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Building new income opportunities for small-farmers in Peru: the case of native and naturally colored cotton

Elena Pisani[a*], Stefano Scrocco[b]

[a] *Dep. TESAF Università degli Studi di Padova, Viale dell'Università, 16 - 35020 Legnaro (PD) Italy*

[b] *University of Salford, Salford Business School, Lady Hale Building - Salford, M54WT, United Kingdom*

Abstract

In the 90's the agro-export boom of Peru, based on a market-led development, has induced a major conversion of large farms to new agribusinesses (i.e. asparagus, avocados, oranges), leaving room for expansion in the traditional agro-industrial sector (i.e. cotton) for small farmers. This study assesses the new income opportunities deriving from the reinsertion of native and naturally colored cotton (NNCC) in the agricultural production of small farmers, by means of a farm economic data analysis, scenario analysis and sensitivity analysis. The analysis has been performed in a specific case study regarding 50 farms of the Moche district in the North coast of Peru, selected by means of a non-probability sampling technique.

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Keywords: small farmers; naturally collored farm economic data analysis; scenario analysis; sensitivity analysis; Peru

1. Introduction

The Peruvian agricultural sector underwent a major shift towards neo-liberal policies over the last three decades (Smits, 2014; Leon, 2014; Gootenberg, 2013; Crabtree, 2002; Kay, 1998), based on a market-led development and trade reforms opening the country to the international markets (Székely and Sámano-Robles, 2014). Liberalization of trade, removal of control on domestic prices, devaluation policies, and tariff reductions have opened new

* Corresponding author. Tel.: +390498272704; fax: +390498272713.
E-mail address: elena.pisani@unipd.it

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opportunities for commercial farmers to exploit the export market specifically in relation to non–traditional agro-exports (OECD, 2011; FAO, 2011; Escobal and Agreda, 2002; Escobal et al. 2000).

The major shift of large farmers out of the cotton sector and into asparagus, orange, apple, avocado has left room for small farmers to start cotton production, not so profitable as the new agribusinesses, but comparatively less demanding in terms of initial investments. Moreover Peruvian small farmers own an ancestral variety of the *Gossypium barbadense sp*. popularly called *algodón El País* or country cotton (Dillehay et al, 2007; Percy, 2009), which is native and naturally colored cotton (NNCC) with numerous hues (russet, brown, copper and green) due to the plant's inherent genetic properties (Dickerson et al., 1999).

The research objective of this study is to contribute to understand if the reintroduction of native cotton, as part of the agricultural production, could change small farmers' incomes and in which way. It must be noted that this is a preliminary research focused on agronomic and economic variables (agricultural production and income). Additional researches will be needed in order to deeply investigate the socio-cultural and environmental variables in order to assess the different dimensions of farmers' wellbeing.

The present analysis is conducted using a farm economic data analysis, scenario analysis, and sensitivity analysis, based on a dataset of agronomic and economic farm-level data, related to 50 enterprises operating on the North coast of Peru and collected in 2010-11 cropping season. The proposed approach is based on estimates of costs and revenues, and on different quantitative scenarios (hypothesis) of NNCC reintroduction (specifically 10%, 25% and 50% of the farmland destined to the crop) and comparing the results with the business as usual scenario (BAU). Based on these first results the sensitivity analysis highlights the most favourable conditions of production based on different price hypothesis (-10%, -5%, +5%, +10%) and in relation to different farm class sizes.

2. Context and research methodology

In Peru four commercial varieties of cotton are essentially cultivated: *Pima*, *Tangüis*, *Supima* and *Aspero*[†]. Besides the commercial varieties, Peru is traditionally known for its NNCC, a small bush producing a long and fine fibre, which has a higher natural resistance to parasites than other commercial varieties. Its natural habitat is along the coastal areas of South America and more specifically those with quite good soil fertility, low rains and absence of frost. Until the beginning of the 20th Century, Peruvian peasants normally cultivated this variety, but after the Second World War white cotton gained economic supremacy. In Peru the question also assumed a legal dimension: the *'Decreto Supremo n° 17 (04/05/1949) sobre políticas sanitaria vegetal'* allowed the Ministry of Agriculture to implement compulsory phytosanitary measures to eradicate the NNCC considered as a vector of diseases and pests causing damage to commercial varieties. Despite these laws, the local farmers put up a strong resistance and continued to plant the NNCC for household needs. In 2008, after many years of farmers' opposition and based on scientific evidence (Galluzzi and López Noriega, 2014; Vreeland, 1999), the NNCC was declared as a genetic, ethnic and cultural heritage of Peru, characterized by a strong resistance to many pests and diseases and with a relevant capacity to be cultivated in extreme soil conditions (salty soils) and with a lower water demand compared to commercial varieties.

In the Moche district, on the North coast of Peru, there are still 6 specific phenotypes of NNCC: white, brownish-grey, pale-brown, dark-brown, brownish-reddish, lilac-purple. The soils required for a good development of the plant are silt or clay-like, but the plant has also adapted to salty soils and is normally cultivated with other plants that have a lower salt-tolerance. This variety requires less water than commercial varieties and in desert or semi-desert areas the most suitable irrigation system is drip-irrigation, but flowing irrigation is normally used (Fernández et al. 2003).

In order to fulfil the research objective – how the reintroduction of native cotton as part of the agricultural production is going to change the small farmers' income – the research methodology was organized in the following consequent steps:

[†] Cotton production in Peru has progressively decreased since the 1960s, but in very recent years this historical path seems to be at a turning point. From 2010 to 2012 Peruvian cotton production has doubled (from 63,758 to 111,375 MT) as well as the area harvested (from 27,963 to 50,515 ha) (International Cotton Advisory Committee, 2013).

i) the *farm economic data analysis* was conducted for 50 farms on a total population of 615 active farmers owning 737.45 ha effectively cultivated[‡], and selected by means of a snowball sampling technique where the selection criterion was the direct knowledge of other farmers owning one or more plants of native cotton. This is a non-probability sampling where the first actors interviewed identify future interviewees from among their acquaintances. This sampling technique has been considered the most appropriate as NNCC producers are normally considered a 'hidden population' that is difficult for researchers to access due to their fear to be identified connected to the long-lasting legal prohibition to produce NNCC that only in 2008 has been removed. Moreover this method evidences the social networks within the population investigated. The negative elements of this method are ascribable to 'community bias', due to the strong impact in the selection process determined by the first participants, and 'risk of homophily' on attributes in the population (WB, 2009). Due to the lack of the random selection, the sample is not representative of the 615 farms, so the results of the analysis are only referable to the selected farmers. The data were collected *in situ* during the 2010-2011 cropping season. The farm economic data analysis was performed following the methodology proposed by FAO (1997), which considers the peculiar features and small-farms' objectives in developing countries;

ii) the *economic budget* of a hypothetical farm producing 1 ha of NNCC was compiled based on information on agricultural practices, costs and revenues collected by means of interviews with farmers already cultivating the product in the Moche district and in other districts of the La Libertad region. The format used for the analysis is the one proposed by Jost et al (2008);

iii) the *scenario analysis* has been performed based on 3 different quantitative hypotheses, specifically: 10%, 25%, and 50% of the agricultural surface of the farm cultivated with NNCC with a converse reduction of the agricultural surface destined to other crops. This procedure allows assessing how the farm costs, revenues and income are going to change due to the introduction of the NNCC and comparing the results with the business as usual scenario – BAU (without native cotton).

iv) the *sensitivity analysis* (SA) was lastly performed, in order to test the reactivity of income (output variable) to possible variations in native cotton price (input variable), specifically different price hypotheses have been tested: -10%, -5%, +5%, +10% compared to the normal market price.

3. Results and discussion

3.1. Farm economic data analysis

The class dimension of the sample is given in table 1, in which the first small-farm class (0-0.9 ha) represents 36% of the farmers owning 7.91% of the agricultural area of the sample, the second small-farm class (1.0-4.9) attests the highest number of farmers (56%) and the highest agricultural area (54%), while the third small-farm class represents the 8% of respondents and owns 33.59% of the agricultural area; the average farm size is 1.85 ha. Table 2 describes the basic socio-economic characteristics of the respondents: the percentage of adult people (52%) is higher than elderly (36%) and than youth (12%), there are more male (90%) than female (10%) directly owning and conducing the farm and the educational status is relatively good (68% of the sample has a secondary education and only 6% of the population has no formal education). The majority of households are composed by 1 to 4 members, and the households with more than 8 members represent only 8% of the sampled population. The main source of income is agriculture (52% of respondents). The 'rural no farm income' is not present as additional economic activity.

Table 1. Small-farm class size and agricultural area owned by person interviewed in the Moche district

	0-0.9	1.0-4.9	5.0-19.9	Total
Farmers (n°)	18	28	4	50

Table 2: Selected socio-economic activities of the respondents (n=50)

	Distribution	Frequency	%
Age	18-40	6	12

[‡] Based on the data of the IV Censo Nacional Agropecuario (INEI, 2013), in the district 868 farmers operate on a total agricultural surface of 1,084.45 ha, which is highly productive thanks to soil quality (alluvial soils) and the irrigation system serving all farms. Farmers are split in two categories: small farmers (*parceleros*) and medium-large farmers, considering a cut-off farm size of 20 ha as proposed by Escobal and Agreda (2002).

%	36.0	56.0	8.0	100.0
% Cumulated	36.0	92.0	100.0	-
Surface (ha)	7.3	54.0	31.0	92.3
%	7.91	58.50	33.59	100.0
% Cumulated	7.9	66.41	100.0	-

	41-65	26	52
	66 and above	18	36
Sex	Male	45	90
	Female	5	10
Educational status	No formal	3	6
	Primary	10	20
	Secondary	34	68
	Tertiary	3	6
Household size	From 1 to 4	30	60
	From 5 to 8	16	32
	More than 8	4	8
Main source of income	Agriculture	26	52
	Agriculture and livestock	24	48

Source: own elaboration based on the survey undertaken in the Moche district in the 2010-2011 cropping season.

A cross-sectional dataset of economic and agronomic farm-level data was constructed based on the following variables: a. personal and family data, b. basic farm data c. data on operating costs and allocated overheads related to the farming activity and gross value of production, d. data on native cotton (costs, revenues).

The analysis of the farm activity has been performed at levels of costs and revenues. The costs are split into operating costs (seeds, fertilizers, chemicals, transport, rental of machinery and equipment, technical assistance, energy, fuels, lubricants, veterinary costs, interest on operating capital and hired labour) and allocated overheads (opportunity cost of unpaid labour, opportunity cost of land, capital recovery of machinery and equipment). The gross value of production is mostly related to crop (mainly cereals and vegetables) and livestock production (mainly poultry); 71% of the gross value of production derives on average from crops, but it should be noted that the poultry sector is an important source of revenues mostly for the smaller farm classes. Table 3 details the main elements of the economic budget in US$ allowing comparisons among different farm dimensions.

Table 3. Gross value of production, operating costs and allocated overheads (in US$) by small-farm class size (average weighted values)

	0-0.9 ha	1.0-4.9 ha	5.0-19.9 ha	Average weighted value	Average weighted value 1 ha
N° of Farms	*18*	*28*	*4*	*50*	
1. Seeds	126.10	227.05	963.16	250.99	256.15
2. Fertilizers and chemicals	163.41	304.48	2109.14	400.43	345.06
3. Machinery and equipment rent	97.60	226.22	1744.20	304.57	175.11
4. Land rent	0.00	297.41	706.63	223.08	108.15
5. Interest on operating capital	54.65	148.95	779.68	166.45	124.86
6. Hired labour	126.26	375.88	531.31	298.45	309.74
Total operating costs	*568.00*	*1579.99*	*6834.12*	*1643.97*	*1319.06*
1. Opportunity cost of unpaid labour	1313.91	1279.85	1957.08	1406.40	2076.43
2. Opportunity cost of land	194.11	722.21	3229.90	738.33	407.25
3. Capital recovery of machinery	64.67	53.88	37.70	57.12	99.74
Total allocated overheads	*1572.68*	*2055.95*	*5224.69*	*2201.84*	*2583.42*
Total costs	*2140.68*	*3635.94*	*12058.81*	*6468.54*	*3857.38*
Gross value of production	*3251.47*	*6902.44*	*19434.79*	*6621.45*	*6290.84*
Gross value of production less total costs	*1110.79*	*3266.50*	*7375.99*	*2775.64*	*2388.36*
Gross value of production less operating costs	*2683.47*	*5322.45*	*12600.68*	*4977.48*	*4971.78*

Source: own elaboration based on the survey undertaken in the Moche district in the 2010-2011 cropping season.

The income of the 50 farms analysed was 2,388.36 US$/ha (as average weighted value for a normalized farm of 1 ha) and the gross value of production less operating costs were estimated at 4,971.78 US$/ha.

3.2. Economic budget of NNCC

The budget estimate is normally used as a useful instrument for planning and decision-making. The native cotton budget, presented in table 4, is based on specific assumptions in relation to native cotton production that come from information collected at farm level in the Moche district, and on widespread experiences of native cotton production as a small agro-industrial crop in different locations of the La Libertad region (more specifically in the Lambayeque and San Martín districts), moreover experts in cotton farm data analysis and agronomists have also been contacted in order to validate the data.

Table 4. Budget estimates of the native cotton production in US$/ha in the Moche district

	US$/ha	%		US$/ha	%
1. Native cotton seed	25.59	2.93	Gross value of production (GVP):		
2. Organic fertilizer	107.35	12.28	Primary product: Cotton	823.68	79.85
3. Integrated pest management	101.60	11.62	Secondary product: Cottonseed	207.90	20.15
4. Rent of equipment	42.93	4.91	Total gross value of production	1031.58	100.00
5. Fuel, lube and electricity	70.84	8.10			
6. Ginning and warehousing	100.23	11.47	*Gross value of production less total costs listed*	*157.39*	
7. Transport costs	71.56	8.19	*Gross value of production less operating costs*	*399.84*	
8. Interest on operating capital	73.38	8.39			
9. Hired labour	38.26	4.38			
Total, operating costs	631.74	72.27			
1. Opportunity cost of labour	-	-			
2. Capital recovery of machinery and equipment	160.76	18.39			
3. Opportunity cost of land	-	-	***Supporting information:***		
4. Taxes and insurance	20.87	2.39	Cotton yield: kg/per planted ha	576	
5. General farm overheads	60.82	6.96	- Price: US$ per kg	1.43	
Total, allocated overheads	242.45	27.73	- Cottonseed yield: kg/per planted ha	990	
Total, costs listed	*874.19*	*100.00*	- Price: US$ per kg	0.21	
			- Farm size	1 ha	

Source: own elaboration based on the survey undertaken in the Moche and Lambayeque districts in the 2010-2011 cropping season

3.3. Scenario analysis

The next step is the scenario analysis: the situation “business as usual scenario - BAU” has been compared with three different proposed scenarios: to allocate 10%, 25% and 50% of the agricultural area of the 50 farms to NNCC production (with a proportional reduction of the gross value of production of the existing crops), and consequently to verify how gross value of production, total operating costs, total allocated overheads, total costs, and farm incomes are going to change. The different situations are presented in table 5 where the values have been normalized in relation to an hypothetical farm of 1 ha.

Table 5. Scenario analysis in relation to the insertion of NNCC in the Moche district (in US$) normalized values per ha

Per farm in US$/ha	Business as usual (BAU)	Scenario 10%	% Variation compared to BAU	Scenario 25%	% Variation compared to BAU	Scenario 50%	% Variation compared to BAU
GVP	6290.84	6092.73	-2.19	5887.87	-5.48	5546.44	-10.96
Total operating costs	1319.06	1236.00	-5.15	1135.29	-12.88	967.44	-25.76
Total allocated overheads	2583.42	2229.86	-9.01	2056.56	-22.53	1346.57	-45.05
GVP - total costs	4971.78	4856.73	+6.12	4752.58	+15.29	4579.00	+30.58
GVP - less operating costs	2388.36	2626.87	-1.41	2696.02	-3.52	3232.44	-7.05

Source: own elaboration

With NNCC, the gross value of production is going to decrease in all scenarios compared to the BAU, and the cost structure is also going to change in a significant way, determining an estimated increase in income of +6.12% in the 10% scenario, +15.29% in the 25% scenario, and +30,58% in the 50% scenario (all the values have been normalized referring to an average farm of one hectare). Both the operating costs and allocated overheads are going to progressively decrease passing from the 10% scenario (-5.15% and -9.01% respectively) to the 25% (-12.88% and -22.53%) and 50% (-25.76% and -45.05%) scenario. It has to be noted that the decrease in allocated overheads is higher compare to the reduction of operating costs in all the three scenarios. Based on the dynamics of the above-mentioned variables, the final results demonstrate that all the set-ups represent a relevant improvement in incomes for the small farmers of the sample. The performance of farm incomes in the three scenarios can been explained by the dynamics of operating costs and allocated overheads that are progressively decreasing from the first to the third scenario. The table 6 details the results in relation to the specific small-farm class size.

Table 6. Scenario analysis in relation to the insertion of NNCC in the Moche district (average weighted values in US$ per class size)

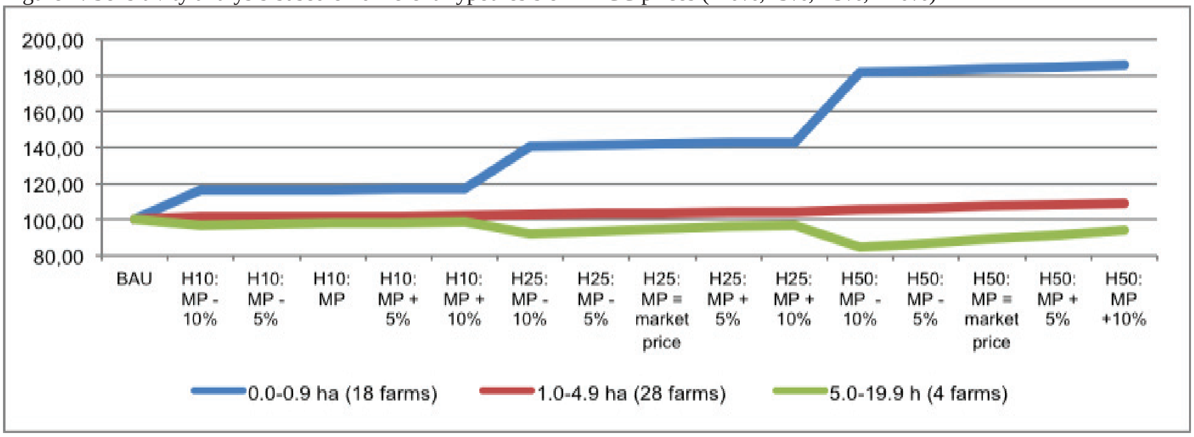
	0-0.9 ha	1.0-4.9 ha	5.0-19.9 ha	**BAU**	0-0.9 ha	1.0-4.9 ha	5.0-19.9 ha	**10%**
GVP	3251.47	6902.44	19434.79	6590.68	3177.56	6716.09	18689.53	6400.10
Total operating costs	568.00	1579.99	6834.12	1636.01	536.54	1543.83	6640.30	1588.92
Total allocated overhead	1572.68	2055.95	5224.69	2135.47	1425.14	1897.11	4890.12	1966.64
GVP – total costs	1110.79	3266.50	7375.99	2819.20	1215.88	3275.15	7159.11	2844.53
GVP – less operating costs	2683.47	5322.45	12600.68	4954.67	2641.02	5172.26	12049.23	4811.17
	0-0.9 ha	1.0-4.9 ha	5.0-19.9 ha	**25%**	0-0.9 ha	1.0-4.9 ha	5.0-19.9 ha	**50%**
GVP	3066.70	6436.57	17571.64	6114.22	2881.93	5970.70	15708.48	5637.76
Total operating costs	489.35	1489.58	6349.58	1518.30	410.70	1399.17	5865.05	1400.59
Total fixed costs	1267.17	1963.45	5612.26	2004.69	834.97	1261.76	3551.84	1291.32
GVP – total costs	1310.17	2983.54	5609.79	2591.23	1636.26	3309.76	6291.59	2945.85
GVP – less operating costs	2577.35	4946.99	11222.05	4595.92	2471.23	4571.52	9843.43	4237.17

Source: own elaboration

The scenario analysis in relation to the first small-farm size (0.0-0.9 ha) attests a substantial increase in income with the following specification: + 9% in the 10% scenario, + 17.95% in the 25% scenario, and + 47.31% (50% scenario) compared to the BAU. In relation to the second (1.0-4.9 ha) and the third (5.0-19.9) small-farm class size the income dynamics attest different performances, but the results are substantially negative.

3.4. Sensitivity analysis. Lastly the sensitivity analysis (SA) has been performed selecting the native cotton prices as input variable and observing their impact (i.e. -10%, -5%, +5%, +10%) on the farm income as output variable. The results are presented in figure 1.

Figure 1: Sensitivity analysis based on different hypothesis of NNCC prices (-10%, -5%, +5%, +10%)



Source: own elaboration

The income has been analysed in terms of both the average income of the 50 farms and of the average normalized income per 1 hectare of agricultural surface. In both cases the income displays a positive performance in relation to the different productive scenarios proposed and compared to the BAU one. Also in the worst case of a 10% reduction in the native cotton price the farm incomes in all the average normalized options are higher compared to the BAU (+5.70% in the 10% scenario; +14.25% in the 25% scenario; +28.49% in the 50% scenario). But considering the values al the level of single class size it emerges the best performance is the one of the first class size, while the third class attests a negative performance.

4. Conclusions

The paper presents how incomes of a selected sample of farms, located on the North coast of Peru, could change in relation to different scenarios in terms of NNCC. Our average results for the 50 farms indicate that the variation of incomes compared to the BAU scenario ranges between +6.12% (in the case the area destined to native cotton is equal to 10% of the agricultural area of the selected sample) and +30.58% (when the area corresponds to 50% of the farmland) as weighted average values. Splitting the data at the level of the three class sizes considered, the best performance is attested by the first class (0.0-0.9 ha). In relation to the other two class sizes the situation is not so profitable, and this is probably due to the fact that these farms have already attested a form of specialization in their production system. Moreover income variations have been tested by means of a sensitivity analysis, using the native cotton price as input variable: average results for the 50 farms attest a positive performance, that is confirmed for the first and second class sizes but not for the third one.

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