

## Can next generation assisted reproductive technologies enhance livestock productivity and farm income in India? | Transcript | CIRCLE

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This is a text transcript for the event “Can next generation assisted reproductive technologies enhance livestock productivity and farm income in India?” presented by the Canada India Research Centre for Learning and Engagement (CIRCLE) at the University of Guelph. The event was recorded on February 10, 2021. Dr. Pavneesh Madan moderated the event. The guest speakers were Dr. Manmohan S. Chauhan, Dr. Inderjeet Singh, and Dr. W. Allan King.

Transcript:

**Dr. Pavneesh Madan:**

Okay, let's get started in the interest of time. Welcome, everyone today is the 13th seminar of our program which has been sponsored and conducted by CIRCLE, and I'll introduce CIRCLE in a second. What does CIRCLE mean? It might have a different meaning in everyone's mind, but today's seminar is: Can next generation assisted reproductive technologies enhance livestock productivity and farm income in India?

I am Pavneesh Madan and I'm a professor of biomedical sciences with a focus on reproductive biotechnology at the Ontario Veterinary College here at the University of Guelph. I'm also one of the members of this CIRCLE and so the interesting question is, what is CIRCLE? Well CIRCLE is a new institution at the University of Guelph established in February of 2020, just last year. We are completing one year and actually this is our anniversary - first anniversary - and it's been started at the University of Guelph, as I mentioned.

It's the Canada India Research Center for Learning and Engagement - learning and engagement are being the key words, and then part of that process of not only learning but engaging India and Canada in a very interesting conversation. Our goal is to build up an interdisciplinary nucleus in Canada for the cutting-edge research on India or the Indian diaspora to showcase, advocate, catalyze, and foster an equitable, respectful, and sustained exchange of knowledge between Canadian and Indian scholars on complex and emerging issues which are related to sustainability, and the social and economic well-being of mankind.

I would also encourage our audience to get connected with us through our website or visit our website. It's [canadaindiaresearch.ca](http://canadaindiaresearch.ca) dot ca and that's the website if you are interested in taking a look at it later, that would be welcome as well.

And the other important thing is our talk today is being recorded, and it will make its way to the website as well. As I said a lot of our previous events are already on the website, so if you're interested in learning what CIRCLE is doing for India-Canada connection, please visit our previous conversations and talks.

I'm at this juncture I'm going to introduce the format for today. Our initial format is we'll start with an opening remarks about a title once I've introduced our speakers, and then we will have

a discussion on the topic continue it up to the one hour mark, and from there on we'll leave the last 20 or 25 minutes for taking up the questions from the audience. But if, in the meantime, you have questions along the way, please use the chat function here and post your question in the chat so that we can pick it up during the question period. We'll also leave the last five minutes for wrapping up the conversation, building some conclusions, and at the end, also, talk about our next, forthcoming event.

Here are a couple of the housekeeping comments and instructions for today. I would request all of you to kindly mute your mics if you're not muted. If possible, please turn off the video cameras. if it's not required right now. You can turn them on again at the time of question period.

You can also raise your hand using the reaction button at the bottom. If you press the reaction button, you can see there is a "raise your hand" feature, and you can use that for asking questions. We will keep an eye about who has raised their hands so that we can invite you properly for asking a question in a very systematic manner. Please keep your comments and questions really brief. We would really appreciate that you can be precise and concise in your question.

With that, I would love to introduce our distinguished guests and speakers for today. And for that, I'm going to start with our first distinguished guest, and that is Dr. Chauhan. Dr. Manmohan Singh Chauhan, the director of National Daily Research Institute.

And before I actually come and speak about the laurels and the distinguished career that Dr. Chauhan has had, I also want to briefly speak about the institute that is National Daily Research Institute. Some of you who may not be aware of what this institute is all about, I would like to mention that it's one of the premier institutes of India. It's recently ranked number one by the Indian Ministry, which is regulating the ranking of different universities in India.

Amongst the veterinary and animal science institutions, NDRI has been ranked number one not this year, but consistently for the last few years. So, you can imagine the quality of work that happens at National Daily Research Institute.

At this juncture, I would also like to introduce Dr. Chauhan. Dr. Chauhan holds his master's and PhD degrees from NDRI, and has trained in several labs across the globe, including a considerable part in Virginia Tech University in the US, and then also a lot of labs in Europe, with major parts being trained in the Netherlands and also in Germany.

He has significantly contributed towards the development and growth of the assisted reproductive technologies in India. He has actually seen and been at the leading edge of the reproductive biotechnology revolution, as we say in India. And before his current appointment, Dr. Chauhan was the director of CIRB institute, or CIRG in Magdu and Uttar Pradesh. And also, I want to mention that his pioneering work in embryo biotechnology has played a leading role in where we are with respect to reproductive technologies in India. I'll come back to you, Dr. Chauhan, welcome to today's presentation.

**Dr. Manmohan Chauhan:**

Good morning, good morning.

**Dr. Pavneesh Madan:**

Yeah, and I'm gonna go to our next distinguished speaker, Dr. Inderjeet Singh. Dr. Singh is at the Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) in Ludhiana and it's my proud privilege to welcome him today.

As all of you know, University of Guelph and GADVASU, as we call him in Canada, has an MOU in Research and Education, which has been signed and re-signed two years back for next five years. We are connected together, born more than one way, and it's our proud privilege to have Dr. Inderjeet Singh with us today on this panel as well.

Dr. Inderjeet holds bachelor's and master's degrees in Veterinary Science and Animal Husbandry from Hissar. He did his PhD in Animal Reproduction from University of Liverpool, UK. Before his appointment at the current institution, Dr. Singh was director animal husbandry for the state of Punjab. It brings a very important perspective about the animal husbandry and livestock production from the forefront of this scenario right from the grass roots level, and that is animal sector in the villages as well. Welcome, Dr. Inderjeet, and we really look forward to your comments today.

The last panel member of our distinguished panel here is Dr. W. Allan King. Allan King, or Allan as we lovingly call him, is professor emeritus here at the Ontario Veterinary College, University of Guelph. Dr. King did his BSc and MSc degrees from Guelph before getting his PhD from Uppsala University, Sweden and then coming back to Canada for his post-talk at the Faculty of Veterinary Medicine, University of Montreal. Then he was appointed as a faculty member at Guelph and he has contributed many years in University of Guelph in the Department of Biomedical Sciences.

Dr. King was professor of OVC's department here, and the only tier-one Canada researcher in animal reproductive biotechnologies, which is a very unique position he held for many years until his retirement in 2018. He is also the currently the co-founder and president of his new company called Karyotekk which does a lot of karyotyping work, cytogenetics work for the livestock sector.

I also want to mention that I was looking at some of his contributions to science. Two things come up amazingly well in the whole scheme of things, and that is he is probably the leading contributor. His paper has been the most cited in the field of veterinary medicine ever. In 2012, it is one of the most highly cited, where some of his work is most cited. He has almost- he's just touching close to 10 000 citations. That speaks about how much of his work has been recognized all over the world.

With that, welcome Allan, and he's all the way just next door but we are, thanks to COVID times, we are sitting in two different rooms and sharing this through a virtual platform. Welcome to all the three speakers and without further ado let me go first to Dr. Chauhan for

the opening comments about this very important topic about improving farmer livestock, you know, livestock contributions towards farmer's income. Over to Dr. Chauhan.

**Dr. Manmohan Chauhan:**

Yeah, yeah. Thank you very much, Professor Pavneesh Madan. I saw him here, my guru and my mentor, Professor Dr. Inderjeet Singh, Professor Dr. W. Allan King, and all the panelists here, as it has been it is a great opportunity for me to have interaction with the imminent personalities working in the area of reproductive biology. It has been said by Dr. Madan, the topic which has been assigned, the role of the assisted reproductive technologies, to help India to have maximum production of the elite animals and then maximum yield of the milk.

Dairy has traditionally been used as a socio-economic and religious consideration in our country, being undertaken by the farmers as incidental to crop production, not as commercial farmers, but commercial enterprise, per se. Despite the largely substantive nature of the activity, the rearing of dairy animals has cushioned the rural households from instability in crop production, serving as an important source of supplemental income of the farm families.

In past four decades, conditioned by the factors such as the increase in the productivity of dairy animals in India, rapidly rising demands of milk in the urban areas and greater monetary needs of rural households to fulfill their growing demands for non-agriculture commodities improvement in milk procurement road infrastructure etc., there has been buoyancy in marketed surplus of milk from the rural areas.

Another change which has been observed gradually, and which is taking place, is the increased shift from the maintenance of dairy animals on home grown feed inputs and public goods, to purchase feed inputs due to decreased size of land holdings and shrinking common property resource base. This setting in the train towards commercialization of dairy enterprises, which would be reinforced in the time to come, has made today's dairy farmers vigilant about the economics of milk production.

Unlike his presidents, who was not very cautious about the net returns from Delhi and several costs components, did not involve out of pocket expenses for him. We have today a 107 billion US dollar market, out of which 54 percent of milk is used by farmers for self-consumption and 46 % is sold in the market, which is around 49 billion dollars. So out of that, 70 percent is being produced by unorganized sectors, being maintained by unorganized sector and 30 percent through the organized series.

As far as the cooperatives are concerned, we have a 7 billion US dollar market. You know that Amul is one of the very important brands here in India, which has 5 billion US dollar market. Here I can tell you that hardly less than 70 percent of the surplus milk is being handled by Amul, and just 2 billion is being handled by the Mother Dairy.

You can see that here, the 55 percent of the private players are processing the milk directly from our farmers. It has been said many times that India has been the leading producers and consumers of dairy products with a sustained growth.

As far as the livestock is concerned, we have total 535 million livestock. As far as the cattle is concerned, we have a 192 million population of cattle and 109 buffaloes. So, both the milk animals, if you just add this together, cows and buffaloes, so you will have 125 million, and total milk production is around 187 million, which is the first among the milk producing country in the world.

These are the some of the observations. What we have the overall growth rate in terms of the dating. Here, we have around 6.6 percent, which has been observed during 2018 and 2019. Per capita availability of milk here is 394 grams per day, and what we expect by 2033 to 2034 is the country's milk production will be 330 million tons, which is has been highlighted here in our NITI Aayog documents.

What we are looking forward to, is to have strategies to meet the challenges, and the challenges are developing the self-help group of land and small farmers. Also, establishing the emergency management procedures and services, including communications to mitigate rumors, which is around sometimes, like during the COVID-19 situation.

What we are looking forward to have, and now today we are also discussing in this aspect, is a suitable breeding program. In order to have a suitable breeding program, we need to have an input using the assisted reproductive technologies and other developed technologies, like the packages and practices, and keeping the reproductive health by providing the continuous veterinary service. These are the other aspects which we are looking forward.

**Dr. Pavneesh Madan:**

Thank you.

**Dr. Manmohan Chauhan:**

And also, the establishment of the efficient blaze label myth procurement system to increase the domestic production. These things we are looking at, but today we will have more discussion here in terms of the assisted reproductive technologies. This is my initial remarks, and just see it over to Dr. Pavneesh Madan.

**Dr. Pavneesh Madan:**

Thank you so much, Dr. Chauhan for those opening remarks. We're gonna go to Dr. Inderjeet Singh. And Dr. Singh, you bring your vast experience with being the director of Central Institute of Research on Buffalos, then being the advisor to the Chief Minister of Animal Husbandry Department, Punjab, working in the grassroots level.

How do you see reproductive biotechnology playing a key role in improving the farmers' income as outlined by the government, that by 2022, or now 2023, or maybe by the next elections in 2024? How can farmers enhance their income by adopting several reproductive technologies?

**Dr. Inderjeet Singh:**

Thank you. I thank you also for selecting the topic of increasing the farmers' income. Definitely the farmers are distressed. Maybe it is agriculture crop farmers, or they are livestock farmers, whosoever they are. We have seen that in the state of Punjab, where I served for almost one and a half years as director, at least 2000 dairy farms closed down over the last five years or six years.

That's only because dairy farming is not remunerative at all, and it requires lot of physical labor. You don't have any spare time, you don't have any hereditary data, and definitely, these farmers, they are also educating nowadays on the borders of our national capital. They are also perceiving threats to their livelihood due to new laws: whether they are going to take away their land or whatsoever they have perceptions. But it is a fact that the income of farmers visibly in other states of the society is getting down and down with every passing year.

In spite of that, India has become number one in milk production. But it's not because of the productivity of our livestock, because the productivity is only 1850 kg per capita of our livestock, which is much lower than the global productivity - that is about 2500 kg. So, we are bringing down, we are pulling down the global productivity of livestock in each lactation, and that requires concerted efforts put in for engaging the productive potential of our livestock.

Definitely, as we all know that culmination of reproduction successfully leads to production. Reproduction becomes very important as well. We have been number one in beef exports as well from the country in 2015, but thereafter due to some government change in the government policies, we are not at number one, but we are left behind Australia and Brazil to be the number one in these exports as well.

And that is the beauty of our native livestock. That is buffalo, which gives us about fifty percent of the bill, and that is only the buffalo meat that is exported, and that buffalo meat that's exported as beef that brought India as number one.

Also, if we talk of the assisted reproductive technologies, the single most important and the simplest reproductive technology which has brought the transformation in animal husbandry sector is artificial insemination. It is artificial insemination that started with frozen semen in early 50's that has transformed the entire genotype, the productive potential of our livestock.

We see same bull having its spread across the globe, across the continents, so that is the most important transformation, and in that aspect I'm happy to share with you that the government of India has given a lot of emphasis on improving the AI services. Previously, when we were students. we saw that the AI services were not good. It was more of a failure story than success, and this was just considered a burden by the field functionaries.

But now, people are realizing, and now we have about 49 semen stations which are A-grade accredited by the government of India. The central monitoring unit is there, which monitors all aspects, including record keeping the output quality from all angles, and then they certify these

semen stations. Only A and B graded semen station are allowed to sell their semen across the country - others are not allowed - so that is a very good thing that we have seen.

From male aspect, we see another assisted reproductive technology can be sex semen, and this sex semen is very, very important, at least for India, where the slaughter of cow is prohibited. But when we go to the cow farmers in the field, they claim that they don't have any much issue about the birth of male cows because they don't survive. They simply say that they don't survive, but they are not allowed to survive, so they don't need sex semen either way. But definitely, it is very useful for as for replacement refers, in case the technology is cheap.

At the current rate, about 1200 rupees per semester for a normal bull, if it is sexed, the farmers cannot afford to have used two straws and to repeat the animal next time again with the sex semen. However, with the new technologies that are available, the conception to first in submission as high as normal convention semen, about 45 to 47 percent is achieved in India, which is a very good moment for this technology to take for the strides in the country.

Another aspect of ICSI (Intra Cytoplasmic Sperm Injection) in case of males I don't advocate to be used, because ICSI we use only when there is some deficiency in the spermatogenesis of the male, and I don't think that we should advocate this type, unless there is some other sentiments attached with that particular male that some family wants its offspring. But in livestock, I don't see any reason we should promote this.

Then, the main aspect of assisted reproduction comes in the female. For ages we have been trying different technologies including synchronization of stress, induction of stress, and lately this embryo transfer technology- not just lately, also it was also tried many, many, many years and decades ago, but it worked, as we initially started. The problem is of the hormonal turmoil within the animal body that the super-stimulatory hormones play in the animal's body. That is not always desirable, and it is to be removed.

Then came the OPU and IVF. We all know that Brazil has made good progress with the opioids, where 95% of the IVF are conducted in Brazilian farms. They have made good use of this technology to make progress in the improvement of their livestock, and those indigenous livestock which belong to India have improved to outperform even the exotic HF animals, or Holstein Friesian, in milk production and that too of better quality.

Also, the government of India has opened about 15 centers across the country, and now some organizations are taking at the farmers doorstep; they are taking embryos, they are flushing the embryos, they are doing OPU sessions, and these are transferred in the field as well, so this technology is picking up.

These 15 centers, almost 10 of them are very well functional, including one at our institute. We are doing in these the cloning, which is another aspect that India has started with Dr. Chauhan under his guidance and Dr. Singh, Dr. Madan, and others. With that CIRB, Central Institute for Research on Buffalo, they also produced about 10 clones in the last three or four years, and

they have survived very well. A couple of them which became adults have also performed; they also donated good semen and with that semen, the pregnancies have been achieved.

But I would prefer if we are able to clone the female animals so that we are sure of their normality. It could be anything that's happening in transgenics whether in cloning that is not compromising something in these animals, then the transgenics definitely there is some scope. But definitely only from reproduction point of view it has different pharmaceutical applications, etc.

Genomics– if we have to apply for reproduction it will be only for two aspects. One is the high fertility, and second is frequency. If we talk of small animals like goats, we have to identify the genes which are there for fertility, or any technology which improves their frequency. That's all from me. Thank you so much.

### Dr. Pavneesh Madan:

Thank you so much Dr. Inderjeet for those opening remarks. That gives us a lot of material to go forward with in the next round. There's certainly more to talk about; some of the beautiful points you pointed out, but you actually made a game perfect case for taking this this question to Allan, because you talk about the Brazil story and what they have done.

There's no better person today around here who can actually talk about that, because he has been at the forefront of helping the Brazilian government and sector in improving their whole animal science scenario, with contributions from a Canadian perspective. Allan, that would be a perfect way for you to come into the picture. Tell us about how you see reproductive technologies, and how you think that has steered some of the rules and regulations with respect to improving income in Brazil.

### Dr. W. Allan King:

Okay so thank you very much, Pavneesh. It's really great to be here, and I want to start with the disclaimer that - or a claimer, I'm not sure which - that the reason I'm sitting here is because of my long-term connection with India.

I was an undergraduate student who really didn't have a focus in where to go, and I happened to take the medical genetics course from Dr. Parvathy Basrur originally from Cochin, I think, in Kerala, and then a graduate from Bangalore. She came to the University of Toronto in 1954, did her PhD, and ended up as a professor in this department actually where I'm sitting now. She brought the point home that there was a really important connection between genetics, reproduction, and animal health, and that was sort of what guided me in my future direction.

Now that I've retired, and retired in this confusing time of COVID, I'm spending a lot more time at home, I'm spending a lot more time with my three-year-old grandson, and he is very much fascinated by the large equipment for construction. So, when we go for walks, we look at trucks, bulldozers and excavators, and through his eyes I can see that one tool can be used for multiple applications.

We can see an excavator digging a hole, we can see an excavator planting a tree, we can see an excavator building a road, constructing a house, and to me that's what reproductive biotechnology is. It is a biological-based machine that you can use for multiple things, depending on what your requirements are, what you can do, what environment you're working in.

But most of all, what you can imagine its application. So, if we look at how reproductive biotechnologies have come about, they've come through fundamental research, fundamental understanding of reproduction, reproductive physiology, and then moving from basic research to field applications, to breeding companies, to the farmers, to the producers.

It's this chain of events that has led to an amazing revolution, actually, in animal agriculture levels of production. One of the really interesting things for us, and we've discussed it already a little bit, is that it's applicable to- [adjusting] Sorry, I'm just checking my time. It's applicable to multiple species, and so both Pavneesh and I have research labs in the Reproductive Biotechnology and Health Unit of the Ontario Veterinary College. Our labs, among others, produce a number of graduates trained in reproductive biotechnologies.

Where they go after graduation varies a lot, but they have a similar background. So, they end up in human in vitro fertilization clinics because of similarity between the bovine embryo and the human embryo. They end up in medicine human medicine, veterinary medicine, they end up in biotechnology companies, stem cell research organizations, they end up in business, and we're very pleased to say that one of our graduates is the deputy minister of human health in Ottawa, heavily involved in the COVID situation that we're living with.

From the Canadian perspective, we initiated, like other countries in the artificial insemination in the post-World War II era, so in the 50s, becoming more and more accessible, becoming more developed and adapted to our agricultural schemes to our climate, to our environment.

Then the next phase of getting really applied biotechnology off the ground was our interest in importing genetic material from other sources, and we turned to importing what we called exotic cattle from northern Europe, central northern Europe. We imported these exotic breeds, but our system is, animals are quarantined for a long period of time before they are allowed into the country.

One way then of speeding the production and proliferation of these animals was through super ovulation and embryo transfer. These were to become the foundation for rapidly integrating and then multiplying valuable genetics. So, we work together domestically and internationally.

The next phase of the development in Canada was we began to move towards in vitro fertilization, and in vitro fertilization has a long history in the fundamental research that was necessary to reach the point where successful offspring were born. Of course, we admire and look to Sir Robert Edwards, the person who initiated and developed the first human in vitro fertilization for successful fertilization, which resulted in the live birth in 1977.

I should note that his PhD was from Edinburgh, in the Institute of Animal Genetics and Physiology, and much of his early research was conducted on the physiology of reproduction in domestic animals. So, we have a long integrated history in other species, we have a long history in wild and endangered species, using these as you are to increase the number and population of your indigenous cattle.

My experience here has been we have gone from in vitro artificial insemination, to embryo transfer, to in vitro fertilization and ovum pickup, to the commercialization of these areas. We did some work with cloning, although we do not officially allow the use of cloning in Canada. We are working together with companies and individuals for stem cell technologies.

Also the genomic revolution, which has now spread to the point where we don't do our bull testing the way we used to. It's become very rapid. We do it through gene screening and gene technology, so that we can predict the future production levels of our bulls' dissemination without needing to go through the long periods of breeding and evaluating the production of their daughters.

We've gone through some very basic technologies, to some of the best technologies which have sped up the development, the dissemination and the increase in product production levels. I think these are very critical and important technologies which come into play. How's my time Pavneesh?

**Dr. Pavneesh Madan:**

Yeah, it's just a minute before you wrap up.

**Dr. W. Allan King:**

Okay, so I just want to briefly touch on my experience and what I've seen in Brazil, because we also have strong student training and collaboration back and forth. India has a very strong connection to animal agriculture in Brazil, so there are two breeds of cattle which are very noted and very important. One is the Nelore breed, which, Pavneesh, you'll have to tell me which region of India they originated in?

**Dr. Pavneesh Madan:**

Andhra Pradesh.

**Dr. W. Allan King:**

They first appeared in Brazil I think 1890-something, and they have now become one of the leading breeds of cattle because of their adaptability, because of their production parameters, because of the tolerance of climate and so on. The other success story for Brazil has been the creation of a synthetic breed the Girolando. It's a cross between Gyr cattle and Holstein Friesian, and 80% of the milk in Brazil now comes from this breed of cattle.

The final production cattle are 1/8 – 2/8 Gyr and 6/8 – 7/8 Friesian. So, they have slowly been integrated, developed, selected for the adaptation to the climate to the environment. Finally, where I've been most impressed, has been the water buffalo. Brazil now has about one and a

half million water buffalo - I know that pales in comparison with the 150 million water buffalo in India, I think it's something like that.

But the origin of the water buffalo were largely from India, and now they're working very diligently to increase the number and the level of production. There are some problems, as you know, with reproduction in water buffalo. Embryo transfer has largely been not very successful due to the difficulty of flushing the reproductive tracts, but going in the direction of ovum pickup and in vitro fertilization, progress is now being made on a routine basis.

Interestingly, Canada now is a producer of water buffalo. We have a stunning total population of less than 2000 animals, and we're trying to develop those to survive in our climate, survive in our housing of the animals, survive in our production. So, we turn very often to colleagues and experts in Brazil and in India, so I think we've worked in a bi-directional exchange of students' knowledge, information, and it's been very productive for both of our countries - all of our countries. I think that's where I am for now.

**Dr. Pavneesh Madan:**

Thanks, Allan. You really helped us take this discussion into a different direction. For all our listeners, I just want to reiterate the reason why we wanted to go away from PowerPoint slides and presentations, because I find during this COVID time a lot of people have been giving that presentation slide mode, and it becomes less interactive. So, our goal is to keep this interactive, so if you have questions please start putting them in the chat so that we can pick it up during the question hour.

But with that, I'm to go back to Dr. Chauhan and lay out one of the first elephants in the room. I think today's panel is going to be releasing some of the elephants out from the chamber, and I think one of the biggest elephants in the room has been that about close to 85 percent of our farmers in India are marginal and small, but they own up to only about 45% of the land while possessing 75% of the cattle.

I think our goal is how do we change this dynamic, how do we help the marginal farmers through the reproductive technologies, what can we develop as a strategy? If we have to put our thinking hats and critical hats and say let's work as scientists and say how can we reshape the marginal farmers' lives, what will be your first two or three points? I know a lot can be said but quick three points.

**Dr. Manmohan Chauhan:**

Yeah it's a quick case like this: so we need to have a quality bull availability to them number one, or the artificial insemination program properly. For that we have to, as a scientist, we have to work on the genomic selection of superior bull and calf, and once we have a genomic selected animals - superior animals - and particularly both so those both can be utilized for the artificial insemination program.

But as far as the assisted reproductive technologies are concerned, what we need to do is we need to move further. Where we can have, as is it has been said, through ovum pickup. We can

go for IVF and then produce a superior, improved or progeny tested bull semen and produce the quality bulls, and which will be available for subsequent AI program, once you have an AI program suitable. So, definitely it is going to improve the marginal or small farmer's livelihood.

#### Dr. Pavneesh Madan:

Dr. Chauhan, the interesting part from this is that whenever we come up with some kind of these solutions, including genomic selection and providing some incentive, it's always, they say, the big farms and the private sector always comes and hogs the first, we call the cake of, or the cream of, the process.

The marginal farmers always are left behind because something has not reached them so how do we go through this barrier? If you can have some quick comments about how to go direct to the marginal farmer, how we can bypass the big dairy sector the big farmers who can afford everything? We can bring a technology and they say, "Yes, give it to me, bring it to my door, because I can pay you X amount of money." Our marginal farmer stays out of this process.

#### Dr. Manmohan Chauhan:

You see, that opponent is the biggest problem. What we have in the farmer's sector is, particularly the marginal and smaller farmers, they do not have a sufficient money available with them. Therefore, the government of India has taken their step for boosting the dairy sector in India, and they have launched many programs like the Department of Animal Husbandry and Dairy.

Some of the programs are there, like the sustaining of the health of livestock and also enhancing the productivity of milk animals through the extension of artificial insemination coverage, which was initiated in 2019. Similarly, like last year, local mission, which is there like conservation as well as promotion of domestic dairy animals.

For this, the fund has been allocated and grown by around 500. But what we have learned here is mainly that we have an artificial insemination program going on. I have been told by the many, many state governments people that they have inseminated around 70 to 80 percent population. But in terms of the calf on the ground, you can see hardly 30 percent, so it still means that we need to have improvement in this direction.

Dr. Inderjeet is there, he knows what is the situation in farmer's sector, and in the field level. But definitely we need to have very well-skilled manpower in terms of the inseminators. What we have is inseminator probably or para-veterinarian. They are not well knowledgeable to use the available semen. Also, some of the maintenance of the semen, they are in their local clinic.

Of course, the government of India is looking forward to have the proper system. There are many programs which have been initiated and hopefully once these programs will be implemented properly, the achievements will be made. But as a scientist, what I believe that our job is to train the manpower to have a very good skill, give them training in our center, in our institute and then once they go back to their respective clinic, they are going to use this in their respective area there and the improvement will be made.

**Dr. Pavneesh Madan:**

Thank you, Dr. Chauhan. Let's go to Dr. Inderjeet, and Dr. Inderjeet would you like to add something to this helping the marginalized section of the society? How we can improve the productivity of farm animals for this sector especially?

**Dr. Inderjeet Singh:**

Yes. You said rightly that these small and marginal farmers have 40 percent of the land, but they have 75 to 80 percent of the livestock holdings. So, it is more equitable as far as the holding is concerned, the livestock holding, it's more equitable. Then, we have to see the environmental practices that are practiced by them. There, they are having only one, two, three animals at the most, and they are kept tethered all the time, so there the main casualty is the heat detection. So, even the simplest technology of AI, of ART, fails there.

The first requirement is to have a very foolproof heat detection method or technology available to them, so that they can get their animals inseminated with better quality semen and they get a better quality calf. Second, as Dr. Chauhan said, it is very important that the inseminator who goes there is competent enough to ensure high fertility in the first insemination. Otherwise, their faith in the technology is also failed and they don't go for insemination. They would rather go for a male bull which is first available, notwithstanding what its genetic makeup is. The third aspect will be if the semen with better fertility can be made available to these type of farmers, definitely they can reap better benefits.

**Dr. Pavneesh Madan:**

Thank you so much, Dr. Inderjeet for those comments. Allan, what are your thoughts about this? Did a similar approach work really well in Brazil? What are your thoughts about the points mentioned by Dr. Chauhan and Dr. Inderjeet?

**Dr. W. Allan King:**

I agree with all of the comments. One is to have an outreach to the producers, and they have to trust the technology that you're providing. I remember I've spoken to farm groups when we were talking about transgenic livestock, talking about cloning and they say, "Oh, we don't want this biotechnology stuff." And I say, "Okay, do you use any biotechnologies in your production?" "No, we don't use any." "Okay, do you do artificial insemination?" "Oh yeah, we do that." "What about embryo transfer?" "Oh yeah, we do that."

The awareness of where one technology becomes a routine thing, and where it's a novel thing, is very great. I think we need to be ambassadors for making sure that people are aware that this is just a progression of what we've been doing and we need to do that through training. I totally agree we need to have artificial insemination that's going to work. We don't want to try to get people to use it and they end up having to use a bull that's available because AI is not performed at the right time, under the right conditions. Once you do that and it fails a few times, you lose credibility. I think that's really important.

I think it's really important that you say for the marginalized farmers to be able to affordably access technology that's going to not only keep their milk flowing, but also provide the next generation of milk producers that are going to be more productive. So, sex semen and efficient AI and heat detection. I think those are critical to be able to reach the smaller farmers.

### Dr. Pavneesh Madan:

Thanks, Allan. Since we are short of time, I'm going to go to the other elephant in the room before we open it for our wonderful audience to bring in their questions. The other elephant in the room has been something I brought up at the web conference and I got a couple of emails after that because some people thought that I was much bold than the occasion required to say that, but that is another elephant which I think both India and Canada need to talk about.

And that is what is indigenous and what's foreign. The indigenous, and I think the point Dr. Inderjeet Singh brought about, that more and more farms are closing. Farmers are giving up on cattle because it's not becoming sustainable. The cost of production is higher than they can envisage and in that, because there was a kind of a trend going towards- there's a popular conversation about keeping indigenous cows. Which, to begin with, have an average of two to three liters of milk, and they're consuming as much nutrition, consuming as much resources, but they are producing so little milk.

On top of that, they are closing down because they said, "Oh we started a dairy farm with the indigenous cows, but look what has happened to the productivity." There is also some resistance in improving the crossbred ratio in those cows so that they can still maintain the good genetics. They can keep their disease resistance, they can keep the tick resistance, they can keep all the drought resistance in the breed, but at the same time bring the milk productivity genes from another foreign cow.

In a country which accepts corn as a makki ki roti, and say it is indigenous. A country which says rajma, which is Mexican red beans, is Mexican and believes it's something which is indigenous. Why do we have this hypocritical atmosphere that when one thing is indigenous, we don't question anything, but when it comes to cows, suddenly cows become untouchable if it's foreign. I think we as scientists have to apply our mind and I think we want to brainstorm here today a little bit.

Brazil did this wonderfully. They adapted. Canada did it wonderfully. We brought all HF from Europe and today we call it Canadian Holsteins because we indigenized everything and I think Brazil did the same. I find there's some problem with the acceptability, why we can accept everything foreign in India. I saw a video of some farmer who was proclaiming why we should have indigenous cattle, with an iPhone in his hand. He can accept an iPhone in his hand, but he's not willing to accept a cow which is similar to any other cow in the world.

What are your thoughts about that? Did we lack in publicly teaching our people? Or do we need more public awareness? Can we have an extension programs to talk about the benefits of cross breeding and how that will be beneficial for improving productivity with keeping the animal number low, yet doing more? With that, I'll start this time reverse, with Allan first.

Dr. W. Allan King:

Oh, that's a hard question, Pavneesh. I'm not really sure how to how to answer this but you know—

Dr. Pavneesh Madan:

That's why I said it's an elephant in the room: we need to start talking about it.

Dr. W. Allan King:

Yes, elephants are kind of big sometimes. For us, we didn't have indigenous cattle, so everything was imported. We do have magnificent Holstein cattle today, and they first came to Canada less than 200 years ago, so it's a testament for what you can do with selection and careful breeding. But how to reconcile the concept that *Bos taurus* and the *Bos indicus* are different, yes, they are, but they still came from the similar early genetic origins.

On how to destigmatize a native breed from something like the Girolando, which is a mixture of- to save and enhance the best qualities of both lines. To me, that's the way to go. But how do you make it palatable? That I don't know, other than education and making it aware to people.

I can give you an example from when people were trying to destigmatize genetically modified animals, which we have not succeeded with yet. There was a suggestion, "Well why don't we do genetically modified goldfish, so that there's some green ones, some fluorescent ones, and then people see that they're just like any other goldfish, just a different color?" Okay that didn't really work, but the idea is we have to make people aware that these are animals and they are genetically related. They have maybe originated on different continents, or came from different continents but they are genetically related.

Dr. Pavneesh Madan:

Thanks, Allan. Let's go to Dr. Inderjeet. Dr. Inderjeet, do you have any thoughts about how we can change the paradigm or bring some change in the public thinking?

Dr. Inderjeet Singh:

Yes I think the crossbreeding. We had our good indigenous breeds, they were quite good in milk and their milk quality was also very good. But the breeders and policy makers of those decades of the 70s and 80s, they did not bother much about blind breeding. Otherwise, it should have been restricted to the lower end of our indigenous stock.

But the people who were having the best genetics of our indigenous animals, they grabbed the artificial insemination, cross breeding first of all, because they were more aware than others. That way, our best animals of indigenous breeds got converted into cross breeds. What Brazil has done, they have very good means, balance, as Professor Allan said, that they have a 67 to 70 percent blood of HF and about 30 to 33, or maybe even 28 percent of this breed.

Girolando is the best breed of cross available in the world as of today, as far as milk production is concerned, and India also has to think on the same lines: we have to back cross our

indiscriminately cross-bred animals which have unknown foreign inheritance. So, if we breed them back to a stage where their indigenous blood remains about 25 to 30 or 33 percent, then maybe the performance will be better.

In to that end, what we proposed to the government of Punjab and government of India when, last year, at the time of republic day, the Brazilian president was the chief guest at the political function, we proposed that we should import high-end Gyr semen. Using these cross-products that we have, they may have 90 percent or 98% exotic inheritance, and if we breed them with our dear animals, that will be about 50/50 or whatever. Because the productivity and the body size of both these animals is similar, I don't see any danger in breeding these animals then.

Secondly the reason for our breeders' and policymakers' failure in those decades could also be that the system of our husbandry doesn't have large farms. We only have people with one or two animals, and they are usually not well-educated. So, it was just like we see in the crop farming sector: if this year the potato rates are high, next year everybody will join the potato industry, and that rate slumps down. If somebody used this cross breeding, if everybody started, irrespective of what type of indigenous animal he had.

On the other hand, we also have very beautiful indigenous animal that is buffalo, that is one hundred percent indigenous as Allan said. It belongs to India and India is proud that we have the best of buffalos, maybe it Murrah, Nili-Ravi, Jafrabadi, Surti, Banni, or whatever. And if we invest in our animal husbandry sector, focusing more on buffalo than reviving the indigenous, I think that will be a wise investment.

**Dr. Pavneesh Madan:**

Thank you so much, Dr. Inderjeet. Dr. Chauhan, what are your thoughts about—

**Dr. Manmohan Chauhan:**

Yes, your question was why the Indians are not accepting the crossbred animal, this was your major emphasis. What we have learned in India is that we rate the milk on the basis of the fat availability or fat percentage and also the SNF. So many times it has been said that the crossbred animal has less fat and less SNF.

The other thing that we know is that today, after going through this, as far as the milk production is concerned, the crossbred is producing around six to eight liters of milk per day. But here, indigenous are producing around three to four kg. Lesser than four, rather, three kg. About three kg milk per day.

But what we have observed is beside this, there is the problem in case of the crossbred animals. The major problems are infertility, repeat breeding, stress detection, and also some of these are prone to disease. What we have observed is that, of course, we need to have, as a scientist, put the emphasis here to remove the infertility from the crossbred animals.

Because, in many parts, like Haryana and Punjab, it has been observed that after third lactation or third to fourth lactation, crossbred animals are not going for the next establishment of

pregnancy because of the repeat breeding. Therefore, these things and probably because of this- and also very recently, the other aspect is that we are having a lot of discussion about the A1 and A2 milk.

It has been said that in India, Indian indigenous animals have A2 milk, which is good for the health. Of course, lot of research is required in this direction. Without the proper research, we cannot say. But now, everywhere, it has been said that A1 milk is not good for the health. We have indigenous animals where A2 milk is available. So, better to opt for the indigenous animals rather than having the exotic animals or the cross-bred animals.

Of course, we have to give the knowledge to the farmers, which is lacking. As a scientist, we have to train the farmers. We have to say that nothing is there in terms of the A1 and A2. Also, what we have observed is the other part: the total life of indigenous and the cross-bred animals, the productivity are, in terms of economics, almost the same because indigenous animals can go up to the eighth or ninth lactation, and in case of the crossbred animals, we observe that after the third or fourth, there are problems. Therefore, probably the farmers are not accepting the crossbred animals.

**Dr. Pavneesh Madan:**

Thank you so much, Dr. Chauhan, those were wonderful thoughts. There's so much more to talk about, especially with A1 and A2 milk and how a couple of blogs disturbed the whole world. There is still controversy; some people say there is difference, some people say there is no difference. More studies are coming and saying it was all a bogus study and we are still trying to ascertain whether there is some more merit to the A1-A2 story, but that's something, as scientists, we need to really put some other scientists on this project and say, "Let's decipher it and tell the world what the real story is, vis-a-vis India as well."

But since we are lacking much time, I want to really have good discussion from our audience, I'm going to take some questions. Please raise your hand so I can systematically invite you one by one. If you see a smiley face to the corner, there's a little plus sign on it. If you press it, it will say "raise your hand," and we can take your questions.

In the meantime, there is a question from Dr. Sumit Singhal, who wants prospects of sex semen with ICSI and bovine. Sumit, I'm planning to do another interactive session down the road where we will be talking about sex semen, the semen technologies especially, bringing the experts in this field to the floor. I'm planning to have that discussion in one of our next seminars, so stay in tune we'll spend a lot of time on sex semen technology ICSI on that seminar.

Also, there's a question from Dr. Shyam Zavar. Dr. Zavar, again, one of my mentors when I started working in India: "Can I get a minute to give some updates on IVF in India?" I know I learned embryo transfer partly from Dr. Zavar, so Dr. Zavar please come on the mic, but please keep it brief if you want to just give a comment about what raymond is doing now with IVF.

### Dr. Shyam Zavar:

Thank you very much. I just wanted to add a couple of things in the context of India. We definitely need a lot of boost for backing of our AI program and for that, ART has got, particularly ovum pickup and IVF has got, a lot of potential. In context to that, yesterday there was a meeting with the government of India, and it was decided to have about 200 000 IVF pregnancies established over the next three years, through which the National Dairy Development Board is going to be the implementing agency, and the end implementing agency will be the milk union.

They have shortlisted 87 milk unions of the country spread across 15 states and then they are going to invite the tender from the agencies, who look to be right now about four agencies, who could be doing this work at the doorstep of the farmer. Considering the cost of about 275 to 300 dollars per IVF pregnancy, the government has decided to give a subsidy of 5000 rupees, which works out to around 75 000 dollars approximately that will be given by the government for every IVF pregnancy established.

Then, coming quickly within few seconds, I want to say JK Trust has been a leading organization in the country and right from 1975 we have been working on embryo transfer in sheep, and then goat and cattle. Since 2016 we moved into the cattle and we have been working on IVF and there is a lot of potential, I feel, even in buffaloes.

Also the initial success which we got in some trials was in buffalo. We look forward to doing a lot more work in buffaloes. Our work right now is focused on the indigenous cattle, also and all type of breeds and we have produced. Near about thousand IVF of calves to date. Thank you very much for this time given to me.

### Dr. Pavneesh Madan:

Thank you so much, Dr. Zavar, for those wonderful remarks and bringing us up to date from yesterday's meeting with the government of India. That is something as latest as we can get in terms of the information. Thank you so much, Dr. Zavar. Any other questions before I go back to the panelists to see if we can address all the other points they mentioned?

There are no further questions. I'll wait for a second more. Raise your hand if you can. If not, I'm gonna go back to Dr. Chauhan this time and go back to- oh, Dr. Sumit has raised his hand. Dr. Sumit, go ahead. Please turn on your mic and ask your question.

### Dr. Sumit Singhal:

A1-A2 is always a controversial issue. So, as we are also the part of the government, and we are planning like that, should we give knowledge or should we say to farmers there is no difference between a1 and a2? There should not be any platform that these scientists should discuss with government, so that such confusion should not be created and should be on only one side.

### Dr. Pavneesh Madan:

Great point.

Dr. Sumit Singhal:

Because it is always a confusion. Farmers are put on the confusing side.

Dr. Manmohan Chauhan:

Yes, Sumit, thank you for raising this issue. Last week we had a discussion with the BIS, who makes the standard for whatever we have in terms of the milk products and not really the products. There was a discussion about the A1 and A2, and then last year we had also the brainstorming session, Professor Madan is here, on the A1-A2 by National Academy of Agriculture Sciences.

It has been clearly mentioned in that document that there is no difference as far as the impact of A1 and A2 on the human physiology, clearly mentioned that there is no such difference, or clinical observations, or scientific reports available on A1-A2, whether A1 is harming the human physiology or A2 is benefiting the human physiology. We can have that discussion in India, and you are the better person to explain to the farmers, to the community, and to our people that there is no difference between A1 and A2, so they are equally good.

Dr. Pavneesh Madan:

I think once that message also goes to the farmers about this non-difference that exists, maybe more farmers are willing to go with the prescribed line of cross breeding, so that the genetic material does not cross above 60 or so from terms of the crossbred line. I think there comes more opportunities for farmer to improve their productivity based on the conversation and our simple, informative process will help us reach out to farmers to improve their livelihood as well. Any other question from the audience?

Dr. Sumit Singhal:

Thank you, sir.

Dr. Pavneesh Madan:

Thank you, Sumit, for that wonderful question.

Dr. Sumit Singhal:

Thank you.

Dr. Pavneesh Madan:

If not, I'll go to Dr. Inderjeet. Dr. Inderjeet, the point that was mentioned was also about when we look at improving the livestock or the farmer's income, the crop improvement or the productivity in the farmland has a ratio of impact factor of only one to 1.8, but when it comes to enhancing their livelihood by improving the productivity or adding value addition to the milk or doing anything related to dairy, then the impact factor of their livelihood improvement improves by one to eight, which is almost eight times if they are only dependent of crop sciences.

Knowing this very well, that that is going to be a game changer in improving the income of the farmers, what would be the top three policies you will create in terms of extension from your new university, so that the grassroot level farmers- I know farmers in Punjab are already very aware of much higher productivity, but I want to use the Punjab experience to let the other parts of India know that this is something that can be done to improve the farmer income.

**Dr. Inderjeet Singh:**

Well, if it's only related to ART, I think it can be only the AI and the sex semen application with proper heat detection aids. To that end, the organized farms are also using the precision farming nowadays in Punjab. They have these electronic heat detection devices on each cow, which tells the precise time for insemination for high consumption rate.

But that's not the case with all the farmers, and especially with the small and marginal farmers. The most important factor that's going to increase the productivity of our livestock of what germplasm they are, is the balanced nutrition. If we can improve the nutrition, that will not only improve their productivity, but also the reproduction.

That is one aspect, and the second advantage of this ART, especially the embryo technologies, is that we can, as Professor Allan said in the beginning, we can transport the plan from across the continents, across the countries, without any risk of importing exotic diseases. That has been very emphatically researched and shown by Professor Elizabeth Singh from Canada, that all sorts of different microbes, viruses, protozoa are not transmitted with embryos. So, this is the biggest advantage.

But as far as the small and marginal farmers are concerned, if they can get regular cycles of reproduction, regular cycles of calving, that added with the balanced nutrition, is the best they can do. Recently, we were having a meeting for a group for creating the daily roadmap for the state of Punjab. When we went to the different farms, we also saw that even the most important component of dairy or for a dairy animal is water. It was not available, aptly, to lactating animals. If that simple practice is changed, that the water is made aptly available, good quality water, then definitely the animal's productivity will increase.

**Dr. Pavneesh Madan:**

Yeah, thank you. Dr. Chauhan, would you like to add something on those lines? Dr. Chauhan, you are still on mute. If you could unmute.

**Dr. Manmohan Chauhan:**

Yeah. Nutrition is a very, very important aspect and you see that, as it has been said, that what we have learned is that around 60% cause of rating any animal, or any dairy animals, the nutrition input is required. Also, sometimes we are going to check the heat, because if the farmers miss one heat, he is going to lose around 5000 rupees per heat and miss out on opportunity.

It means, therefore, that proper management practices are required. Some of what we have learned is that the mineral mixture ability is very, very important to the farmers, the dual stuff,

because sometimes they are giving the feed properly, without taking care of the trace elements. You know that in reproduction, the zinc and copper is very, very important, so you need to have a supplementation in terms of the mineral mixture or area-specific mineral mixture which can enhance the productivity of the animals.

The other aspects is like this: we say the proper vaccination is timely. Sometimes, what we saw was that farmers believe that the animal is fine, everything is okay. He doesn't care about the deworming of the animals. What we have observed particularly in goats and in the other ruminants, if you are not giving the deworming to the goat in time, you are going to lose around the 15 to 20 percent of the overall growth of the goat, so thereby, you lose the meat production. So, these are some of the aspects. Therefore, we have to give the emphasis to train our farmers and to give them the packages and practices so that they can enhance their livelihood.

**Dr. Pavneesh Madan:**

Thank you, Dr. Chauhan, for that wonderful feedback, and also giving us some information about how to go about our next steps, and also what we should be focusing on. I think it's our collective duty, as most of the people in this field are together listening to this deliberation.

We can jointly work towards developing new ideas, and develop that collective idea which can be propagated to others and make sure that we bring this out to other populations or other worlds and say, "This is what we want to do, this is how we should go about brainstorming together," and help the marginal farmers to improve their income by adapting some of the things we talked about.

I think, as we all agreed, awareness is going to be a really key factor. Whether it's awareness about nutrition, about management, about genetics, and also about the quality of milk, the value addition of milk. Those are the key things that we brought up in this conversation. Since we have only five minutes left, I will give each of the speakers a minute to conclude with their final remarks. I'll start with Dr. King first.

**Dr. W. Allan King:**

Well, I think I'd like to conclude with the way I started: that reproductive biotechnologies are just biology-based, knowledge-based techniques that make an important enhancement to productivity, to efficiency and hopefully in the case of the smaller farms, really enhance their livelihood. It comes down to education, training, and awareness, and I'm not sure how to best reach to people. It's not going to be easy, it's a slow process, but they have to have something that they trust before they use it.

**Dr. Pavneesh Madan:**

Thank you, Allan, those are really wise comments coming from you. Dr. Inderjeet?

**Dr. Inderjeet Singh:**

Yeah, I think that as far as the Indian livestock scenario is concerned, the major emphasis should be on the cow side of things, whether it is any application of technology, any diagnostics, whatsoever we have to do. If it is applicable at the farm level, then only it will be feasible to derive the maximum out of that technology.

**Dr. Pavneesh Madan:**

Thank you, Dr. Inderjeet. Dr. Chauhan?

**Dr. Manmohan Chauhan:**

Yeah, thank you, Pavneesh. We know that dairy provides a source of regular income, whereas income from the agriculture is seasonal. This regular source of income has a huge impact on minimizing risk to income, and there is some indication that the areas where dairy is well-developed have less incidence of the farmer suicide in India.

You can see Rajasthan there. Rajasthan always fears the drought situation, and even then, the suicide cases are almost nil, and I can say that because of dairy or dairy farmers. Of course, the recent technologies, like assisted reproductive technologies like ovum pickup, and IVF, and then cloning, will have a great impact in the future, where we can have availability of this suitable germplasm or elite animals available to the farmers, so that the milk production will be increased, and then therefore they will enhance their income.

As it has been said, our emphasis is always to go for the capacity building, which is a very important aspect. Also, we will see if they take together all these things. Definitely, we will announce the livestock development and also the applications in different government nuclear farms tomorrow once we have elite bulls available. Those bulls will be flies for the farmers and therefore, through this way, I believe that more than 60 percent of farmers income will be announced by 2022-23.

**Dr. Pavneesh Madan:**

Thank you so much, Dr. Chauhan, for those wonderful words. As I conclude, I want to go back in time. Probably it was around 1990, and it's been a privilege to have a few of my mentors in the same frame here today, I remember a time when I informally went to Dr. Chauhan and said, "I want to learn some parts of the IVF," and he was kind enough to show me how to make BOA and BOB media, and how to do the in vitro capacitation. We have come a long way since then.

The same thing with Dr. Inderjeet, where he had just come as a scholar from the commonwealth. He was my teacher in one of my courses and I remember him bringing a Mac computer on his desk, and for the first time we actually saw mini-Mac sitting on a table. As he came back from Liverpool, sharing the same frame with him today is very pleasing.

Also, Dr. King here, who has been my mentor since I passed my PhD and came towards central Canada or southern Ontario. He has been a fascinating person to work with. I thank all of my three mentors for being here today, for deliberating, taking the time. I know it's really late in

India - almost about to be 11 p.m. in the night, but I want to really thank you on behalf of CIRCLE for being here today, and I look forward to more renewed participation and conversations to strengthen the science between India and Canada.

I also would like to thank all the people who are present as an audience today and some of you who contributed with your intellect by bringing some questions, and Dr. Zawar for bringing us the latest information with what the government of India is planning to do in terms of improving the livelihood, right from, as they say, from the oven. That was information which came right from the oven!

With that, I want to also let our listeners know that our next seminar is by Dr. Josie Wittmer titled "Waste Work in the 'Clean City': Perspectives of Women Waste Pickers," on Wednesday, the 24th of February at 11 a.m. Again, 11 a.m. is the standard time. I know in India it gets a little late, 9:30 p.m. at night, but that's the time that CIRCLE has fixed for these seminars. Therefore, it will be interesting to know the story of the Waste Work in the Clean City by Dr. Josie Wittmer.

If you are interested in this topic, please log in again in our next seminar on February 24th. Once again, visit our website [canadaindiaresearch.ca](http://canadaindiaresearch.ca). At that, I would like to once again thank you all on behalf of Canada India Research Center for Learning and Engagement – CIRCLE. Thank you one and all for being here today and we'll keep on this conversation in the coming years.

**Dr. Manmohan Chauhan:**

Thank you, Pavneesh, for giving us this opportunity to have an interaction and to see Professor Allan King. I saw his many publications, very good quality publications in IVF initially, and then subsequently in other aspects such as assisted reproductive technologies. Thank you everybody and we hope that we will meet you shortly. Thank you so much.

**Dr. Pavneesh Madan:**

Thank you, thank you.

[End of transcript]