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NEXUS BETWEEN AGRICULTURE AND REDUCTION OF POVERTY STUDIED ON IMPACT OF PRODUCTION OF CORN, CHILI PEPPER, BEANS AND TOMATO IN 32 STATES OF MEXICO

Dipl.-Kfm. Tomáš Hes, PhD.[1], Lic. Mariana Ramírez Manzano[2], Miguel Ángel Martínez Damián, PhD.[3], Prof. Tomás Martínez Saldaña, PhD.[4], and Mario Rechy Montiel[5]

Abstract: *Agricultural growth and poverty reduction nexus is not elementary as agricultural growth not necessarily translates into a reduction of poverty levels. This phenomenon was experienced in the past decades in Latin America, where the increase of productivity led agricultural output did not necessarily lead to diminished poverty levels, while ostracizing poor producers from global closed production-market circuits dominated by well-capitalized groups with economies of scale and global diversification benefits. The deliberate choice of appropriate agricultural products with the highest yields for marginalized population is therefore possibly one of the key strategies conducting to higher incomes on a mass scale. The study considers the impact of production of four strategic traditional agricultural products produced in Mexico within the span of 10 years, corn, beans, chili pepper and tomato on poverty reduction in 32 Mexican states and concludes that commercial crops with speculation potential such as green chili pepper may have been in the chosen period a better choice for the small scale producers than subsistence crops as they seem to have a statistically important impact on poverty reduction, and seem to be ideal cash crop complementing subsistence crops such as corn.*

Keywords: *green chili pepper, agricultural output, poverty reduction*

1. NEXUS BETWEEN POVERTY AND AGRICULTURE

Although the growth of agriculture leads to reduction of poverty, the relationship between agricultural development and poverty in agricultural areas is not

[1] Czech University of Life Sciences Prague, Faculty of Tropical AgriSciences, Kamýcká 129, 165 21, Prague 6, Czech Republic, Email: hest@ftz.czu.cz
[2] Universidad Nacional Autónoma de México, Facultad de Ciencias Políticas y Sociales, México, *Email: mramirezmanzano@gmail.com*
[3] Colegio de Posgraduados, programa de economía, México, *Email: angel01@colpos.mx*
[4] Colegio de Posgraduados, México, *Email: tms@colpos.mx*
[5] Universidad Autónoma Chapingo, DICEA, México, *Email: mariorechymontiel@gmail.com*

unambiguous and in some cases is openly disputable. The large data cementing empirical evidence for such hypothesis are only recent (Schneider, 2011). The high correlation between agriculture and poverty levels suggests that most of the poor work in agriculture rather than that it is the low productivity of agriculture in early development stage which is responsible for their penury. The logics of the poverty – agricultural nexus is derived from the fact that most acute poverty is often in remote or inaccessible areas with low human population density where agriculture is the only mean of income generation, yet at the same time not equaling rural presence with poverty. On the other hand, it can be dubious to confirm that the higher efficiency of agriculture can drive the development spiral through the trickle-down effect of gearing up farm incomes, causing the rise of savings and investments and kick-starting industrialization, as it may as well lead to the concentration of capital and perpetuation of the ostracism of the poor smallholders. Kydd (2001) describes their situation as a lack of capitalization perspectives in the era of globalization. Even though poverty

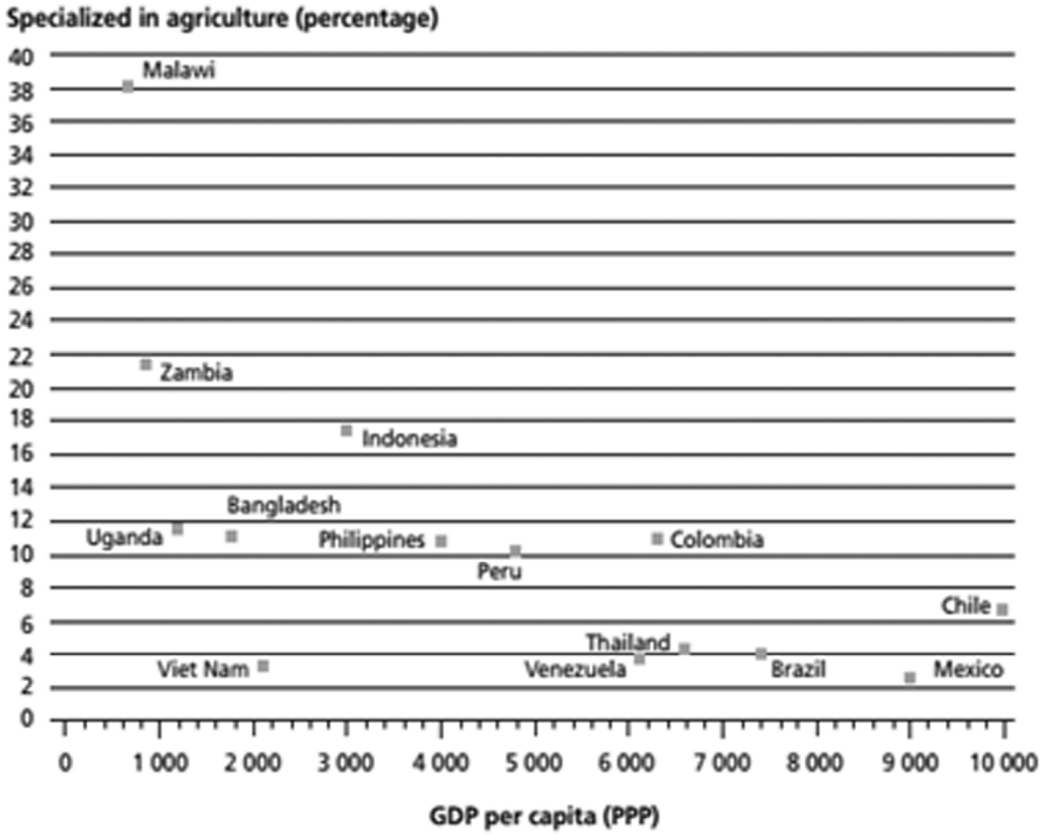

Figure 1: Relationship between agriculture and GDP

(*Source*: Hertel et al., 2004)

and inequality can be mitigated through agricultural growth through increased farm incomes, the economic linkages among agriculture and poverty are complex and likely to be embedded in wider societal frameworks. As Sen quotes that paradoxically the best way to escape poverty is actually to stop working in agriculture (1999). This interpretation is seemingly being proven at present by on-going planetary exodus of rural regions and related urbanization pressures. Complexity of agriculture and poverty nexus is also potentiated by the fact that poverty is a rural phenomenon, while agriculture is central to the lives of the poverty stricken population as well as the principal source of subsistence and the main consumption expenditure.

Search for a better comprehension of the linkage between economic growth, poverty, income and commerce remains an eternal research topic fueled by the fact that poverty in developing regions is a rural phenomenon, with estimates of more than two-thirds of all the poor worldwide living in rural regions, reaching 884 million people at the extreme poverty level, with rural poverty rates reaching 28% on average, being substantially higher than urban poverty rates (14%) (IFAD, 2011). Most of the poor living in rural regions depends directly or indirectly on agriculture related activities, which are considered the principal source of livelihoods for an 87 percent of the inhabitants of rural regions with 2.5 billion people, while providing jobs for 1.2 billion smallholders as well as landless workers (FAO, 2004). In addition, urban poverty can be also to a major extent considered as a result of deprivation of populations in rural areas, engaged in rural–urban migration flows. However, as Anriquez quoted (2007), public policies in the past favored public, industrial and service sectors, while the role of agriculture, which seemed to be for the sake of simplification equated with rural presence, in poverty mitigation, received rather scant attention. Studies done in India in the past demonstrate that in the long run the food prices seem to have the largest impact on poverty alleviation (FAO, 2011). Summarizing the employment share of agriculture in developing countries, agriculture is accountable for 55 % of employment. Cross-country econometric estimates illustrated that GDP, agriculture led-growth provided almost double effects in benefiting the poorest part population than growth generated in non-agricultural sectors as seen on Graph Nr. 1 (Ligon et al. 2007; World Bank, 2015). One example is China, with its household responsibility system, technological change and liberalized markets, registering a steep decrease in rural poverty from 52% in 1981 to 7% in 2002, while in India, agriculture is considered the key to slower but substantial decline of poverty in the past decades (Keralis, 2014). Ghana in Africa had shown 24%-point reduction in rural poverty during the past two decades, attributed to recent strong agricultural performance and attributing the success to broad-based agriculture development (Xiao, 2010). The ambiguity between agricultural growth and its impact on poverty levels can be well seen on the continental example of Latin America. The ongoing agricultural growth did not impact poverty level in the past decades in Latin America. Subsidies were not the solution, as shown in the study by Scott in 2011, as states with most subsidies had also the least agricultural growth. As mentioned by Graciano et al. in 2009, even when the agriculture increased

its output in the recent decades, it had no effect on the poverty levels. Besides, between 1990 y 2006 the labor income had diminished in Latin America, with the exception of Brazil and Chile. If there was a reduction of poverty in this period, it was due to increase of remittances, according to CEPAL (2009). In a similar tone, in Bolivia, the growth of agricultural sector concentrated in export-oriented sector of large capital-intensive farms, the employment cut and shifted to higher-skilled, higher-wage workers, with little effect on poverty mitigation. Summarizing, the fight against poverty based on the premise of agricultural growth should therefore be based upon more concrete and well detailed instruments.

2. RELATIONSHIP BETWEEN POVERTY AND AGRICULTURE IN MEXICO

Mexico, with important global standing as far as agriculture output is concerned, could not be excluded from the wider continental picture. Predominantly agricultural culture, the country has 196.4 million hectares of land (Ornelas, 2003), with 27.3 million hectares (14.3 %) used for agricultural activities (both crop and intensive animal husbandry). Although this compares well with that of countries like China as well as Japan that have 14.5% and 11.5% respectively of their total exploitable land under agriculture, it still remains inferior to that of developed countries such as Germany, Spain, USA and

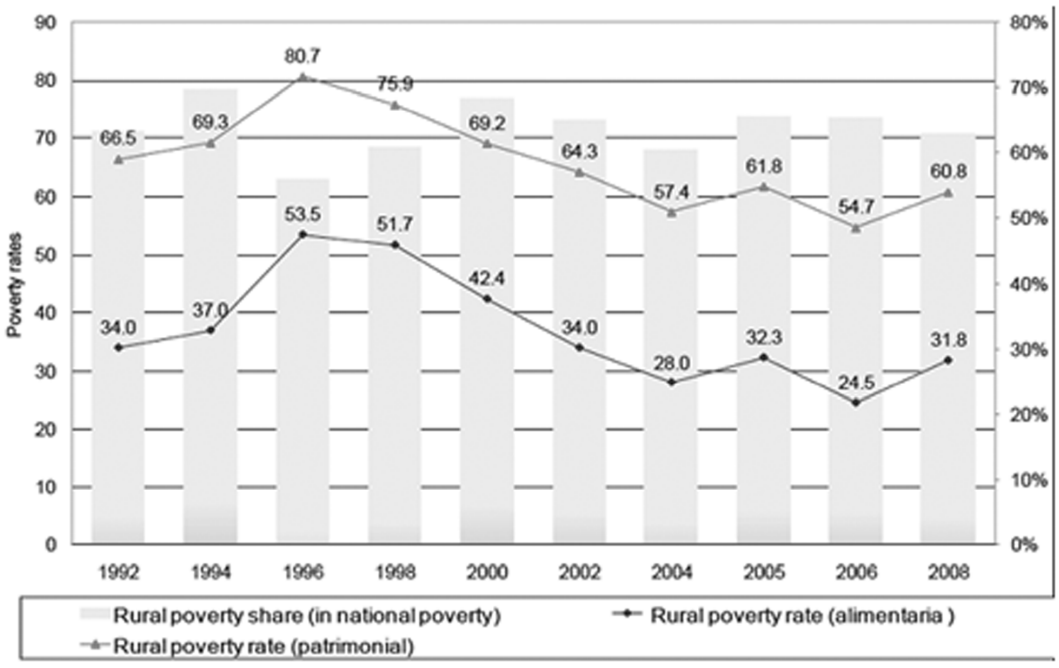

Figure 2: Rural Poverty levels in Mexico between 1992 and 2008

(*Source*: WDI, 2007; OECD, 2007; EUROSTAT, 2007)

United Kingdom that have exploited their agricultural land in 34.6%, 40.3%, 19.3% and 29.5% respectively. The conditions under which the agricultural sector is in Mexico can be summarized in stagnation of production, a state of non-completion of agrarian reform, polarization of property, referring to existence of large "latifundios" close to small parcels which induce loss of competitiveness, the lack of dynamism little job creation, heterogeneity in the conditions of competition producers, lack of financing to small farmers, and gradual increase of imports of products in the basic diet of the people (Hernandez et al., 2014).

In the last decades of the past century, there have occurred radical changes in Mexican agricultural policy. The old schemes characterized by strong state intervention in the agricultural activity through subsidies, price support, state marketing of produce have all ceased (Saldaña et al., 2003). The late 80s and 90s have seen the proliferation of neoliberal policies in Mexican agriculture and the disintegration of traditional agricultural services. These perhaps explain the irregular agricultural growth patterns through this period, especially in the late 80s and 90s. The sector was not able to rapidly adjust to these changes and hence it slowed down in the agricultural activity. The problem of low productivity of agricultural labor still remains dramatic and requires attention. The rural population actively occupied in agriculture remains high yet contributing a very small percentage of the GDP, even if this measure self-consumption and local barter. This perhaps is explained by regional and structural marginalization that still is a strong characteristic of the Mexican rural sector and for that matter of agriculture. Neoliberal policies and the opening up of the economy have led to the increase in Mexican agricultural exports, especially that of fruits and vegetable products. However, the volume of imports has also correspondingly risen substantially and Mexico will need to keep aware of the possible imbalances that can arise out total state withdrawal in aiding its agricultural sector (Saldaña et al., 2003). Additionally, it must be said that Mexico belongs to countries with highest dependency in terms of alimentary needs satisfied by importing goods, despite a history of self-sufficiency. Agricultural growth has been weak in recent decades, concentrating mainly in the field of commercial agriculture and therefore to a certain extent unrelated to the situation of the poor. During the eighties and nineties, the agricultural sector registered a moderate growth of 1.5 % during the decade, lower than the growth of the country and population. However, the production of food grew more (2.2 % between 1980 and 2002), largely as a result of any improvement in the yield of each crop and a change of a combinations of crops towards higher value. Agricultural growth was higher in the northern states, where agriculture is a commercial activity in the irrigated land where commercial agriculture focuses on crops and more sold (World Bank, 2005) and recently, growth of the rural sector exceeded the average growth on a national level. Regarding poverty in Mexico, it is a largely rural phenomenon, signaling a potentially strong link with agriculture. The dynamics of poverty in Mexico, in general and particularly the rural, shows that the poverty is reduced continuously and significantly between 1950 and 1984, remained almost constant levels between 1984

and 1994 and had a sharp increase in 1996, which seems to be a result of combination of public policies, migration forces and agricultural production decrease. Opening agricultural policies that began to be applied in the late eighties seem to have benefited especially commercial agriculture, having little impact on the poor. The limited impact for the competitiveness of small farmers and rural poverty may have been due to lack of an additional long-term strategy for the agricultural restructuring and support shown to bring poor farmers to convert to more crops promising and seize new market opportunities (World Bank, 2005). 1996 and 2004 the downward trend resumed, to reverse the rise in 1996 (Székely 2005). In 2010, 61% of the total rural population were living beneath the poverty line, translating into 15 out 25 million people (IFAD, 2014) were living 13 million people in rural areas in settlements inferior to 2,500 inhabitants, living below the food poverty line. For these inhabitants, agriculture derived income, represents on average 42% of the total income (Sagarpa, 2006). While 2% of the human population is estimated to live under 1.25 USD per day, according to UNDP, 4.8% lives with 2 USD per day and 17.6% find themselves below the national line of poverty (UNDP, 2010). At present, according to Cepal (2014), 4.3 million households are dedicated to agriculture, with the average of 3.4 hectares per household unit. Contrary to other countries such as Brazil or Argentina which grew 2 and 7% respectively, the agricultural output of Mexico fell by 0.75% in the past 6 years (Cardenas, 2014). The nature of rural poverty in Mexico can be well described by Schultz industrial impact hypothesis, reformulating the Fisher-Clark structural transformation model, by quoting that economic development comes in a specific location matrix, which is predominantly industrial-urban and is most efficient in the gravity centers of economic development, causing deep regional disparities, especially well describing less developed localities of rather more industrialized countries such as Mexico. The data mentioned above demonstrate the pressing need for agricultural development as a tool of poverty reduction, yet dotted with innovative and original approaches, defining the conversion of public policies of investment, credit and protection of national production against subsidized dumping competition stemming from the USA.

3. AGRICULTURAL CROPS FOCUSED BY THE STUDY

The study focuses on traditional strategic crops for Mexican agriculture, with key function in Mexican as well as global economies. Four crops were chosen, due to its historical and economic importance of the culture as well as subsistence of the local population, while reaching important values on a global level, as described below.

3.1. Corn

In terms of food, economic and social terms, corn is the most important crop in Mexico, being the 4th largest corn producer in the world, but is also its major consumer. Although practically covers the entire demand for white maize to domestic production, the country is deficient in yellow grain specifically, which has many uses, primarily for livestock consumption and therefore must import requirements above 5 million

tons yearly averages. During the period 1996-2006 it was sown on 51% of the total applicable area generated 7.4% of the volume of total agricultural production, accounting for 30% of total production value. In 1996 it took a turn for the establishment of the pricing policy of indifference, in which producers sell to industrial-based international prices and the federal government, through ASERCA institution which paid the difference to the target price. Nationally about 2 million farmers who grow corn (PROCAMPO Census 2004) are identified. Of this total, 85% of farmers conducted its work on farms whose length is less than or equal to 5 hectares.

3.2. Beans

Beans are produced in almost every state of Mexico, although those temperate-semiarid regions with dry and warm winter, are crucial for the national production, with the states of Zacatecas and Durango and in the second, Sinaloa and Nayarit being the main producers. With respect to production volumes, beans on average presented a decline in 1980 and 1985 and in the last decade, the production volume has rotated around 1.2 million tonnes with falls below in a few years. This pattern is explained by varying guarantee prices for the different types of beans with respect to consumer preferences especially in the 1990s. On average, however, production volumes have remained high, rising from about 0.9 tons in 1975 to slightly over 1.2 million tonnes on average in the last decade, placing Mexico at the third rank on a global scale (Sagarpa, 2014).

3.3. Tomato

The tomato crop is the 8th most important value crop of Mexico, whose most common varieties are “saladette” and “bola”, besides “cherry” variety. In 2012, the production of tomato generated 3.2% of the total value the agricultural sector and participated with 0.3% national planted area (more than 50 000 hectares), which has declined at an average rate 3.5% annually between 2007 and 2012. However, view of the increase in performance that went from 37.4 t / ha to 51.4 t / ha in that period, Mexico is the leading exporter of fresh tomatoes on a global level, producing nearly 20% of volume and 25% the value traded, which are primarily sold to the US. The country exports about 1.5 million tons per year, representing between 50 and 70% production volume. In 2014 the value of the exports reached more than 1,100 million USD (Sagarpa, 2014).

3.4. Chili pepper

The chili pepper (Capsicum spp.), belongs to the family Solanaceae, which was domesticated in Mexico than 8,000 years ago. It is grown in most of the country in the two agricultural cycles and part of the group of the main exported horticultural products, the main customers United States, Japan, Canada, the UK and Germany, although 80% of national production is consumed internally. According to the Mexico’s Agri-food and Fisheries Information Service (SIAP), the country is the biggest exporter

of green chili pepper in the world and the sixth largest one of dry chili pepper (Gaytan et al., 2013).The national production in 2014 reached 1,853 thousands of metric tons (Sagarpa, 2014), positioning Mexico at 2nd rank worldwide.

4. METHODOLOGY

4.1. Data

The secondary data concerning 448 values on poverty from 32 federal states of Mexico, as well as related to economic and demographic development in the years 2010, 2012, 2014 (Graph Nr. 4) was collected from the National Council for Evaluation of Social Development Policy (CONEVAL), which has among its powers the issuance of guidelines and criteria for defining, identifying and measuring poverty using information generated by the National Institute of Statistics, Geography, (INEGI). The measurement of poverty must be made at least every two years for each state.

The secondary data with 384 values related to *agricultural production of the chosen 4 products in years 2010,2012,2014 (Graph Nr. 5) was collected from the* SIAP, which has among its powers to coordinate, to the agencies of the Federal Government, the governments of the states and municipalities, in statistical and geospatial information required by the food industry.

4.2. Estimation method used

We compare the production of four chosen agricultural products with four chosen indicators, searching for a correlation, through cross sections of longitudinal panel

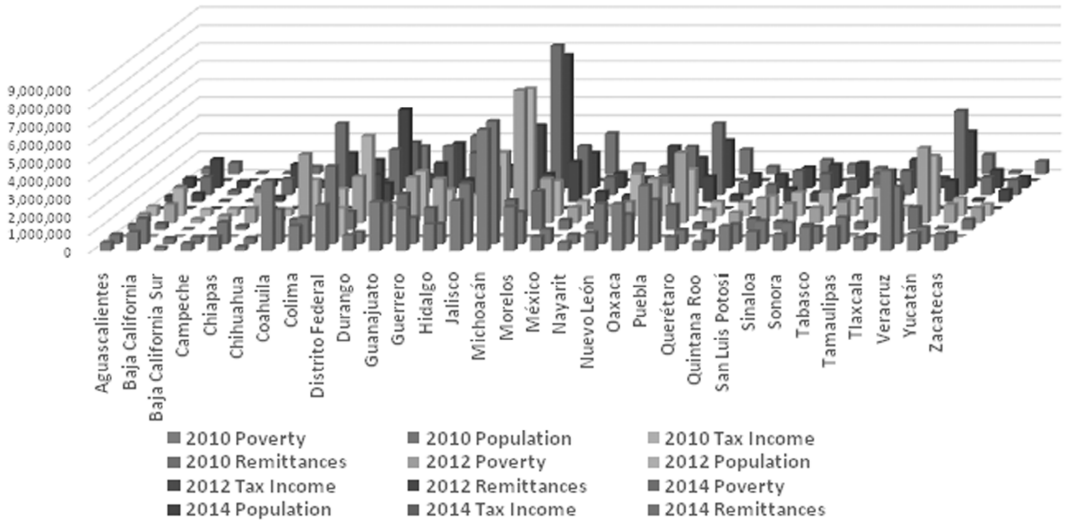

Figure 3: Economically Active Population (millions), poverty (millions), fiscal income (millions of pesos), remittances (millions of pesos): 2010, 2012, 2014

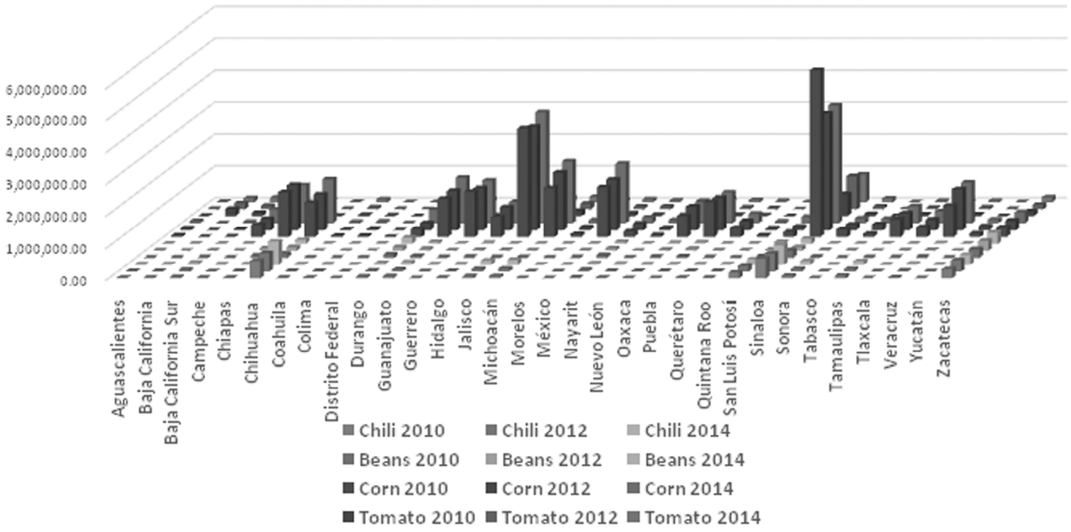

Figure 4: Production of Chili pepper, Beans, Corn, Tomato (thowsands of tons): 2010, 2012, 2014

data analysis with fixed effects within an Ordinary Least Square (OLS) method, as depicted in the formula below. In the first calculation (Regression 1) the statistical relationship between the crop production and the poverty reduction in the three year-sets were sought, including remittance variable, while in the second calculation (Correlation 2) the statistical relationship between the crop production and the poverty reduction including other variables that could explain the dependent variable such as economically active populations, fiscal income and remittances, was calculated. Statistic fit and F-test was applied to both calculations in order to confirm the robustness.

$$y_1 = \alpha + \beta_1 x_{it} + \beta_2 x_{it} + \beta_3 x_{it} + \beta_4 x_{it} + \varepsilon_{it}$$

Formula 1. Regression 1: relationship between the poverty reduction and chosen crops including remittances

Table 1
Variables applied in Formula 1.

y_{1-4}	be a performance variable of local output (chosen agricultural product): chilli, beans, corn, tomato
x_{it}	be the independent variable x: poverty level estimations
β_{1-4}	be the coefficient of x: poverty level estimations
α	be the intercept of the regression line and the Y axis
ε_{it}	be an error term - residual value describing market iand time t

$$y_1 = \alpha + \beta_1 x_{it} + \beta_2 x_{it} + \beta_3 x_{it} + \beta_4 x_{it} + \varepsilon_{it}$$

Formula 2. Regression 2: Relationship between the poverty reduction and chosen crops including more population growth, fiscal income growth and remittances

Table 2
Variables applied in Formula 2.

y_{1-4}	be a performance variable of local output (chosen agricultural product): chilli, beans, corn, tomato
x_{it}	be the independent variable x: poverty level estimations, economically active populations, fiscal income, remittances
β_{1-4}	be the coefficient 1-4 of *x*
α	be the intercept of the regression line and the Y axis
ε_{it}	be an error term - residual value describing market iand time t

4.3. Results and discussion

The first examination in Table 3 revealed that the production of green chili pepper shows convincing signs of poverty reduction (p=0.0135) as well as the remittances flow (p=0.0592). Production of beans (p =0.4859), corn (p=0.6002) and tomato (p=0.3870) does not seem to have impacted the poverty level in the given period in the 32 states of Mexico. The second examination in Table 4 dotted with other socio-economic variables reconfirms the potential of remittances to reduce poverty (p=0.0003), while hinting at the potential of green chili pepper at least at the 10% confidence level

Table 3
Results of the time series testing for regression 1

Variable	*DF*	*Estimate*	*Error*	*t Value*	*Pr> |t|*
Intercept	1	584.0025	543.6	1.07	0.2871
Remittances	1	-0.421	0.2188	-1.92	0.0592
Chili pepper	1	0.002412	0.000946	2.55	0.0135
Beans	1	-0.00103	0.00148	-0.70	0.4859
Corn	1	0.00009	0.000170	0.53	0.6002
Tomato	1	0.00059	0.000677	0.87	0.3870

Table 4
Results of the time series testing for regression 2

Variable	*DF*	*Estimate*	*Error*	*t Value*	*Pr> |t|*
Intercept	1	419.9845	463.7	0.91	0.3689
Economically active population	1	0.001148	0.000245	4.70	0.0001
Fiscal income generated per state	1	0.000744	0.000399	1.86	0.0674
Remittances	1	-0.89465	0.2322	-3.85	0.0003
Green Chili pepper	1	0.001483	0.000823	1.80	0.0770
Beans	1	-0.00028	0.00126	-0.22	0.8279
Corn	1	-0.00007	0.000150	-0.46	0.6493
Tomato	1	-0.00015	0.000624	-0.24	0.8121

(p=0.0770). Production of beans (p=0.8279), corn (p=0.6493) and tomato (p=0.8121) does not seem to have impacted the poverty level in the given period in the 32 states of Mexico. At the same time, the fiscal income (p=0.0674) as well as the population growth (0.0001) seem to be statistically significant at the confidence level of 10% and 5% respectively.

The results of both regressions demonstrate the differences of the impact of different crops on poverty reduction, with a consistent view of chili pepper as being possibly the best crop out of the four products involved leading to mitigation of poverty, in contrast to beans, corn and tomato, which do not show signs of such impact. The importance of remittances as a means of poverty reduction is unsurprising as it is the significance of growth of economically active population for growth of poverty levels, as population growth ceteris paribus, as acknowledged by most social scientists, implies growth in all strata of the society, including the growth of the share of the marginalized population (McNicoll, 1999).

5. CONCLUSION

The advancement of the agricultural sector vitally contributes in gearing up of economic frameworks, figuring as a development priority of many economies. Agriculture does have efficient powers in reducing poverty. The claim that agricultural output is a key driver of poverty reduction should however not be accepted without critical judgement. Generic view of agriculture as an all-encompassing poverty mitigation tool, without understanding the output generators, may be misleading. For this reason, study of concrete crops may be essential in understanding the economics of poverty reduction.

The decision to plant chili pepper, which could be regarded as a cash crop with speculative potential, has shown to be significant for the poverty reduction in the studied period and with higher impact on the poverty reduction than beans, corn or tomato that can be considered to a major extent as subsistence crops. The choice of the crops may be therefore one of the key decisions within the panorama of decision taking on macro-level that is to be studied by the state authorities prior to setting national priorities. Undertaking this type of questioning, a doubt on the nature of rural poverty arises: what if the rural poverty attributed to small scale cultivators is rather less explainable by complex socio-economic and culture based factors, but simply to a major extent simply by wrong agricultural alignment to market demand applied on a mass scale by smallholders? It is an irreversible fact that governments, influenced by a global economy, are changing public intervention approaches to agricultural development. Liberal trade is seen to have had and continues to have a profound influence in Mexican agricultural development patterns, with a mixture of consequences. This clearly calls for carefully worked out agricultural development strategies without which products of the industrialized and highly competitive economies will certainly wallop the markets of the less economically powerful ones

with far reaching consequences on the course of agricultural development. There exist commercial, agricultural enterprises privileged in aspects of commercialization and on the other hand massive rural subsistence agriculture that occupies a marginal place in government programs yet having a big section of the rural population depending on it. It is certain that as Mexico continues to modernize her agriculture, it will need to address these regional and structural imbalances otherwise they will continue to deepen its negative impact on her agriculture. For agricultural development to be able to mitigate the levels of poverty in a substantial way, smallholder farming must be competitive and sustainable, organized on grass root level in order to be able to reach economies of scale. The course of such policies was recently undertaken by major state owned development bank Financiera Nacional Agropecuaria, however in order to have a major impact, such instrument is to be generalized on a national level. However, if Mexico's trade partners pursue different policies such as the recent US subsidies to agriculture, the possible result will be a flood of foreign agricultural production on the Mexican market, with dangerous potential of the importation of genetically modified crops, with far reaching negative impacts on Mexican agriculture and to rural population. The US subsidies may in a bizarre transformation of cycle increase the Mexican poverty landscape through the competition of US subsidized and transgenic crops and at the same time dampen it through the remittance flows coming from Mexican migrants back to Mexico, as also shown by this study. As Kydd puts it (2001), technological and institutional development is to be co-evolutionary as globalized institutional thinking is unlikely to provide stimulus for private agricultural research regarding smallholders. Hence, as a suggestion derived from the findings of this paper, the government is to provide a positive externality institutionalizing a public information system targeting especially the poorest strata of the rural agricultural producers, with the mission to study on an ongoing basis the commercial potential of relevant crops and provide structured, localized and steadily actualized production recommendations founded on hard data continuously gathered from the producer regions as well as from the markets on a seasonal basis. Unlike to most modern Agricultural Marketing Information Systems (AMIS), which are considered principally a tool of sales price forecasts (Sulaiman et al., 2015), the proposed tool of analysis would involve ceaseless involvement of a variety of socio-economic indicators also related to poverty, searching for synergies and proven impact, similar to the regressions calculated in this study. Profit margin is not the only nor the best measure of contribution of agricultural production. The results could be used for strategic planning of joint national poverty alleviation and agricultural public policies as well as a tool of advisory for the individual farmers. The ultimate aim of public policies should be human happiness of many (Veenhoven, 2004), ranking higher rather than economic progress leading to happiness of a few. Seen from this point of view, national agriculture due its linkage with rural regions with high incidence of poverty, should be seen as an ultimate poverty mitigation tool as well as – and not only as - a generator of GDP growth.

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