.plataformadeconocimientoindustrial-lac.org/fileadmin/unido/files/projects/SERE_2/2.9.1_indicadores_de_Crecimiento_Verde_C.Ch..pptx
Vargas, P. (2009). *El cambio climático y sus efectos en el Perú*. Lima: BCRP.
Wackernagel, & Rees. (1996). *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island: New Society Publishers.