

PROPERTY , TECHNOLOGY AND SUSTAINABILITY EVOLUTION IN NARIÑO, COLOMBIA

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ABSTRACT: This paper examines a rich, but very fragile area in the southern part of Colombia from the pre-Columbian era to the present, analyzing the interrelation between property, economic and social aspects and the choice of technology as well as the sustainability results. Common property in the pre-Columbian era, and common property (*resguardos*) in the colonial era, achieved an agricultural technology that resulted in a sustainable agriculture. Common property in the republican era, as well as share contracts, resulted in overexploitation and resource degradation. Private property in form of latifundiums, favoured the conservation of natural resources but also the overexploitation of human labor, including demographical crisis. Nowadays, small-holders of private property are degrading the resources at a rate that is putting the sustainability of the region at peril. This paper advocates for an integrated study of the relationships between biophysical, socioeconomic, institutional and technological aspects, in the study of type of property and the sustainability of agriculture.

Much has been published about the influence of the type of property on the incentives to protect natural resources. It is now accepted that private property provides incentive to protect, to investigate and to invest in natural resources, whereas, open access leads to the "tragedy of the commons" (HARDIN, 1968; ANDERSON, 1983; SIMMON & BADEN, 1984; SCHLAGER & ORSTOM, 1992). More recently, common property has been identified as a type of property that can lead either to the protection of natural resources or to their degradation, depending on multiple aspects, so each case has to be studied individually (RUNGE, 1981, 1986; CIRIACY WANTRUP & BISHOP, 1975; BHAT & HUFFAKER, 1991).

In order to contribute to the debate on property influence on resource conservation, an area of southern Colombia was selected to be analyzed historically. The history of the area shows successful common property in the pre-Columbian times, with population densities that could only be recuperated at the middle of this century and a relative high standard of living (no one in this society suffered of hunger). At the present the region shows a high population density with a high emigration rate, smallhold private proprietaries with high production risks and clear signs of soil erosion that, if continued, will lead to irrecoverability of this soil. What has changed over this 500 years? Why is private property leading to natural resources destruction nowadays and why could common property preserve this resources to be used until now?

This paper identifies the different property systems and analyzes their results in terms of resource conservation. The framework was expanded in order to include social and economic variables as well as the technological production systems, since the interrelation between this factors proved to be determinant in the conservation strategies of this communities. Technological factors such as the production systems of the pre-Columbian societies proved to be an important factor in soil conservation, since the introduction of the mouldboard plow is the leading cause of soil erosion nowadays. Another important conservation factor was the demographic catastrophe. On the other side, human congestion proved to be determinant in soil overexploitation in common

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property republican resguardos. Only in share tenancy, there was an interrelation between property systems and soil conservation as theory indicates it should be.

The paper gives also insights on the evolution of property rights. The analyzed property systems were: The pre-Columbian common property, the colonial latifundium (private property), the "resguardo" (common property), differentiated in two eras, the colonial (17th century to 1850) and the republican (1850 to 1940), share tenancy (end of the 19th century to 1968) and the smallholders private property (20th century).

THE AREA. BIOPHYSICAL FACTORS

The area studied was the mountainous region of the departamento de Nariño in southern Colombia. It is a tropical area with days and nights of equal length throughout the year, but is relatively cold due to the high altitude (1.800 - 3.000 mt above sea level). Its topography evolved during the Tertiary forming rough slopes and deep narrow valleys. During the Cuaternary volcanic forces were active redesigning its landscape, covering it with rich soils of volcanic origin. This makes the region highly susceptible to hydric erosion, due to the quality of the soils and the steepness of the farmed areas.

Nevertheless, this area is favored by its raining pattern and its lack of aggressivity. Rainfall in the northern area varies from 1.000 to 2.000 mm and in the south is below 1.000 mm. a year. There are two raining seasons in the year, depending on the movements of the intertropical convergence zone (IGAC; 1985). Most interesting is the low rainfall intensity. In a ten-year study MENESES & BERNAL (1989) found that 96.8% of the rain showed an intensity of less than 10 mm/hour; the average of kinetic energy was also lower than 70.0 kgf/mm. RODRIGUEZ (1984) found that hydric erosion was between 77.4 and 529.0 kg/ha/harvest, depending on the type of crop, and "mechanic erosion" caused by conventional till, amounted to 4.4 tons/year vs 2.1 tons/year with no till. He concluded that, because of the steepness of the cultivated land, repeated use of mouldboard plow causes earth movement and deposition several times bigger than hydric erosion.

PRE-COLUMBIAN PERIOD

When the Spaniards arrived in 1532, the area under study was inhabited, going from south to north, by three different indigenous groups: The Pastos, the Quillacingas and the Abades. The most developed cultures were the Pastos and Quillacingas, both agriculturally centered societies in transition between cacicazgos and federations. There is no final conclusion on the debate as if the Incas succeeded in conquering the Pastos. FAVRE (1974) and VILLAREAL (1988), among others sustain that the Incas conquered the Pastos territory in 1523, after a 12 year war. More recent archeological and linguistical research (GROOT) shows an important Inca influence in Quillacingas territory, indicating that they were conquered by the Incas via the eastern part, that they were Incas refugees, or the importance of the Incas culture influence in the post Columbian era.

Archeological research shows signs of human habitants since (GROOT). First they had mesoamerican influence and later Andean influence. Their society was highly evolved, with

social stratification and urbanized. The largest city was Pupiales, with approximately 30,000 inhabitants (VILLAREAL, 1988).

Soil property was communal in the Pastos, Quillacingas and Abades societies. Land was allocated periodically, depending on familiar or communities (ayllu) priorities. Everyone in the community had access to land, but it was not an unregulated access. Community land was allocated between the state, the local gods and the ayllu and inside the last one, plots were allocated to each member of the ayllu. The members of the ayllu worked together in each kind of land. Products of the gods land went to the priests, the products of the state land went for the state and the products of the piece of land of each member of the ayllu was his/her property. Chiefs and priests used the products to enhance their standards of living, providing for artisans, gold-smiths and construction of roads and terraces, but a part was also allocated for the orphans, the widows or stored for periods of famine. Buying, selling or renting land were not known in this societies.

Land allocation was made by the community through an elected council, according to status but most importantly, to ecological reasons. Altitude and weather determined the species and varieties that could be cultivated, and they cared that each family had at their disposal the several kinds of products that could be cultivated. So each family was allocated plots at different altitudes in what MURRA (1980) denominates a vertical coordination of space, that provided means of autoconsumption and to diversify risk. Another important consideration was land rotation. The council determined which plots were to be cultivated, with which crop, and also which ones should remain uncultured.

The agricultural technology of the Andean societies can be classified as a soil conservation technology. Much of the usual practices in Andean agriculture, are now being recommended for soil conservation. First, a mention must be made about the development and domestication of species and varieties adapted to their ecosystem (NATIONAL RESEARCH COUNCIL, 1989). It was mentioned above the crop adaptation to different altitudes. This diversity covered also a great quantity of varieties of maize, potatoes and quinoa to different conditions of solar irradiation, rain pattern, pest resistance, drought and freezing resistance. Vigorous plants are able to protect soil against raindrops kinetic force and enables a better water infiltration.

Multiple cropping, as well as intercropping, rotation and fallow, traditional in this cultures, are being now recommended as a sound conservation practice (BLANCO, 1983; VALLENA, 1983; OBANDO & ARIAS, 1982; MONSALVE & ARIAS, 1984). This agricultural practices also enhance productivity, plant symbiosis and deter pests.

Soil preparation was also an important soil conservation practice. As this societies had not animal labor, land was prepared manually with the use of a stick, that removed just the soil necessary for plant to grow. This means a lot of work, but it preserved the stability of the soil.

Terracing was also known by the indigenous communities; GROOT, has digged terraces in the southern part of the area of study. Terracing is a soil erosion control practice recommended for medium steep slopes as it diminishes the water run-of force.

THE CONQUEST

Spanish conquest marked a total disruption not only in agricultural production, but most importantly in demographic terms. There is no coincidence as how many Indians there were before Spaniards arrival or how many died in the wars against the Incas. Male census done in 1558 and 1570, more than 20 years after the conquest, show a 45% demographical decrease. The census done in 1590 shows that there remained only 30% of the population censused in 1558 (COLMENARES, 1983;).

There are four factors that explain such a catastrophe. The first one is the introduction of diseases for which Indians had no natural defenses. Second, was the disruption of family and production processes. Males were separated from their families in order to mine gold in places different from where they lived, separating families and leaving only women and children to produce the food not only for themselves but for the Spaniards and the church. In the third place, there was the treatment they received. Work in gold mines was extenuating, food was scarce and the climate was not only different, but also made them more prone to illness. Many died by punishments or at the conquering battles against less developed but more ferocious tribes. Finally, many of the Indians escaped to unconquered lands.

After the gold rush, Spaniards, and especially the crown, grew conscious of the importance of human labor and land as sources of wealth. The conquerors started a land distribution process carried out among themselves. The crown, started to separate Indian labor from the conquerors and devised the *resguardo*, which proved to be an important factor in culture and Indians preservation. This process gave start, one, to the colonial latifundiums and the other, to the *resguardo*.

COLONIAL RESGUARDO

The *resguardo* is a complex institutional system. It was established by the crown as means to protect Indians and to provide them a way of living. It proved to be an important factor to permit the continuity of their culture and to stop the demographic crisis.

The *resguardo* gave land to a community of Indians and recognized its political system, consisting of a chief and the members of the council. Between 1593 and 1637 land was given to the Indians under two requisites: 1. land property was of the whole community and not individual. 2. the land could not be sold, nor leased (COLMENARES, 1983; GONZALEZ, 1970).

The quantity of land allocated to the Indians was very low. COLMENARES (1983) estimates that it varied between 1.5 and 3.0 hectares per tributary, depending on the quality of land. The quality of land allocated varied, depending on whether the Spaniards had already taken possession of the land. Most of it was given in the worst land of the territory.

Simultaneously with the *resguardos*, another institution was created: The *mita*, which stated the amount of time that Indians had to work for the Spaniards. A tribute, which was distributed between the state and the church was also established.

Resguardos land was allocated by the council, according to the number of family members and ecological reasons. A part of the resguardo was kept undivided and was cultivated communally to pay the tributes to the king, the Indian defender and the priest, as well to sustain the widows and orphans. A third part was kept communally to provide firewood and pasture.

Indians easily adopted new technology introduced by the Spaniards. Soon they cultivated barley, wheat and beans and introduced them into their rotation and multiple cropping systems. They also introduced new animals such as chickens, pigs and sheep. Big animals couldn't be maintained as the resguardos land was too little.

Resource conservancy depended on the quantity and quality of the resguardo, as compared to the population of the community. One and a half hectares to maintain a family and to obtain the tribute to be paid, was clearly not enough, and the intensity of rotation had to be increased as well as the fallow time had to be diminished. Nevertheless, in the years following the institution of the resguardo many Indians fled or died, leaving more land per capita. Indeed, during the 17th century, the crown sold part of the Indian land, as there were no Indians left to work it. This selling was very important in the central part of Colombia and meant the abolishment of resguardos as an economic factor. In Nariño, Indian culture was still very important and mixing with the white population not as common, factors which contributed to preserve the importance of the resguardo in the southern part of Colombia.

Although being a case of common property, it was clearly not an open access situation as they had the tradition of allocating land and crops in a communal decision, according to the conservancy technology developed by their ancestors. The only problem some of them faced was the population density, that forced the diminution of fallow time and the disruption of their vertical production coordination.

Most of their erosion control techniques survived, especially vegetal biodiversity, land preparation, rotations and multiple cropping. Some disappeared, such as vertical control and, fallow time was diminished. Terraces were abandoned or taken away by the Spaniards to be used as pastures for big cattle.

THE COLONIAL LATIFUNDIUMS

Colonial landscape was dominated by pastures characterized by low intensity of use. Just after their arrival, Spaniards distributed among themselves the land available. Spaniard regime had a council for each city, composed and elected by Spaniards and they used it to allocate land. Between 1564 and 1569, 40 Spaniards were benefited with land allocation, that can be calculated to extend up to approx. 80.000 hectares. Most of the beneficiaries were members of the council and land distribution varied a lot. For example, one of them got 15.000 hectares of cattle, sugar and agricultural land, whereas in the vicinity of the province's capital, Pasto, most of the adjudications were of around 8 hectares, as they were suitable for agricultural production due to the vicinity of the city and the availability of labor (CALERO, 1991).

Land property was no source of wealth unless there were labor available to make it produce. After the demographic crisis, crown reform and mita creation, there was also a labor crisis, which was reflected in the importance of cattle raising as a means of production. So most of the available land was used to breed cattle with an impressive low intensity. An example was Zimarronas, which was evaluated at the Jesuit expulsion. It amounted to 32.000 hectares and had only 673 steers (COLMENARES, 1969).

In certain parts of the area of study, such as Sandoná, Consacá and Juanambú, sugarcane was grown. Soon indigenous labor, attracted by a good salary, but captive because of debts, was found to be insufficient, and slaves had to be imported.

During colonial times, the region was more or less autarquic. Indians grew staples such as potatoes, quinoa, wheat and barley, which were consumed at the cities. To the west of the region, gold was found, and the cattle raised was commercialized there to provide food for the slaves. Sugar products, such as brown sugar and alcoholic beverages, were exported to Quito in exchange for Spaniard goods and textiles. Not that the Indians didn't produce textiles, but they were of better quality than those imported from Quito.

The results of colonial times in terms of resource conservation was very good, as much of the land remained fallow and with low intensity of use. This is explained both by the demographical crisis that occurred during colonial times, as by the low level of economic activity, concentrated principally in gold extraction at places nearby. Property rights were not as important as this factors in explaining the conservation results. It was alright private property, but land was not the limiting factor of production. Latifundiums could exploit only what labor availability allowed.

Nevertheless, the colony left institutions whose evolution proved to be negative in terms of resource conservation an well-being of the future generations. First of all, there was the concentration of the best quality land in the hands of a few, which is the origin of the dichotomy of latifundism and minifundism. Second, was the introduction of big cattle, more heavy and with different eating habits, and so, more prone to cause destruction. Third, there was a disruption in Indians vertical control. Finally, Indians attracted by salaries, but maintained by means of debts, were the source of small-holders share tenancy prevalent in the 19th and beginning of the 20th century.

THE REPUBLICAN RESGUARDO

The resguardo survived the colonial times as an important source of food production, it prevailed against the liberal policies of the new republic, but was incapable to survive to the pressures imposed by its population growth.

The land reforms of 1850 declared that the resguardo's land could be sold or leased as a mean of recognition of the citizenship of the Indians. In the central parts of Colombia, when the law was established, most of the resguardos land was already sold, Indians were displaced and had to work for a salary or as share-tenants. In the south, they resisted the urgency to sell and remained in their land producing food staples.

In 1809, the region had the following population: 12.300 Indians, 740 slaves, 7.700 mestizos and 2.600 whites (GUERRERO, s.d.). During the following century the Indian population experienced an important increment. In 1935 there were 42.000 Indians.

From the economic point of view, it is clear that lands that were little, but enough to provide food for 12.300 people, were clearly insufficient to provide food for 42.000. Demographic growth, compared with a stable amount of land, was the most important factor in turning the resguardo antieconomic.

In 1947, the last resguardos were divided, allotting to each of its members just a very small amount of land. For example, Obonuco's resguardo, with 70 hectares, was divided between 200 families and Jongovito's resguardo, with 84 hectares, was divided between 100 families. It is clear that 0,35 hectares to live on, is not enough to provide for a decent standard of living (IGAC, 1982).

Resguardo's land was intensively used during the last century of life of the institution and this was reflected in soil erosion. Fallow time was not used, parcels were harvested two times a year. Rotation, multiple cropping and intercropping was conserved as well as the soil preparation method.

Poverty was common among the Indians and their nutritional and health standard was very low. They had to complement their incomes working as share-tenants or with the production of handicrafts.

Republican resguardo is an example of common property that lead to resource overexploitation. But the explanation of this is not to be found in institutional or technological change, as collective action and most of the soil conservation technologies survived. The explanation lies in the demographical growth, that made this kind of property antieconomical.

SHARE TENANCY IN THE 20th CENTURY

Share-tenancy was an important kind of property during the first half of this century, but its importance diminished since 1968, as a consequence of the agrarian reform laws.

Share-tenancy was a remanent of the mita, that established that a certain amount of Indians had to work for a salary at the latifundiums. As labor was so scarce, the terratenientes devised several methods to attract the Indians, such as permission to build a house and space to produce their food and maintain one or two animals. They devised also a system of loans that the Indians could never repay, which attached them to the land, forcing them to work for the propietor. The dwindling of the land available per family at the resguardos forced also many of them to work with the large landholders.

Share tenancy is a type of property in which the landholder puts the land and the share tenant puts labor; production is divided between them according to certain norms.

In the area of study, these norms varied with the place, the crop, and even within the same property, different kinds of share tenancy could be identified. For example, CORTES (1968) describes the following:

Specialized labor: Workers could work two hectares and pay for them working free during three days a week.

Share tenants: Could cultivate two hectares and build a house there. If the parcel was less than two hectares, the landowner got 50% of the product. If the parcel was bigger, he got 75% of the sugar and 50% of the banana.

Sub-share tenants: They didn't work directly with the landowner, but with the share tenant. They got 20% of the tenant's part.

"Agregados". They got an hectare and could build a house. They had to work 54 days a year for the landowner. His wife and children had to do additional work, such as firewood gathering and crop surveillance.

Poverty was prevalent in this area during the first half of the century. In 1964, 84.8% of the properties and 47.4% of the area in share tenancy was of less than 5 hectares. CIDA (1966) stated that in minifundist areas, farmers had to devise complementary forms to gain access to land in order to increase their income. It was frequent to observe that farmers were simultaneously proprietors, share-tenants and workers. Salaries can be used as an indicative of economic situation. In 1950 the salaries in Nariño were the lowest of the country; they were half the national average and only one third of the salaries paid at the Meta's Departamento (KALMANOVITZ, 1982). This situation was prevalent until the eighties, when they started to equiparate to the national average.

Share tenancy is a type of property that discourages investment in land and conservation. There is no security of tenure, and benefits on investments in land could be received either by the landlord or another tenant. Another factor that limits land investment is the poverty of tenants, who had trouble to survive; intensive use of land was encouraged, with diminishing use of fallow. Agricultural techniques in share-tenancy land must have been different from the Indian tradition. It is possible that they used the proprietor's plow. Plantation decisions were no longer a matter of tradition and communal decision, the landlord decided what had to be planted and were. Rotation and multiple cropping was therefore abandoned.

Until 1938, the region continued to be autarkic, such as it was during colonial times and the early republic. This changed in 1938 with the construction of the road that connected the region with the central part of Colombia. The region turned to be a supplier, at national level, of wheat, barley, potato and beans. Coffee plantation was also encouraged. Most of this new production came from the big farms, that substituted crops for cattle, using the labor available from resguardos and share tenancy.

In big farms, plow started to be used, substituting animal for human labor. Tractors were not common, because of the steepness of the land. Regarding soil conservation, the introduction of

animal traction was said to had no effect, as the plow was roman type. " Only the absence of mouldborg plow and the shading of coffee can explain why, there are no symptoms of erosion in the majority of minifundio's areas" (CIDA, 1966).

SMALLHOLDERS

Minifundism is the result of resguardo's dissolution and of inheritance subdivision of medium and large estates. In 1964, Nariño was predominantly minifundist. 67.27% of the proprietors had farms of less than 5 hectares, representing 15.93% of the total area. Programs for minifundist classified them as farmers with less than 20 hectares. This kind of farmers were 93.24% of the total and had 31.61% of the land. For 1991, minifundism grew both in terms of number of farmers and the extension covered. Latifundism diminished both in number and area.

Since 1964 this area was favored by two big programs that were designed to improve the standard of living of small farmers. The first one, was the agrarian reform, that divided big farms among smallholders or people without land. It was effective from 1968 to 1973. The second program, Integrated Rural Development, which started in 1978 and continues its actions up to now.

Both of this programs were designed as integrated programs. The first one was concentrated on land adjudication, but was complemented with credit, roads, schools, and cooperatives. The second one was concentrated on credit and technical assistance, and was complemented with roads, schools, hospitals and rural electrification. Both programs, however limited in coverage, were beneficial for the standard of living of the poor, but this was obtained with the unsustainable use of natural resources.

Agricultural technology was changed by this programs. First of all, the agrarian reform permitted the generalization of the use of the mouldborg plow, which is cataloged as the number one cause of soil erosion in the area of study. It is not that it was not known before, but subsidized credit made it possible that even smallholders could buy the animals and the implements, that were also leased for other small farmers who couldn't buy them (CORTES, 1968).

Modern agriculture was also transferred to the small farmers. More productive varieties were adopted in many crops, varieties that were dependant on artificial fertilization and chemical pest control. This was specially true with beans and potatoes. Potatoes growing is heavily fertilized and uses lots of nematicides. It is also the most profitable crop in the area. Leaving outside family unpaid inputs, it produces 4.2 times as much as wheat and times 2.3 times as much as beans. Because of its profitability, potatoes are now the single most important crop, and other crops, that were important in multiple cropping and rotation are used less. As a result monocropping is increasing, and so does the use of chemical fertilizer, chemical pest control and chemical weed control. As they produce for the national market, the great variety of species and subspecies used, was reduced to two or three, with the consequence of biodiversity loss. Crops such as quinoa, disappeared almost completely as there was no market demand for it.

Agricultural modernization was not restricted only to potato. As it can be seen on the next table (1), it also covered beans, maize, sugar cane and cassava, as well as cattle production. Part of

this tendency to monoculture is also explained by the effect of P.L. 480 wheat imports, against which the Nariño's farmers couldn't compete, with the result of a drastic reduction in the harvested area (CANDELO, 1986).

Indian agricultural soil conserving practices were finally disrupted, especially in cold climates where potato grows. First, biodiversity of plants adapted to their environment were substituted by plants that require heavy use of chemical inputs. Rotation and intercropping, as well as fallowing was diminished. Manual soil preparation was substituted, first with animal traction and second the roman plow was replaced by the mouldborg plow. Land was prepared not just one, but several times. It is now common to pass three times the mouldborg plow and three times the disk harrow, but in wheat it was common to hear of farmers that tilled the soil 9 times. Terraces were lost during the colonial days, as well as the vertical production coordination.

Table No 1. Farmers that adopt ICA's recommendations. Percentage. 1986.

CROP	Land prep	Improved seeds	Planting	Fertilizing	Chemical pest control	Disease control	Weed control
BEANS	80	70	80	75	70	70	80,00
POTATO	80	65	70	80	75	80	85,00
MAIZE	50	60	50	30	65		45,00
SUGAR CANE	78	53	73	65	30	30	83,00
CASSAVA	55	55	40	15	40	30	60,00
MAIZE// BEANS// POTATO	70	50	83	25	40	75	85

SOURCE RAMIREZ, 1986.

Now agricultural research tends to correct this trends, as soil erosion has become one of the leading causes in soil productivity loss. Multiple cropping is being tested to look for its impact in productivity (synergesis) and pest control. Cultivated plants biodiversity is being collected and classified. No-till and reduced till practices are being now recommended.

CONCLUSIONS

The region has evolved through several types of property regimes with different results in terms of resource conservation. Two types of common property regimes, with collective action lead to a resorce conservancy result: The pre-Columbian regime and the colonial resguardo. One type of private property lead to resource conservation: the colonial latifundium, and this result is explained by the low intensity of use of land. Share tenancy, as it was expected, lead to resource overexplotation and to modification of agricultural soil conservation techniques. Finally, private property coincided with an agresive tecnicla change program, and the results are

unsustainable in terms of natural resource use. Property institutions evolved to a system that should encourage resource conservation, but technical change lead to a not conservative resource use.

Modern agricultural technology proved to be the most important cause in soil erosion and environmental degradation in the area of study. Economic and sociological factors such as kind of property, population growth and poverty, were present in this area and helped to destroy some of the soil conservation technologies developed by the Indian population. Nevertheless most of the soil conservation technologies survived the changes in property regimes, the population density and poverty. It was not until development programs stimulated "green revolution" technologies that the natural resource and environmental problems began.

Solution to environmental problems calls for intensive scientific research that takes into account not only productivity indicators, but also sustainability parameters and care must be taken on the type of technology transferred. Monoculture of potato had an important beneficial impact on minifundist well-being; this shouldn't be lost. It should be complemented so that current agricultural practices change in such a way, that they no longer continue to degrade soil.

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