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COMPARATIVE STUDY OF PASTORALS PRODUCTIONS SYSTEMS OF ANTHROPOGENIC PLAIN OF MAGA LAKE AND THE NATURAL FLOOD PLAIN OF WAZA-LOGONE (FAR NORTH OF CAMEROON)

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ABSTRACT

The floodplains of Far North Cameroon form the major areas of pastoral production. These basins belonging to the pure extension type are characterized by a drastic decrease in fodder production and pastoral yield. This study aims to characterize the systems of pastoral production in the "Yaéré" or natural plain of Waza-Logone compared to that of "Ndiyam Shinwa" (NS) or anthropogenic plain of Lake Maga. Zébu breed cattle were evaluated in the both plains. Semi-structured interviews were carried out with 57 shepherds, chosen on the basis of their availability, in situ observations made on the 57 herds of shepherds interviewed and body measurements were collected on 60 adult and juvenile cattle each. It emerges from this study that the average height of calves in the herds, the calving rate and mortality rate of cattle do not show any significant difference between the both sites whatever the period. However, the body condition score (BCC) of cattle degrades faster in natural plain than in anthropogenic plain. The percentage of cache tic cattle (M-) in the anthropogenic plain changes respectively to 0.0%; 0.3% and 4.2% in November, March and May in NS against 0.0%; 1.5% and 4.3% in a natural plain. Fatty cattle (G-) are only observed in November, 2.4% in anthropogenic plain against 3.5% in natural plane. The average live weight of juvenile cattle (104.1 ± 16.8kg in May and 92.5 ± 24.0kg in November) and adults (163.0 ± 21.2kg in May and 158.9 ± 24.8kg) in the natural plain differ significantly from those in the anthropogenic plain: 98.7 ± 16.4kg in May and 86.1 ± 17.3kg in November for juvenile cattle and 149.1 ± 12.3kg in May and 157.0 ± 16.6kg in November for adults. The permanent availability of drinking water in the natural plain would be at the origin of the better performances of the cattle and the improvement of fodder quality. Bromatological studies would provide more response to this study.

Keywords: anthropogenic plain, natural flood plain, pastoral production, body condition score, barymetric.

INTRODUCTION

Breeding is an important socio-economic activity in Sub-Saharan Africa. It performs both economic and environmental functions (Sawadogo, 2012). Economically, the poorest populations depend on this activity as source of food and monetary income (Zoundi and Hitimana, 2008; Ziébé et al., 2005). From an environmental point of view (Espagnol et al., 2018) livestock appears in this arid strip of Africa as the most efficient form of available pastoral resources development (Nori, 2007; Wane, 2006). In this arid strip, pastoralism is based on the strategic mobility of animals in search of water and fodder (DERA / UA, 2013), characterized by an extensive mode of exploitation (Sipowo et al., 2007) by transhumant herders. Transhumance is a breeding system where pastoralists move in search of water and new pastures in the dry season with an anchoring land where they return with the herds in the rainy season (FAO, 2012; Sipowo et al., 2007). Thus, a system of breeding or pastoral production can be explained as a mode of combination between land, force and means of work to achieve production, characterized by the nature of the productions, the strength of labor, the means of work used and their proportions (Rouveirolles, 2007). In Cameroon, the livestock sub-sector contributes gross domestic product of around CFAF 165 billion, while providing direct income of around 30% to rural populations (Messomo, 2006). In the Far North region of Cameroon, the success of transhumant livestock farming is due to the existence of the Diamaré, Mayo Danay and Log one et Chari floodplains, also called "Grand Yaéré" (Naah, 1990) which receives thousands of cattle each year from Niger, Chad, Nigeria and Cameroon (Requier-Desjardin, 2011). More than 6.2 million of cattle's are estimated; 7.7 million of sheeps and goats, 70% of which are transhumant (MINEPIA, 2009) in search of pastoral resources to exploit. In the market, the monetary value of an ox depends on its condition. However, the embonpoint condition of cattle depends on the exploitation of available resources (Jaymelynn et al., 2016). Assessing the weight with the scale is tedious for production systems. This assessment can be made from the assessment of the body condition score. In fact, the Body Condition Score (BCS) is a method of scoring an animal's body condition by evaluating fat deposits directly under the skin, in the lumbar and pelvic regions. It helps to assess variations in body condition and to adapt the food intake (Tiago et al., 2019; Jaymelynn et al., 2016; Trudi et al., 2011; Vall and Bayala, 2004). Considering the systems based essentially on moving animals on natural pasture (extensive mode), the adaptation of the ration according to the score of body condition requires changes of course, most often linked to the availability of food, drinking water near the courses. The present study entitled "Comparative study of pastoral production systems of the anthropogenic plain of Lake Maga and the natural flood plain of Waza Log one - Far North Cameroon" was carried out as part of the research work for the obtaining the engineer diploma in agriculture, animal husbandry and derived products (AGEPD), option animal production and aquaculture (PAA)

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from the Higher Institute of Sahel (ISS) in 2014. This work was carried out with the support of the Research and Pastoralism Support Center (CARPA), in partnership with the University of Ohio. This study aims to master pastoralism in the Sudano Sahelian zone of Cameroon, to understand the probable reasons for the decrease in current productions and to compare the pastoral productions of the flood plain created by the action of man or anthropogenic plain of Lake Maga also called "Ndiyam Shinwa" to that of natural Waza-Log one or "Yaéré". Specifically, is comparing the zoo technical performance of the herds in the two sites using various performance data collection and analysis tools.

MATERIALS AND METHOD

Study area

This work took place in the flood plains of "Ndiyam Shinwa" and "Yaéré", located between the geographical coordinates 10 ° 50 and 12 ° 30 North latitude, and between 14 ° 00 and 15 ° 20 East longitude . This zone is characterized by an arid sudano-sahelian climate, with average annual rainfall of around 700 mm of rainfall and temperatures of up to 40 ° C in the shade. The choice of these two sites is justified by their fundamental difference linked to their nature: the natural plain to the artificial or anthropogenic plain created by the construction work of the dike of Lake Maga for rice growing needs. Figure 1 shows the location of the two plains.

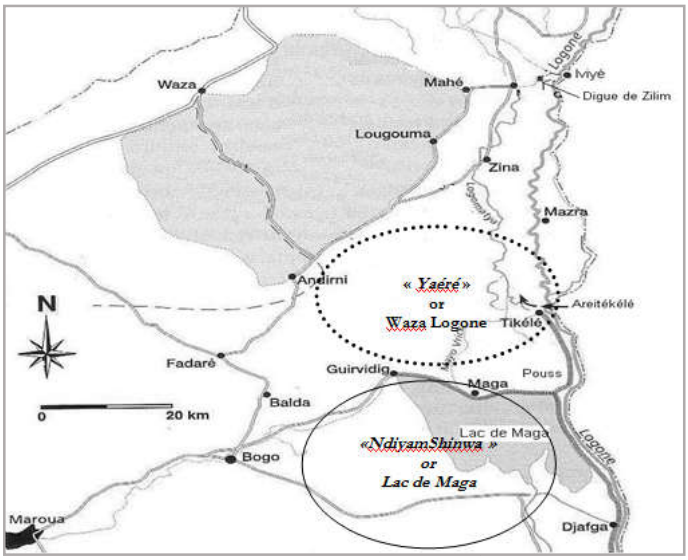

Figure 1: Location map of the study sites (Source: Fotsing.,2007)

Study period

This study was conducted during one year (in 2014), with specific times of data collection. Three time intervals for data collection were selected depending on the availability of water:

- November, corresponding to the period of recession when the water has withdrawn from the plain, fodder resources abound and watering points are available. These plains are full of sedentary, transhumant and nomadic herds from various horizons;
- May, corresponding to the end of the dry season. At this time, the pastoral resources of the natural plain are no longer available for all the herds, watering the calves remains a real problem. Only the sedentary herds remain in place in these plains;
- March corresponding to the median period between November and May considering the availability of pastoral resources. During this period, the fodder availability curve begins to drop and the ponds begin to dry up. Only sedentary herds and a few intra-plains transhumant are observed there. The other herds are gradually moving to other horizons.

Semi-structured interviews with shepherds

57 shepherds including 04 pilots (i.e. 02 shepherds per plain) were chosen on the basis of their availability. Semi-structured interviews were conducted with the 57 shepherds. The choice of pilot shepherds per plane was guided by his absence of migration from one plain to another during the previous year and especially by their availability. The interview consisted of exchanging with the shepherds on the zoo technical performances of the herds: the number of cattle, the number of adult and young cattle, the number of farrowing during the last twelve months, the number of deaths during the twelve last months.

Observation in situ

In situ observations were carried out on the 57 herds of shepherds who agreed to undergo semi-structured interviews. They permitted to assess the size of the herd by physically counting the animals in the herd by applying the "choice without replacement" method. Thus, samples of 10 animals are chosen at random and gradually from the herd and the BCS of each animal is evaluated as shown in Figure 2. A maximum of forty (40) cattle is observed per herd to estimate the BCS of the herd. Batches of 10 cattle are counted until the entire herd has been assessed. The estimation of herd is obtained by adding the various batches constituted and then compared to the figure advanced by the shepherd during the interview. The evaluation of the number of calves present in a herd is made by counting the calves tied near each herd before the morning milking or the number of rope present in the part reserved for calves when they are on pasture.

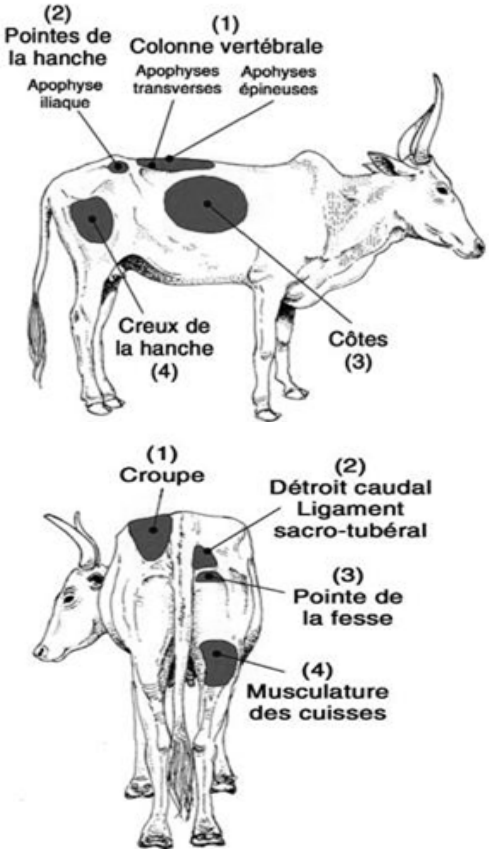

Figure 2: The anatomic points of BS notation (Vall et Bayala, 2004)

Barymetric measurements

Barymetric measurements (thoracic perimeter (T) and scapular-ischial length (L) in m) were made according to the method of Pater (2007) and the live weights (Pv) calculated according to the formula of Crevat Pv = 80 * T3 (Abdoulaye et al., 2017; Dodo et al., 2001; Delaye et al., 1955). They were carried out on 15 adult animals of more than 2 years and 15 juveniles of 2 years at most preselected in each pilot herd. Each animal was identified according to the description of coat, age and distinguishing marks.

Statistical analyzes

After collection, counting and coding, the data were analyzed using the statistical approach based on the calculation of frequencies, means and standard deviations, thus making it possible to estimate the distribution of the results between the sizes of the herds, the number of farrowing and of deceased; the barymetric results and the body condition scores were processed by the Excel 2007 spreadsheet, then imported into the XLSTAT 2007.8.04 software for analysis of variance. Multiple comparison tests were performed using the ANOVA analysis of variance test followed by Fisher's pair wise comparison test. The differences were observed to be significant at a 95% confidence interval, at a tolerance level of $p < 0.01$.

RESULTS

Zoo technical performances

Table 1 shows the results of the zoo technical performance evaluation of the herds observed by site in November and May. This table shows the average percentage of calves at each observation, the average farrowing rate and the average mortality rate between observation periods for each site.

Table 1: Zoo technical performances of the herds evaluated in the two sites

Evaluated performances	November		May	
	Anthropogenic plain	Natural plain	Anthropogenic plain	Natural plain
Percentage of calves (%)	5,0[a]	6,4[a]	7,9[a]	5,2[a]
Farrowing rate (%)	8,2[ab]	15,4[a]	2,2[b]	3,1[b]
Mortality rate (%)	2,9[ab]	5,1[a]	0,6[b]	2,2[ab]

It emerges from this table that the herds observed in the two sites show no significant difference between the percentages of calves present during the herd observations. As far as calving rate, we observe a difference in the natural plain between the period of November (15.4%) and that of May (3.1%). However, there is no difference in farrowing rates between sites for the same period. As for the recorded mortality rates, we observe that they are relatively high (5.1% in November and 2.2% in May) in the natural plain compared to those observed (2.9% and 0.6% respectively in November and May) in the anthropogenic plain.

Cattle body condition scores at both sites as a function of time

Table 2 presents a summary of the change in the body condition score in percentage over time and in space.

Table 2: Summary of the evolution of the BCS in time and in space.

BSC en %	Novembre		Mars		Mai	
	Athropogenic plain n= 7	Natural plain n=19	Athropogenic plain n=8	Natural plain n=11	Athropogenic plain n=5	Natural plain n=7
M– (1)	0,0	0,0	0,3	1,5	4,2	4,3
M (2)	4,9	2,9	9,8	15,0	19,9	21,4
M+(3)	13,7	8,1	17,1	17,6	14,7	13,1
N– (4)	17,0	13,8	17,8	13,6	11,2	12,6
N (5)	13,1	13,8	6,0	3,5	3,9	4,0
N+ (6)	8,0	11,0	0,4	0,5	0,3	0,4
G– (7)	2,4	3,5	0,0	0,0	0,0	0,0
G (8)	0,0	0,7	0,0	0,0	0,0	0,0
G+ (9)	0,0	0,1	0,0	0,0	0,0	0,0

n = number of herds assessed; M - or (1) = Cachectic; M or (2) = Skeletal; M + or (3) = Fairly thin; N- or (4) = Good overweight; N or (5) = Medium overweight; N + or (6) = Very good overweight; G- or (7) = Fat; G or (8) = Too fat; G + or (9) = Extremely fat.

It emerges from Table 2 that, compared to time, the general condition of the cattle is better in November (2.4% of fatty cattle in the anthropogenic plain and 3.5% in the natural plain; 0.0% of cachectic animals in the two plains), then deteriorate in March (0.3% cachectic animals in the anthropogenic plain and 1.5% in the natural plain; 0.0% fatty animals in the two plains) and is accentuated in May (4.2% and 4.3% respectively of cachectic animals in the anthropogenic plain and the natural one). Compared to space, Table 2 shows that the natural plain records more fatty animals in November (3.5% G-, 0.7% G and 0.1% G +) compared to the anthropogenic plain (2.7% G-, 0.0% G and G +). However, in March and May, no fat cattle were seen on the two plains. In March, when the watering points for livestock start to dry up and fodder resources become scarce, it is observed that the cattle of the anthropogenic plain are overweight (17.8% of N-, 6.0 % of N) compared to those of the natural plain (13.6% of N- and 3.5% of N). In May, a period of extreme scarcity of fodder and water resources, the cattle observed in the two plains show almost the same general condition for the same classes.

Estimation Of Live Weight Of Cattle

Adult cattle

Table 3 presents the results of the comparative estimation of the mean weights of adult cattle in the two plains and during the two data collection periods. Statistical analysis ANOVA followed by Fisher's test at the level of p <0.01 to 95% confidence interval shows that between cattle from a natural plain (163.0 ± 21.2 kg) and those from the anthropogenic plain (149.1 ± 12.3 kg), there is a significant difference in the estimated average weights of adult cattle in May. At the same sites over time, there is no significant difference.

Table 3: Estimation of the mean weight of adult cattle

	Mean weight (kg)	
Period	**Anthropogenic plain**	**Natural plain**
November (n=15/plain)	$157,0 \pm 16,6^{ab}$	$158,9 \pm 24,8^{a}$
May (n = 15/plain)	$149,1 \pm 12,3^{b}$	$163,0 \pm 21,2^{a}$

Juvenile cattle

Table 4 presents the results of the estimation of mean weight of young cattle under two years old at the two sites. From the ANOVA analysis of variances followed by the Fisher test, at the threshold of p <0.01 to 95% confidence interval, it emerges that compared to time, there is a significant difference in the mean weights of young cattle from the natural plain in May (104.1 ± 16.8 kg) compared to the least of November (92.5 ± 24.0 kg). However, compared to the sites, there is no significant difference between the live weight of the cattle for the same period.

Table 4: Estimation of the average weight of juvenile cattle

	Mean weight (kg)	
Period	**Anthropogenic plain**	**Natural plain**
November (n=15/plaine)	$86,1 \pm 17,4^{bc}$	$92,5 \pm 24,0^{c}$
May (n = 15/plaine)	$98,7 \pm 16,4^{ab}$	$104,1 \pm 16,8^{a}$

DISCUSSIONS

Zoo technical performance of cattle

The average size of the calves in the various herds observed during this study did not show any significant difference either with respect to time or with respect to space. This is because cows perform at peak reproductive performance when all of their maintenance and production needs are met. This is due to a diet which represents more than 70% of investments in breeding (Si, 2007). So, feed is the determining factor for zoo technical performance in breeding. Taking into account the gestation period in cows which is 280 days, i.e. 9 months and 10 days (Foyet, 2005, modified from Gayrard), therefore the calves observed in November were born from cows which were fertilized at least before February, corresponding to the period when the cows have met all the needs (maintenance and reproduction) and the availability of pasture in these plains begins to fall. Those observed in May come from cows fertilized at least before August, corresponding to the period when the plains are flooded and at the end of the crossing of the period of famine (Scholte, 2007; Moritz, 2005). Knowing that the herds are driven to the plains in pure extensive mode, all maintenance and production needs depend on the availability of natural pasture. The latter also depends entirely on the rainfall and the re growth capacity of the plant cover after passage of bush fires considered according to Rippstein *et al.,* (2000) as a factor of conservation and management of savannas. Thus, these insignificant differences between the average number of calves in herds at the sites over time would be related to the almost identical nature (Scholte, 2007, Moritz, 2005) of the floodplains. Indeed, during the recession in early September, unexploited fodder during the entire flood period is available in quantity. This would therefore cover the maintenance and production needs of the cows and allow them to reproduce. These plains are characterized by the same climatic hazards, hence, not significant differences between sites. The average calving rate of the observed herds does not show any significant difference between the two (02) sites with respect to time.
Indeed, this non-significant difference is linked to the similar nature of floodplains (Scholte, 2007; Moritz, 2005). However, in the natural plain, there is a significant difference between the farrowing observations of November (15.4%) and those of May (3.1%). This difference would be linked to the quality of pastoral resources (fodder and watering water) in November. In fact, farrowing in November correspond to gestations during the period of availability of fodder in the rainy season, while those in May correspond to gestations during the period of extreme drought in the plains of the Far North of Cameroon. As for the mortality rates of cattle, they are relatively high in the natural plain than in the anthropogenic plain (5.1% and 2.2% against 2.9% and 0.6% respectively in November and May), although 'there is no significant difference for the same observation periods between the sites. According to the shepherds surveyed, there is a high calf mortality when the plains are flooded, corresponding to the period of November. This statement seems to explain the high calving rate in November and the non-significant difference in the mean size of the calves observed in the two sites compared to the observation periods. In addition, the shepherds surveyed in these localities claim that the permanent availability of water would help improve the quality of pasture even in the dry season. This would therefore ensure the availability of fodder essential to meet the needs of the animals.

Cattle Body Condition Score

In November, we note that the cattle of the natural plain presented a better general condition of the herds (0.1%; 0.7% and 3.5% respectively G +; G and G-) and less lean animals (2.4% m and 8.1% M +) compared to cattle from the anthropogenic plain (only 2.4% G-; 4.9% M and 13.7% M +). Given that the plains present the same physical aspects during recession (Scholte, 2007; Moritz, 2005), a period corresponding to the abundant availability and optimal exploitation of fodder by livestock and that the biomass is high with a good concentration of nitrogen between 0.38 and 0.74%, in addition to the availability of drinking water in ponds (Scholte, 2007). This difference observed in relation to the body condition of cattle in the natural plain is linked either to the specific characteristics of the animals or to the quality of forage during this period. However, in March, we observe that there is an inversion of the BCS of the herds concerning lean cattle: 1.5% of M- and 15.0% of M in the natural plain against 0.3% of M- and 9.8% M in the anthropogenic plain. This observed difference is linked to the availability of permanent water in the routes of the anthropogenic plain. Indeed, the month of March corresponds to the period of extreme heat when most of the routes are degraded and overgrazed, the various water points dry up and watering requires great mobility towards the bed of the Log one River. So water would be the determining factor for successful breeding in these flood plains. In May, it is observed that the animals in the two sites show the same trends for the same BCS. The month of May corresponds to the start of the rainy season in this part of the Region, we see that the evolution of the body condition score of the different herds is almost identical for the two sites, which would correspond to the general state of animals in the Sahel after crossing the famine period. Indeed, this period corresponds to the end of the dry season

when the rangelands are totally degraded on the one hand, and in the other hand the beginning of the rainy season is likely to cause the development of parasitic germs due to the humidity. Depending on the weather, the further we advance in the dry season, the more the fodder resources are degraded. This leads to the loss of their energy value, and the fodder is no longer a stuffer, which would be at the origin of the deterioration of the body condition score of the herds. In short, from November until May, there is a deterioration in body condition with each setting of parameters regardless of the plain. The animals store reserves in the muscles in November (observation of fatty animals in herds), reserves which will be used during the period of scarcity in March when the fodder resources are almost degraded and no longer contain important nutritional values.

Variation in the live weight of cattle

The estimated average weight of adult cattle from the pilot herds in the natural plain (163.0 ± 21.2 kg) shows a significant difference compared to that of cattle from the anthropogenic plain (149.1 ± 12.3 kg) for the period of May. Indeed, in May, pastoral resources are scarce in the Far North flood plains. This observed difference would be linked to the quality of the fodder from the natural plain. According to the shepherds who have experienced the two sites, the pastures of the natural plain are better than those of the anthropogenic plain except that they are not available all year round in sufficient quantity. However, there is no significant difference between the average weights of juvenile cattle between the two plains with respect to time, we observe that they are clearly higher in the natural plain (92.5 ± 24.0 kg and 104.1 ± 16.8 kg) compared to those of the anthropogenic plain (86.1 ± 17.4 kg and 98.7 ± 16.4 kg) respectively in November and May. In short, depending on the weather, the natural plain turns out to be the best route for cattle in global comparison compared to that of the anthropogenic plain. Only the permanent availability of drinking water during the dry season (March) would limit the development of performances expression in cattle. This seems to confirm the words of the shepherds surveyed. In addition, the re growth of the plant cover at the start of the rainy season (May) after the passage of bush fires on unused ranges would be of better quality. This passage of bush fires would reduce the parasitic load capacity of this area. Therefore, would explain a better weight gain in these adult cattle of the natural plain.

CONCLUSION

This work aimed to contribute to the comparative characterization of pastoral production systems in the anthropogenic plain of Lake Maga or "Ndiyam Shinwa" and the natural plain of Waza-Logone or "Yaéré" in order to understand the reasons for the drastic decline of pastoral production in the plains of the Far North Cameroon. It emerges from this study that in general, the herds of transhumant pastoralists consist of around one hundred head of cattle, which can easily be managed by a single shepherd. The no significant differences between the various parameters evaluated of pastoral performance of the cattle in the two sites would be related to the similar characteristics of these plains. The significant prolificacy observed in November would be linked to the quantity of fodder available, while in May this difference would be linked to the quality of the fodder. The natural plain would have better forages compared to those of the anthropogenic plain. The significant presence of lean animals in the anthropogenic plain in November, - a period when fodder is available in large quantities -, concerning the cattle from the natural plain, shows that the fodder of the latter would be of better quality. However, in March, a period when water for watering livestock is scarce in the natural plain, the deterioration of the general condition of the cattle compared to those of the anthropogenic plain shows that the scarcity of water would limit cattle production. The assessment of the average live weights from barymetric measurements shows that the pastoral resources of the natural plain are of better quality.

Acknowledgments

The realization of this work was possible to collaboration of herds on the two plains.

Authors' contributions

This study was carried out with contributions to each author. **DA** contributed to concept and design of study, acquisition, analysis and interpretation of data, drafting and revising the article; **ZMJ** contributed drafting and revising the article; **ZR** contributed to concept of study; **VNRRB** contributed design of study and acquisition of data; **SK** contributed acquisition of data via CARPA and **FHS** contributed to scientific supervision of study in ISS.

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