# Performance of alpacas from a dispersed nucleus in Pasco region, Peru

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**Abstract**
The alpaca (*Vicugna pacos*) is native animal from the High Andes of Peru. The main product is a special fiber of high value for the textile industry. A genetic improvement program has been carried out in the Pasco Region in Peru in order to improve the alpaca fiber quality and quantity since 2010. Six alpaca production units agreed to form a dispersed nucleus with the technical support of UNALM. Alpacas were selected by visual appraisal and grouped in the following categories S, A, B, C, and R. Fleece weight (FW), and body weight (BW) were recorded at shearing time in 2011 and 2012. Also fiber samples were taken to measure fiber diameter (FD), and coefficient variation of FD (CVFD) by IWTO-12 regulation. A model that includes effects such as category, age, sex and their corresponding interactions was used to analyze the data by using SAS. Alpacas from different categories differed in FD and FW but not for CVFD and BW performance. Alpacas from category S had lowest FD. FD and BW tended to increase with age. A selection index has been developed for simultaneous genetic improvement of FD, CVFD and FW.

**Resumen**
La alpaca (*Vicugna pacos*) es una especie nativa de los Andes del Perú. El producto principal es una fibra especial de alto valor para la industria textil. Con el objetivo de mejorar la producción y la calidad de la fibra de alpaca se está implementando en la Región de Pasco en Perú un programa de mejoramiento genético desde el 2010. Seis unidades de producción de alpacas acordaron formar un núcleo disperso con el apoyo técnico de la UNALM. Las alpacas fueron evaluadas mediante evaluación visual, y agrupadas en las siguientes clases selectivas S, A, B, C, y R. El peso de vellón (PVLL), y peso corporal (PC) fueron medidos al momento de las esquilas del 2011 y 2012. También, muestras de fibra fueron tomadas para la medición del diámetro de fibra (DF), y el coeficiente de variación del diámetro de fibra (CVDF) por el método IWTO-12. Un modelo que incluye los efectos de clase selectiva, edad, sexo y sus correspondientes interacciones fue utilizado para analizar los datos con el programa SAS. Las alpacas de la clase selectiva S presentaron menores valores de DF. El DF y PC tendieron a incrementar con la edad. Un índice de selección está siendo desarrollado para la mejora genética simultánea de DF, CVDF y PVLL.

**Key words**: alpaca, disperse nucleus, breeding program, Peru

## Introduction

The alpaca (*Vicugna pacos*) is a native animal from the High Andes of Peru, and it is raised mainly for its special fiber of high value for the textile industry (Wheeler, 2012). Although most alpacas are in the South of Peru, the alpaca population has been increasing in Pasco Region since the last decade. There is an interest to genetically improve alpaca fibre quality and quantity. Therefore, a multi-communal central nucleus (MCN) was implemented by "Centro de Investigacion y Capacitacion Campesina"(CICCA) with 22 communal enterprises. CICCA was created by Universidad Nacional Agraria La Molina (UNALM) in 1996 (Mueller

*et al*., 2002). The MCN was run from 2006 to 2008 (Barrantes, 2012). Communal enterprise contributed with 305 Huacaya females (13 for each one) and 10 Huacaya males were imported from Puno (6), Pasco (2) and Junin (2). The purchase of males was supported by a group of mining companies named "Grupo Minero del Centro" (GMC). The nucleus was established in Palcan communal enterprise but due to land ownership problems and the lack of funding, the nucleus was dissolved. So, the implementation of a dispersed nucleus arises as an alternative to face problems encountered in the management of central nucleus (Mueller, 2006). Therefore, a pilot research and development project was started to form a dispersed open nucleus with 6 alpaca communal enterprises (Ruiz *et al*., 2012). This activity was funded by VLIR-UNALM project.

This paper aims to describe the performance of Huacaya type alpacas from a dispersed nucleus breeding program formed by 6 alpaca production units in the Pasco Region of Peru in 2011 and 2012.

## Material and Methods

The Pasco Region is located in the central Andes of Peru were annual rainfall varies from 800 to 1200 mm per year, but it is concentrated in the wet season (October-April). The mean annual temperature is less than 10 $^{\circ}$C with frost occurring at early morning mainly in the dry season. Mountain rangeland is the predominant landscape; vegetation is composed mainly by native grasses and forbs.

In 2011 two communal cooperatives, two communal enterprises and two Alpaca family associations agreed to form a dispersed nucleus (DN) with the technical support of UNALM. The alpaca population under study was Huacaya type with a white-colored fleece. All data were recorded in 2011 and 2012.

Alpacas were selected by visual appraisal and grouped in the following categories S, A, B, C, and R, where S corresponds to the best animals and R corresponds to worst ones. Fiber fineness, fleece density, white-colored fleeces and general appearance were the main criteria used to assign alpacas at one category (Barrantes, 2012).

Fleece weight (FW), and body weight (BW) were recorded by digital scale at shearing time. Also fiber samples were taken to measure average of fiber diameter (FD), and coefficient variation of FD (CVFD) by using SIROLAN LASERSCAN and following IWTO-12 regulation. Fiber analyses were performed in the Animal fiber laboratory at UNALM.

A model that includes effects such as category, age group, sex and their corresponding interactions was used to analyze the traits. Age group had four levels: Milk teeth, two teeth, four teeth and full mouth. In order to account for differences in shearing interval, the staple length was included as a covariate in the model for FW. Data were analyzed with the GLM procedure of the SAS 9.2 software.

## Results and discussion

The overall alpaca population under the selection program was about 11105 animals, where adult females and males were 5363 and 498, respectively (Table 1). This population was divided in two strata: nucleus, also known as "plantel", and base, also known as "majada".

The nucleus is composed by the best animals, adult females and males are 856 and 137, respectively (Table 2). It seems that the female nucleus size was appropriate to produce male replacements for the base (16% of adult females). Moreover, the number of males in the nucleus was sufficient to mate females from the nucleus, and it will be feasible to implement a sire reference scheme to establish a genetic link among farms.

***Table 1.*** *Population structure by age-sex class and communal enterprises at 2011*

| Class | Racco | Yurajhuanca | Huayllay | Vicco | Cachipampa | Sanjo | Total |
|---|---|---|---|---|---|---|---|
| Adult female | 1649 | 1021 | 1809 | 524 | 120 | 240 | 5363 |
| Adult male | 136 | 141 | 189 | 20 | 3 | 9 | 498 |
| Castrates | 140 | 0 | 295 | 0 | 0 | 0 | 435 |
| Yearling female | 463 | 465 | 297 | 115 | 30 | 81 | 1451 |
| Yearling male | 464 | 372 | 360 | 111 | 36 | 75 | 1418 |
| Lambs | 0 | 756 | 781 | 221 | 54 | 128 | 1940 |
| Total | 2852 | 2755 | 3731 | 991 | 243 | 533 | 11105 |

***Table 2****. Nucleus size by communal enterprise and gender at 2011*

| Communal enterprise | Males | Females | Total |
|---|---|---|---|
| Cooperativa Racco | 15 | 381 | 396 |
| Cooperativa Yurajhuanca | 35 | 67 | 102 |
| Granja Huayllay | 69 | 201 | 270 |
| Granja Vicco | 10 | 127 | 137 |
| Asociacion Sanjo | 3 | 35 | 38 |
| Asociación Cachipampa | 5 | 45 | 50 |
| Total | 137 | 856 | 993 |

A preliminary analysis of the alpaca's performance from a dispersed nucleus in Pasco region was performed. A high phenotypic variation for all traits was observed (Figure 1). This might be due to environmental effects such as management, sex, age and year, but also due to genetic differences between animals. Further research is needed to disentangle the phenotypic variation of traits in genetic and environmental components, as it was done in a previous study regarding genetic analysis of traits from Peruvian alpacas (Gutierrez *et al*., 2009).

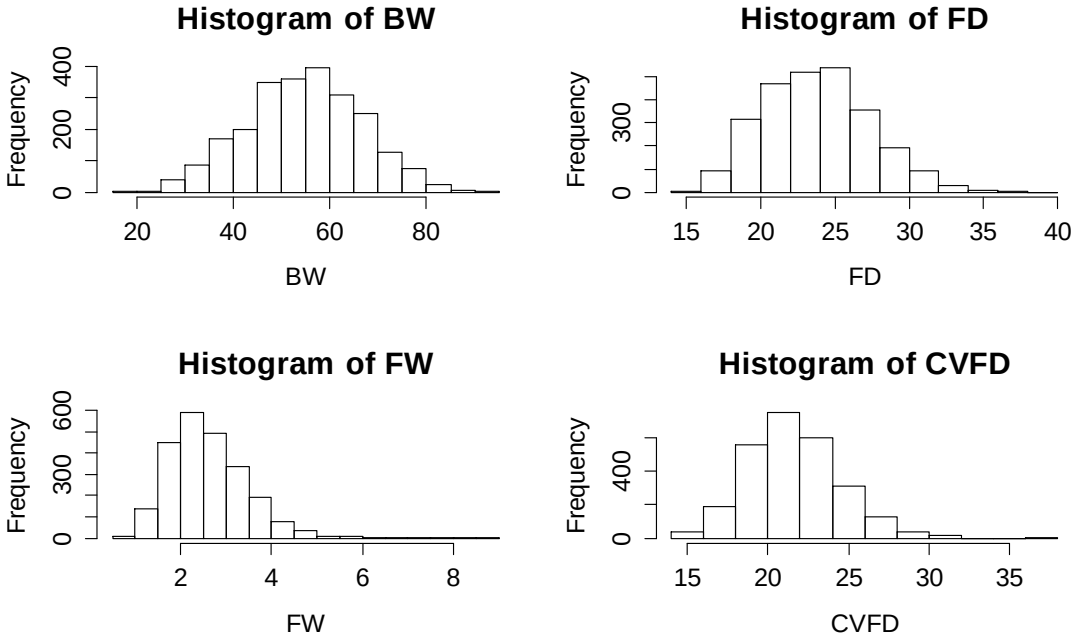


***Figure 1.*** *Histograms for Body weight (BW), fiber diameter (FD), fleece weight (FW), and coefficient variation of fiber diameter (CVFD)*

Means for FD, CVFD, FW and BW are presented in Table 3. The average of FD was slightly coarser than alpacas reported in other regions of Peru, but the average of CVFD was lower (Morante et al, 2009; Quispe *et al*., 2009; Cervantes et al., 2010). Also, the average of FW was higher than in other studies (Gutierrez *et al*., 2009; Quispe *et al*., 2009).

***Table 3.*** *Means of fiber diameter (FD), coefficient of variation of FD (CVFD), fleece weight (FW) and body weight (BW) by category and sex*

| Category | FD (µm) n=2219 | | CVFD (µm) n=2219 | | FW (kg) n=1745 | | BW (kg) n=2266 | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| S | 20.1 | 20.9 | 21.4 | 20.1 | 3.1 | 2.7 | 52.5 | 49.2 |
| A | 22.4 | 21.9 | 21.4 | 21.4 | 3.5 | 2.6 | 54.9 | 52.1 |
| B | 23.4 | 23.1 | 21.1 | 21.9 | 3.0 | 2.6 | 56.1 | 51.5 |
| C | 23.8 | 24.6 | 21.7 | 21.6 | 2.7 | 2.6 | 53.9 | 56.5 |
| R | 23.9 | 24.6 | 21.9 | 21.9 | 2.7 | 2.4 | 51.8 | 55.6 |

Alpacas from different categories differed in FD and FW. Alpacas from category S had lowest FD, as we expected because fiber fineness was the main attribute for assigning animals in this category. Reduction on fiber diameter is one of the main breeding objectives for alpacas (e.g. Morante *et al*., 2009; McGregor, 2012; Ruiz, 2012; Barrantes, 2012).

Also, alpacas from categories S, A, and B showed higher values for FW. A significant interaction was found for gender by category for FD and BW, differences between females and males were detected in categories C and R for FD and in categories B, C, and R for BW.

Up to our knowledge, there were no available references for differences among categories for the traits analyzed in this study.

In addition, age by sex interaction was found for FW. Differences between males and females for FW were found at older group of ages (four-mouth and full-mouth). This result may have to be interpreted with caution, because some farmers delayed the shearing time to allow them to participate in alpaca shows. Therefore, the shearing interval was not the same for all animals, and finest male alpacas had longer shearing intervals than others. Although, staple length was included as a covariate in the model for FW, perhaps it was not sufficient to take into account differences in shearing interval.

Younger alpacas had lower FD and BW than older ones; these results are in agreement with other studies where an increasing trend with age for FD and BW was reported (e.g. Quispe *et al*., 2009; Wuliji, 2011; Candio and Gutierrez, 2011; McGregor, 2012). In the other hand, there were no differences found for CVFD in group of age, sex and category; these findings are in agreement with another study (Quispe *et al*., 2009).

Differences among alpaca farmer's location and years were not evaluated in this study due to the small number of observations for category S, and for the combination of category by sex. However, these effects will be evaluated in further analysis of the data, using a model that will not include category as fixed effect.

## Conclusions

A preliminary analysis of the alpaca's performance from a dispersed nucleus in Pasco region was performed. The DN was at the beginning stage, so this data should be seen as a reference for future analyses of the impact of DN on the genetic improvement of alpacas. There were differences found in categories for FD and FW, but not for CVFD and BW, so the visual appraisal may not be appropriate for improving FD, CVFD and FW simultaneously. A selection index has to be developed for simultaneous genetic improvement of FD, CVFD and FW.

## Acknowledgements

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# PERFORMANCE OF ALPACAS FROM A DISPERSED OPEN NUCLEUS IN PASCO REGION, PERU

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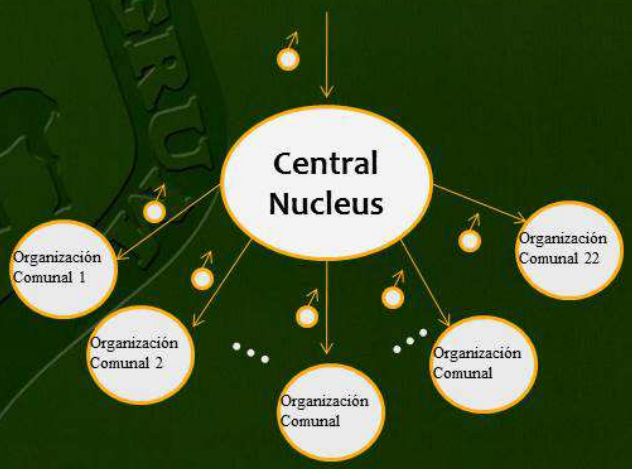
## Introduction I

- Alpaca population has been increased in Pasco since last decade
- Genetic improvement projects seeks to improve fiber quality and production
- A central nucleus was implemented in Pasco-Peru (2007-2010)

1. CICCA: "Centro de Investigación y Capacitación Campesina" (Ayaracra, Pasco). Created in 1996 by UNALM.
2. "Palcan" multi-communal nucleus was created with 22 communal organizations. Funded by " Grupo Minero del Centro".



## Introduction II

Management of Central nucleus faced many problems:

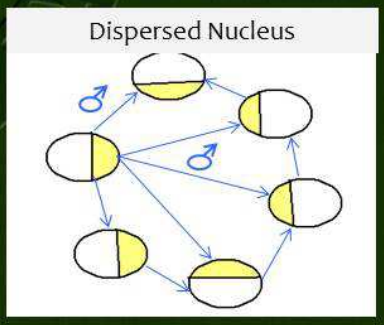
- Tenure of land
- Loss of support

Therefore, a dispersed nucleus was proposed and implemented with 6 alpaca communal enterprises in 2011, sponsored by VLIR-UNALM project in Pasco-Peru.

Two strata:

-Nucleus "Plantel"

- Base "Majada"




## Location of Dispersed nucleus


- Cooperativa Comunal de Racco y Yurajhuanca
- Granja Comunal de Huayllay y Vicco
- Asociación de Ganaderos de Alpacas de Cachipampa y Sanjo.

## Alpaca population by organization and age-sex class (2011)

Table 1. Population structure by age-sex class

| Class | Racco | Yurajhuanca | Huayllay | Vicco | Cachipampa | Sanjo | Total |
|---|---|---|---|---|---|---|---|
| Adult female | 1649 | 1021 | 1809 | 524 | 120 | 240 | 5363 |
| Adult male | 136 | 141 | 189 | 20 | 3 | 9 | 498 |
| Castrates | 140 | 0 | 295 | 0 | 0 | 0 | 435 |
| Yearling female | 463 | 465 | 297 | 115 | 30 | 81 | 1451 |
| Yearling male | 464 | 372 | 360 | 111 | 36 | 75 | 1418 |
| Lambs | 0 | 756 | 781 | 221 | 54 | 128 | 1940 |
| TOTAL | 2852 | 2755 | 3731 | 991 | 243 | 533 | 11105 |

Table 2. Nucleus ("Plantel") size by organization

| Organization | Males | Females | Total |
|---|---|---|---|
| Cooperativa Racco | 15 | 381 | 396 |
| Cooperativa Yurajhuanca | 35 | 67 | 102 |
| Granja Huayllay | 69 | 201 | 270 |
| Granja Vicco | 10 | 127 | 137 |
| Asociacion Sanjo | 3 | 35 | 38 |
| Asociación Cachipampa | 5 | 45 | 50 |
| Total | 137 | 856 | 993 |

## OBJECTIVE

- To analyze alpaca performance for body weight (BW), fleece weight (FW), fiber diameter (FD), and coefficient of variation of FD (CV) in a dispersed nucleus in Pasco Region (Peru)

## Methods

- Alpacas from "Plantel" were classified by visual appraisal and grouped to categories: S, A, B, C and R.
- BW and FW were recorded at shearing in 2011 and 2012 (November-December)
- FD and CV were determined by Sirolan Laserscan (IWTO-12) at UNALM animal fibre lab (Interwoolabs).

## Methods

- **BW, FD and CV**

$$Y = \mu + \text{Age group} + \text{Sex} + \text{Category} + I + e_{ijkl}$$

- **FW**

$$Y = \mu + \text{Staple Length} + \text{Age group} + \text{Sex} + \text{Category} + I + e_{ijkl}$$

  - SAS 9.2, PROC GLM

# Results

Table 3. Analysis of variance of traits

| Factors/covariate | FD n=2219 | CV n=2219 | FW n=1745 | BW n=2266 |
|---|---|---|---|---|
| Staple length | NI | NI | ** | NI |
| Category (C) | ** | NS | ** | NS |
| Age group (A) | ** | NS | ** | ** |
| Sex (S) | NS | NS | ** | ** |
| C*A | NS | NS | NS | NS |
| C*S | ** | NS | NS | ** |
| A*S | NS | NS | ** | NS |
| C*A*S | NS | NS | NS | NS |

- NI: Not included in the model
- NS: Not significant (p>0.05)
- **: p<0.01

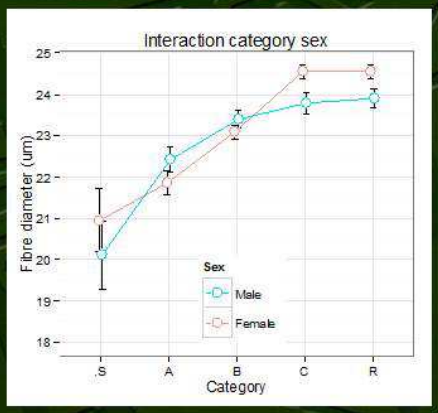
# Results

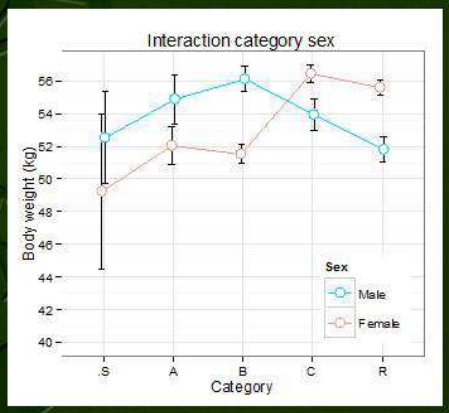
Table 4. Average of traits by category and sex

| Category | Fiber diameter (µm) | | Coefficient of variation of FD (µm) | | Fleece weight (kg) | | Body weight (kg) | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| S | 20.11 | 20.94 | 21.44 | 20.09 | 3.14 | 2.72 | 52.54 | 49.24 |
| A | 22.42 | 21.86 | 21.41 | 21.35 | 3.45 | 2.56 | 54.87 | 52.07 |
| B | 23.40 | 23.09 | 21.12 | 21.90 | 2.95 | 2.58 | 56.12 | 51.52 |
| C | 23.78 | 24.55 | 21.72 | 21.56 | 2.71 | 2.57 | 53.94 | 56.45 |
| R | 23.90 | 24.55 | 21.88 | 21.91 | 2.72 | 2.42 | 51.79 | 55.58 |

## Results

Interaction category by gender for FD and BW




## Concluding remarks

- Alpacas from different categories differed in DF and FW, but not for CV and BW.
- Alpacas from category S and A had lowest DF.
- DF and CV tended to increase with age.

## Future work

- Implementing sire reference scheme
- Build a pedigree information
- Implement a genetic evaluation
- Multi-trait selection by using EBV