EXPERIMENTAL DIET FORMULATIONS FOR BLACK RHINOCEROS

Bill Sadler

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Sadler: What I would like to do is go over very briefly the study we have been conducting at Fossil Rim. I will give you a little up front reasoning of where we started and what levels we chose, and what the philosophy of the diet was all about. The first issue that became sort of clear from the very beginning was that we have always had trouble with this, and balancing calcium/phosphorous ratio in alfalfa based diets has always been a challenge because there is a tremendous amount of calcium in comparison to the phosphorous. The other issue that we got into very quickly was that in a lot of the herbivore based diets that we produce for zoological animals we look at total phosphorous, we do not look at available phosphorous. Although we do not have any immediate proof of that, we do certainly know in monogastric animals, that a horse is sort of sitting in-between here on how much phosphorous they can use from phytate. For all of you that do not know what phytate is, phytate is just a complex carbohydrate that binds phosphorous. In a ruminant, the microbes breakdown the phytate and phosphorous becomes available, and everybody is happy. But in the monogastric, like a chicken, that is a real problem. It can not do that, and it can go phosphorous deficient. We know in horses that they use some phytate phosphorous, but we know their entire source can not come from phytate phosphorous. Therefore the diets have always been blended. So in this case we were very interested in maintaining a ratio, or trying to get as close to a ratio as we could of calcium to available phosphorous, the ideal is 2.2:1. We are looking at a range of 1.5 to 2.5. We have not actually achieved that as close as we wanted, but I will show you some numbers in a minute.

The other area that we wanted to follow on, and a few more points that I would like to add, was this issue of browse versus graze type animals. We have done a lot of reading of what *Hoffman* has presented for wild ruminants, and dealing with what he calls concentrate selectors versus roughage grass eaters. That may be actually better terms at times than browsers and grazers, because the concentrate selector gives the terms we have all heard from everyone today that these animals go around and selectively pick out pieces.

But what does that mean in a diet? Well, to us what that meant in a diet was very clearly what Ellen [Dierenfeld] has already brought out, is that these animals to us do not handle starch very well. They have generally poor mechanisms to deal with starch. We know this is true in wild ruminants, and we tend to notice it a bit in horses as well. So what my first intent was, was to get rid of most of the starch. From a microbiology standpoint, I will not bore you with 274 volumes of 275, but the basic point is that when starch is digested it produces high amounts of acid. Acid kills cellulytics. Cellulytics are what we want to grow, and therefore we are sort of in competition. If any situation develops where starch is rapidly digested, we could really kill cellulytics; which further complexes the problem, the animals can not process the fiber

that we are giving them. Another thing that we know about cellulytics in general, is that they live extremely well on simple sugars. So what Ellen [Dierenfeld] was showing in some of the data, and what was very interesting to me, is that the cellulytics live very well on simple sugars, and that is what they are trying *to leach from* cellulose. So part of our concept in the new diet was to get rid of the starch, bring in our simple carbohydrate energy from sugars, molasses and things like that. And again, like Ellen [Dierenfeld] has mentioned is very true, our goal is to try and mimic and get as close as we can. We will never be able to harvest individual browse plants and grind them up and make a pellet out of them. Our goal is to match the nutrients and then try and do as much as we can with form and availability.

The other issue was fiber. We wanted to provide a very high level of digestible fiber with some insoluble fiber. We know these animals eat a tremendous amount of browse, and as Ellen [Dierenfeld] described 290 two inches or three or four centimeters around will break through. So we wanted to give some of the bulk of the diet as well. So those became the original concepts of browse versus graze.

The other issue was the skin ulcers. We felt that vitamin E programmed into the, included... I am not going to spend a lot of time on antioxidants, because you have a gentleman here that knows a lot more about them than I do. But, we certainly wanted to provide a reasonable level of vitamin E. We were particularly interested in providing the correct amount of essential fatty acids in the diet as well. So we began to look at some of the oils that we could add that could provide that at the same time.

The other situation was some yeast. Yeast has always sort of been a magical ingredient to nutritionist. It has lots of goodies in it that we do not quite always understand. At the same time we also knew that Fossil Rim was providing yeast to the animals, so we went ahead and included some at that time.

So that gives you an idea of where we were trying to go with the diet.

Blumer: These things were in response to some changes we were trying to make in the diet following the mortalities, and trying to address some of the problems that we were seeing in those particular sick animals. A lot of them were done before we got involved with Bill [Sadler], and then further refined in this program.

Sadler: I want to comment that you can pick up pieces. We knew Eric's [Miller] concern, we knew about the hypophosphate problem that had developed. We were trying to tackle a variety of things at one time. So that was part of where some of the logic came from. We were looking at the problems as nutritionist, not as pathologists or veterinarians; so maybe attacking it in a little bit different area.

Just a brief summary... In May 1992, I hope I have got my dates right, the particular shipment arrived in the United States. In August of 1992 the experimental feeding began. There was a slow conversion from a typical ADF-16 type diet, which I assume most of you are familiar with, to a *Missouri* back rhino diet that was formulated under the reasons and the type that I just described to you.

We began to do some palatability testing, and ran into some refusal of the diet. Some of the issues that we began to look at was first of all a magnesium level that may have been viewed to be too high. We

had incorporated some magnesium oxide into the diet. If you are not familiar with magnesium oxide, it is incredibly unpalatable, at least in most herbivores. We thought that was perhaps one of the problems, so it was removed. Yeast was taken a look at, and eventually the aspen chips that we used, and the fiber as well. Each time we removed one of those or manipulated it, we seemed to get to a little better palatability. So in April 1993, palatability issues seemed to be resolved and we began working on one particular product at that point in time. Now, the philosophy of what we were trying to do never really changed. All we did by removing one of these, is that we solved it by another source. When we lost aspen chips we brought in a different high cellulose containing ingredient so that we would not lose the concept of what we were going with browse. We just could not use that particular ingredient it seemed at this time.

Historically, that is very interesting, because this trail really goes back may years ago. I should have mentioned it at the beginning. Richard [Kock?] had commented in one of your articles that he had recommended the SDS Browsing diet. We are a sister company to SDS in England and have that very formulation. Actually where we started was, was with the browse diet that had been used very successfully in England and in parts of Europe. So we do not know if we have an "n" value here of two animals that are throwing us off, or whether we have got something with slightly different ingredients. But, there is a historical trail that actually goes back then 12 years in what has been used.

To give you an idea where we ended up... This is sort of the total nutrient intake of the animals as we are now calculating it to be. Roughly a 15% protein, 21% crude fiber; I am with Ellen [Dierenfeld], I do not get a lot of interest in crude fiber, other than pig regulators ask us to put on all our tags, so we just sort of 348 calculating it and doing it. More important is the NDF level of ADF, which refers to the hemicellulose and cellulose and lignin type fractions in the fiber. We ran a little higher fat diet, not as high as actually some that Ellen [Dierenfeld] showed. I was not actually aware of that. We may have more opportunities in that area that we did not think about. We thought that we were adding as much as maybe we would normally do to herbivore diets. Of course the key was that we added some linoleic acid. As you can see, both animals are getting a fair level of that.

Bolin: What is TPGS?

Sadler: OK, if you give me to the next overhead, it will make a lot more sense. This gives you our calcium intake and phosphorous. As you can see, our ratio of calcium to phosphorous is good in the sense of total and our calcium to available phosphorous is improved. If you take a standard ADF-16 type diet, or a standard herbivore diet, what you will end up with is about a 4 to 5 there, instead of a 3.4 or 2.8. So we had made some significant improvements in the amount of available phosphorous to calcium. But, we were not able to get it quite as low as we wanted.

TPGS is a water soluble form of vitamin E that is produced. It has had some good success in elephants in raising the blood levels of vitamin E, so this was provided as one of the forms of vitamin E in this particular trial. That gives you the IU's per kilogram of the diet that was provided. We calculated it out

I think for an 1100 kilogram rhino, and it came up to 2.6 IU/kg. I think Ellen, you have an article that somewhere between 2.0 and 2.5, or 2.6 or something, so we are very much in that ball game in 376.

Dierenfeld: Per kilogram body mass per day.

Sadler: Yes, that is per diet, I used per kilogram of diet.

Kenny?: How did you give it to them?

Sadler: It is a liquid material, and it is just poured on top.

Blumer: It is squirted on the alfalfa with a syringe.

Sadler: They readily consume it, it has a touch of alcohol in it. Then vitamin A, and we have talked a little bit about that.

Stuart: Could you elaborate a little bit on the form of vitamins A and E? Other levels they have had...

Sadler: Vitamin E is provided at the level of 25 IU's and then there is some acetate *DL4* in the diet as a standard amount.

Stuart: Is that 387 *acid*?

Sadler: Right, it came from the standard herbivore type diet. We did not convert all of it out. We have done elephant trials where we have taken all of the [vitamin] E out, but in this particular case, do to the sort of the emergency or the crisis of the situation we were not ready to run the gamble and yank it all, so we left the acetate.

Stuart: And your [vitamin] A level, is that supplemental?

Sadler: That is supplemental added to the diet as acetate. Intakes, there are going to be two of these, one for the male and one for the female. We will go over them very quickly. You need to know that the week of 6-6 is the week we knocked the animal down to take the blood samples. We had seen this before, obviously they are not fed to get them ready for the knockdown and then they come back. Where we are right now is they are basically consuming about what we are feeding them. The goal of this was to provide about 50/50 cube/hay. So very closely, they were eating around 20 lb. of cubes and 20 lb. of alfalfa, so that was what the goal was a day. Twenty pounds of cubes which would be roughly nine kilos, and about nine kilos of hay. That is where we had formulated with the alfalfa.

Blyde: *That is a lot for* one rhino.

Morkel: If you put it in terms of the fiber content.

Sadler: Right, you have got to remember, these are not high concentrate dairy type products, these are high fiber. These are diets that contain a tremendous amount of fermentable and soluble carbohydrate. We are trying to match some of the browse that has been missed.

Dierenfeld: I think in the field it was 30 kilo per day of total browse. If that is 50% water, that is 15 kilos per day per rhino which would be roughly similar to this.

Sadler: So do not think of this as a traditional dairy high grain type diet. This is a very high roughage or high fiber based diet to try and mimic some of the characteristics of browse.

Tolt: How are you feeding it in the morning or evening?

Blumer: We are feeding just in the evening. We have tried a number of different scenarios. But what we have ended up with is that if we gave them anything more than the evening, it just sat. So right now they get fed at about 4 PM, and they come in and eat over the course of the evening. At one point we were trying to feed them some alfalfa or some grass hays in the morning; but certainly in the earlier stages when we were dealing with palatability problems, they were filling up on that stuff and not going for the cubes. We have been trying through all of this to work out a system where they eat about equal amounts of... We are trying to cut down on the amount of alfalfa because of the calcium/phosphorus problems. So it is all being formulated based on equal mass of alfalfa and cubes.

Sadler: This is the female, a very similar pattern. She is a bit fussier about her diet and she has been from the word go when we started this whole program. Again, we may have an animal situation here. I did not score the animals. I am glad I saw that number. I would like to ask Evan [Blumer]. I would score that the animal condition of these two rhinos is relatively good. I do not know where you would put them. I would sort of say in that "4" range.

Blumer: I would say about "4." They are definitely not big and rounded, but they are in good shape.

Sadler: Good condition. We also may be running into situations where we are not sure what they should be eating. We saw on Ellen's [Dierenfeld] data that 1.1% body weight to 2.5%. We certainly are very comfortable with this ballpark, even on some of these dips in days we are certainly staying in those kinds of ranges on consumption.

We have done two samplings of the animals since the beginning of the trial. 8-21 is the beginning, and before the trial really got started at all, so even up through the palatability issues. As you see, the vitamin E levels, this was the female, have basically remained very much the same, and have stayed around that 0.8. We just saw Ellen's [Dierenfeld] report of 0.8 for one area down to 0.2, but I guess we are on the upper end. On the male, I do not know if the 2.1 is real, or why it is that high. That is one of the higher vitamin E levels I have seen in a black rhino. I guess I have not had a chance to visit with Ellen [Dierenfeld] about all our data. That would be one of the higher I would assume that your lab has seen as well.

Dierenfeld: For the 2.1?

Sadler: Yes, given your ranges.

Dierenfeld: We actually got 1% *average* higher.

Sadler: OK, but it is certainly on the high end. It looks like we have been able to stabilize it for nearly 10 months at around 1.3 for them.

This is the vitamin A issue we have been talking about earlier that was brought up. It looks like we started off about the same and stayed there. It does not look like there is any change. It does not look like their diet had any effect on that. Though I certainly do not know if on 8-21 if that is "normal" or not. But, it looks like right now there is not any change.

Munson: I do not know if I missed something, but why are you just looking at vitamin A and [vitamin] E, and not B vitamins and all the others?

Dierenfeld: Technical measurements. The difficulty of measurement.

Munson: Your assumption than is that for instance, all the B vitamins are normal level in the material you are putting into the feed?

Sadler: The diet is certainly formulated to carry a level of B vitamins that has been shown to be at least quite adequate for horses and other herbivores.

Munson: And the processing of it, or anything like that, does not effect them?

Sadler: Does not seem to be. Those are all good questions, but we do not really probably know. Everything seems to be reasonable and then the technical difficulty in analysis are just tough on those vitamins.

Blumer: As you may remember, when we first started dealing with skin lesions, one of the many different anecdotal things that you referred to me was that increasing the B vitamins was a way to deal with that, and Brewer's yeast was a reasonable way to consider getting those in. I do not know if you told me that, or if somebody else did.

Munson: Yes, it was coming out of the Netherlands with the recommendation that this might be associated with biotin and there have been some similar lesions with pellagra.

Blumer: That is why we started feeding the brewer's yeast and then when they told me that they had this diet, they tried to match that, and that ended up being one of the factors that decreased palatability. When they began to look at it, we were so far above requirements for horses at least, with the added brewer's yeast, we backed way down to without the brewer's yeast.

Munson: I do not blame them--have you ever had brewer's yeast?

Smith: Your irons are going up and down, what is the answer to that?

Sadler: No, I do not have an answer, but we certainly have talked about iron a lot in the issues of hemoglobin, so that was certainly one of the minerals we wanted to track. Yes, we have one going up and one going down. I have no knowledge of what that means other than... That is why we are tracking it, so we can try and stabilize it.

Munson: Are those significant differences, those probably are not too significant are they?

Sadler: With two animals and one data point we do not really know until we get more data. I can not even say that, you are right.

Smith: You usually do not see iron moving around that much.

Munson: You consider that a lot of movement?

Smith: Well, you are talking about a 50% change in iron. I do not measure in iron ppm. I take it was done with *atomic* 513. So I have a hard time figuring out what these numbers are.

Dierenfeld: Is there any hemolysis in any of these samples?

Sadler: Not that I am aware of. Evan was there when we pulled them. Are you aware of any hemolysis or any problems in sample taking? I do not think so.

Blumer: Not to my knowledge.

Sadler: I think it was spun down and looked very good from what I understood.

Blumer: I would have to go back and look, but I do not remember anything.

Smith: How were they handled? You have to watch how you handle iron samples. You can get a lot of contamination real easy. Vacutainers are OK, but if you put it into any other glass, use glass pipettes, or something like that...

Blumer: We take all of our samples directly in a vacutainer.

Smith: Then spin them down and then what...

Blumer: Spin them down, and it varies a little bit. We are not quite as far out of things as these guys are out in the bush in Zimbabwe, but we are a bit removed from civilization. It is a little hard to get some of these things dealt with in an appropriate basis.

Sadler: That is a good thing to track. If there is a glass transfer that we are missing, we may have made a...

Smith: The easiest way is to use all plastic that you have not used before. If you do not have access to that, the easiest thing to do is spin it down and tip it into another red top vacutainer. That way you will not contaminate it.

Sadler: I thought they were going into plastic. I will check on that and to make sure.

Blumer: I think anything frozen is going into plastic. We are using plastic pipettes.

Smith: It may not be the source, but it is one of the places you can look for it.

Blumer: If you can give me some specific concerns or recommendations, we can certainly change it. We are gong to be doing these animals again in about ten days.

Bolin: This is total iron, right?

Sadler: Yes.

Bolin: So free iron is what you worry about isn't it?

Smith: Well, under these kind of conditions there is probably not any free iron, it is all bound to transferrin. In most species you have about twice as much iron binding capacity as tied up, but there are exceptions to that. But, I do not think under these conditions you have got that at all.

Sadler: Linoleic acid seemed to be staying fairly stable. Again, I do not know what the black rhino blood value is to be, but compared to other animals it looks to be fairly decent.

Calcium and phosphorus are both tracking extremely well against... I was scratching down notes from some of the stuff that Ellen [Dierenfeld] was showing and writing down numbers whenever I saw blood values put up on the screen. These certainly match very closely to what you would get from horses. There is no doubt about that. They track right along with what we routinely see in numbers of bleedings. In our company we have got hundreds and hundreds of samples of horse blood profiles on healthy animals. These appear to be reasonable to what they are doing.

Tolt: That is very close to the free-ranging ones.

Sadler: It is? So they look to be staying up. Of course, as I said, what we are attempting to do was to provide the opportunity of more available phosphorus, given all of the concerns for phosphorus and not providing it all in phytate. There is a solution for the animal if it is all in phytate, and that is coprophagy. But we are not sure in captive situations or in zoos where dung and that is removed very quickly or hosed down and the animal is maintained in a very clean environment, whether that is a very good source. I think at Fossil Rim, if they chose to, they could probably have access to the dung out at pasture, but in other situations that would not be the case that we were trying to 580 extremely closely.

That is pretty much where the results stand. As I said, the study is very much ongoing, very sort of occurrent to the world. This is sort of a basic diet. The supplement that we are providing is low protein because we are balancing that against alfalfa which is very high, so that is where we chose that level. It just gives you an amino acid profile. Fat is around 4.4 oleic to over 2.3 *route* is what we are targeting and that gives you an idea. You were talking about the amount of fiber, we are looking at nearly 42% of the diet is NDF, so there is a very high amount of fermentable carbohydrate in the diet. It is very high mineral, which was not the choice, but when you bring in a lot of fiber that sort of comes with the territory, at least in most cases. Selenium is around 0.67. And you can go through the rest of the vitamins if you have any questions. In fact, with B vitamins, there is a pretty good compliment of all the soluble and water soluble vitamins available, other than probably ascorbic acid, the [vitamin] C which of course in *most occasions* is not needed by these animals.

Smith: Were you adding any iron to this, as ferrous sulfate or anything?

Sadler: I am going to have to actually check, there should be a low level in the mineral mix of iron. Generally that will calculate out... A raw diet will give you about 190 ppm to around 200 ppm in an iron deficient diet with natural ingredients. That is about as low as you can do without going to purifieds and about 140 ppm is what is being added. I am pretty sure it is ferrous sulfate, not oxide.

There is a pretty good zinc level. Sodium up around 0.35. Ellen, I was interested in that and it looks to be around the point where your range numbers came in on horse requirements. Any questions? The study is to continue and we are sampling in ten days.

Kenny: How will you know if you have a better diet if the parameters you are tracking are pretty much the same other than the iron, from the diet before?

Sadler: How are we doing to know if we were successful or not? That was the challenge from the word go. We fed this diet for ten years and they lived happily and produced a baby every two years and everything was great. But, we still know that we were right *it is going to be chance*. We do not know in all cases. We are tracking other things like stool condition, body scoring, and trying to watch everything we can. But you are right, there is no definitive answer at the end on any of the diet, if it will solve all the problems without just historically going through it. We are trying to track all the key parameters that we know, and trying to say does it continue to keep them up and does it maintain the animals? You are right, there is no way to prove... Without doing weight gain or something magical to say they are gaining weight and looking good, rather than a production trial, there is no way to make any diet and prove that it is better than another one. Maybe that is the inherent problem with nutrition at the end of the day. We think we have incorporated concepts though, that are more matching to what we are trying to do. That is perhaps a better way to put it.

Blyde: How much is it going to cost?

Sadler: Right now, when we started with Fossil Rim, the price of the product was for the test, and was built to be no different than their current feeding costs. What ever differences there are, we are absorbing. This is a slightly higher diet than grain diet, because we are bringing in energy from sources that are not traditional. We are taking corn and cereal grains out which are relatively low in cost, and adding things like sugar and that which are fairly high in cost. So there is some trade off, but right now it is not dramatic, 10% to 15% higher than what a traditional herbivore diet would cost today, is what it is looking like.

Blyde: It is not going to go as far is it, if you are feeding 20 kg per day?

Sadler: That is again where we started. Part of this is a nutritional study.

END TAPE 6A BEGIN TAPE 6B

R. Kock: Can I just make a comment about this. How have you picked the *DMI* compared to the old diet? How much more does rhino...

Sadler: It is about the same right now.

R. Kock: It is about the same as the original diet?

Sadler: Right, and what we kicked out is we basically have taken out the starch, grain and cereal sources and replaced them with either fermentable fiber or simple sugars to provide the energy, which is the concept of what the browsing diets were built in Europe originally, the same concept of 006.

R. Kock: I think this business about cost in the diet, when it comes to rhinos, look at the value of the individual. If anything, I do not think it is relevant. If animals die of nutritional problems, then we need to find solutions, but then it may take more money to pay for it.

Dierenfeld: Is there any magic to aspen as opposed to the other browses that are being fed naturally?

Sadler: The whole reason of choosing aspen in the very beginning, was to provide a high amount of insoluble fiber in a form. I mean you can provide aspen in a flour, you can provide aspen as a chip. We had chosen in these diets to always make it a chip. We were trying to give it some physical stasis in the gut, as well as what it brought nutritionally. I do not know if there is anything magical about it. We have had good success with it in things like moose, and dik dik and gerenuk in some areas where we have fed it. We have always had good feelings about it, but when we ran into a bit of a palatability challenge with it, we were very comfortable to move to other high fiber sources.

Dierenfeld: The point I am getting at is that you could probably use locally available browses and things that are manufactured locally.

Blyde: Oh, I am not really tight!

Tolt: Just something I would value your opinion on, and others... At one point in Zimbabwe, with our boma rhinos, we were adding peanut hulls/husks with the cubes. The rhinos actually liked it. What do you think of that?

Sadler: We like peanut hulls. We use peanut hulls in horse diets. The challenge we have with peanut hulls, this is what Evan [Blumer] alluded to a little earlier, is that in our country and I assume in yours, peanut hulls are just an absolutely excellent source for aflatoxin--just love it to death. When you measure them, you can find it almost day in and day out. Our challenge has been what to do about now introducing a low level of aflatoxin in the diet. We are not talking about adding 1% or 2% of the diet. We are talking about adding 15%, 20%, maybe 39%, particularly in a cube. That ends up being a lot of ppm of aflatoxin potentially, and that is where our scare eventuated.

The other thing is cottonseed hulls and cottonseed meal. Cottonseed hulls have tremendous good digestibility in ruminants. And with 032 we are left with raw cottonmeal left in the hull which is an aflatoxin issue and a gossypol issue, which causes hemolytic anemia in animals. Again, we felt that those were not prudent decisions given the crisis that we are at. With a stable population and lots of animals being produced, trying to deal with cost and trying to grow a population, you might experiment out of it with some other choices. But, right now it is just those two that scared us a bit. But they love them.

Tolt: We only used them for a short while.

Sadler: But, that was our problem with them. Nutrition wise and fiber source wise, I have no trouble with them.

Stuart: We have had negative 039 as a fiber source, because once you pellet that peanut hull, the scratch factor as we use in ruminants is diminished dramatically.

Sadler: Yes, it is a grind issue. And we have got ways in our mills to keep the grinding a little better than what you get when you take them down to a smaller pellet. There are some things you can do there.

Morkel: We have tried with this phosphorus problem to use *leaf* blocks high in phosphorus. What is your opinion on that?

Sadler: Would these be the salt based or the molasses based?

Morkel: Salt blocks.

Sadler: In general I would have no trouble. That should be phosphorus, basically Dical, I am assuming. I do not know, it could be *monomodium* phosphate or something like that. The challenge with Dical is there is two parts calcium. You get into this ratio problem again. Dical is not the best balance of calcium/phosphorous either; so you are also taking in probably a lot of calcium. But I am saying that without seeing the ingredient composition on your particular product. In general, I think it is probably OK as long as you are aware of what additional calcium is coming in at the same time. I am not saying this is a *wreck* or anything, but it still leaves you with some additional calcium to deal with in the diet as well. Ellen [Dierenfeld] has shown that these guys eat a lot of calcium and do fine. So our concern may not be founded. We may be worrying about something we should not be worried about.

Foose: What do you think as alternatives for the aspen chips?

Sadler: We went to a base of soybean hulls, which is almost pure cellulose, beet pulp; we also added I believe in this case, I have to 056 it out 056, just to get to the real digestible part of the diet.

Foose: What is your lignin content?

Dierenfeld: It is not on there.

Sadler: I would have to calculate it out. It is fairly high, it is a pretty decent level. I do not know off the bat. Concern?

Foose: No, just curious.

Sadler: We looked at it when we formulated the whole profile, but I do not remember where it has ended up with the changes.

Foose: I think it would be very different perhaps with the ingredients that you are using now, than it would be with the aspen.

Sadler: That is part of why the rice went in, it adds a lot more lignin back. That was part of the reason to do a blend. We could not add just soy. Soyas would only add cellulose fraction or 063, so we added some indigestible ones as well to take a look at. So we did not stay as tight on the lignin as we would do with the aspen. We did make some changes, but hopefully not dramatic as far as taking them out.

Tolt: How are these cubes presented?

Sadler: It is part of an oval, about as big around as my thumb type shape. We like that shape, because whatever scratch factor, what we were talking about with Rob [Stuart], whatever structural fiber we have got in there we do not want to lose.

Blumer: We tried smaller and they did not eat it as well.

Sadler: Right, and we would lose some of the fiber. It is the kind of milling where they grind the feed through the pellet meal, which is really expensive and dumb. *When you do you can make it too little.* We did not want to lose that value in a big animal like a rhino. The same ingredients in different size animals have dramatically different passage rates, because of the orifice openings of these animals. What you feed to a dik dik, and what you feed to a rhino, you might change the particle size. You might use the same ingredient, you may use a different ingredient, or the ingredient may have a different value. Dehydrated alfalfa may have a much better retention and fiber value with a small animal because of orifice and particle passage, where in a rhino it probably would move at a different rate. So we try to take care of that. There have been lots of studies on sheep on that.

Blumer: I would like to make two brief comments on that. One, a lot of the reason that we went off on this project was because we analyzed the diets that we were feeding that were provided to us by what we felt were reliable manufacturers for zoo diets in this country. Those diets did not have in them what we thought was in them, and they had things in them that we were not expecting to find in them. So there was a lot of concern. We talked to those individuals, and certainly there is a lot of controversy as to whether they say it is not there; and we have taken kind of a forensics approach to it and say that the stuff is in there. So that is a lot of... The impedance was not that... I mean *Dave's comment* is very good. We are going through a lot of work, if we are no better off what is the point? But initially there were some things that really scared us in what we saw in our diet. The other thing is, there has been for at least one of the animals, a tremendous improvement in stool quality as compared to animals in the bomas or free-ranging animals that are eating more browse. These fecals are much coarser, they are less "cow pie" body, then we often see in rhinos in zoos. The other one is the male that has had an intermittent diarrhea since the day he arrived that he has not resolved with this diet. But he is in excellent condition, and 094 a reason for it, so we will just call it stress.

Sadler: My last comment would be that our approach is that these are a browse type animal. We have had good success in some other browse type animals with this dietary concept, where we have got good measurements and where animals were clearly going downhill, then suddenly they were healed pretty quick that are still walking on the earth and with us. So even though in some cases those were ruminants, we felt the same concept potentially had value in trying to develop a black rhino diet. This may have input even into a white rhino diet. Even though it is a grazer, it may have similar characteristics and things we want to look at as well. So that is where we are. If at the end of the day, if you are all right, there will be a very subtle reason why it works a little better than something else. We are very nervous about starch though. We have seen too many cases where starch and wild animals when they get scared and excited, clearly set off fermentations in the gut. An acidotic type condition can really throw them off deep and can be very difficult to come back from.

Morkel: On that note, a picture which we have seen a number of times, and I know it has also been seen in Zimbabwe and Kenya, you catch and have an animal which has been injured, burned or whatever, usually in poor neck. You put it in the boma, you have to try and get it through the crisis. It eats well for a day or two *and then usually of course*, it runs out of puff, and down it goes and you put in a drip for a day or whatever, and it usually does not make it. We are looking for something... The problem is that it is a free-ranging animal and in that day or two you are certainly not going to get it on to cubes. You want to get some energy quickly into that system. What we were thinking of using before was a wheat gruel of commeal or something like that. From what you have said, that would probably not be the way to go, rather you could go for either corn syrup...

Sadler: Molasses, corn syrup.

Dierenfeld: Soluble sugars in there. You want to put some five carbon sugars. You have to get ribose and pentose sugars into it. Pectins, what you would normally use for diarrhea, that kind that can break down.

Morkel: What is a bit more available for us?

Tolt: Sugarcane.

Morkel: That would be excellent, there is not a single piece of sugarcane in Namibia!

Sadler: Let us look at this, we may not solve this now. Let's you and I talk, because what maybe we can offer to the group, is we do have a good library as a company of ingredients. If you can tell me what is available, maybe we can figure out of which ones those are, at least the best choices or what you might be able to bring in at not a high cost to be able to increase their value. But no, starch is scarce in these particular type of animals.

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