An Artificial Neural Network Study for Predicting Sex in Bulls

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***Abstract*— In this study, the research and analyzes were carried out on sex determination of bull sperm cells using an artificial neural network. Gender identification is important in animal breeding, focusing on the desired outcome and planning. For analyzes to be performed with artificial neural networks, sperm cells should be examined under a microscope and computer-aided separation must be performed along with the obtained data. As the subject of the study, these analyzes were done by preferring back propagation artificial neural network and normalizing the data. Outputs of the network were compared with numerical results and the results were found to be sufficiently sensitive. The input variables of the artificial neural network system are discussed in terms of semen speed, size and durability. Obtaining of female semen and male cells as output variable is discussed. After analysis of the output result data, with the data obtained from laboratory and their realizations, it was observed that the study succeeded.**

***Keywords*— Artificial neural networks, Gender determination, Semen separation, YSA**

I. INTRODUCTION

Biotechnological improvements are being exploited to improve herd fertility. One of the last points in biotechnological developments is the production of semen-determined semen [1].

In cattle, the sex of breeders is shaped during fertilization. When the ovum carrying the X, chromosome is combined with the sperm bearing the X chromosome during fertilization, the female (XX) will be formed with the Y chromosome and the male calf (XY) will be formed. If the spermatozoa before and after insemination can be classified according to X and Y chromosomes, the gender of the spermatozoa embryos produced with these sperm will be determined in advance.

Methods such as centrifugation, electrophoresis, sedimentation, filtration, pH changes in the preservation medium, immunological techniques and motility criteria are used in the detection of X and Y chromosomes in sperm. However, because of the significant differences in gender-determined sperm rates obtained as a result of these methods, it has been reported that the practical use of the mentioned techniques is not very reliable [2] [3] [4].

The pre-determination of the sex of the offspring is accompanied by some advantages in breeding. Gender identification enables the planning of production strategies and biotechnological study programs of enterprises that produce milk or meat. Today, alternative breeding systems are being studied in terms of calf production in cattle breeding. For this purpose, researchers are conducting research on the use of developing semen technology in aquaculture [5].

II. ANALYSIS with YSA (Artificial Neural Network)

Artificial intelligence is defined as the ability of a computer or computer-controlled machine to perform tasks related to high mental processes, such as reasoning, decision making, meaning making, generalization, and learning from past experiences, which are generally assumed to be human-like qualities. Artificial Neural Networks are approaches that try to create a new system by imitating the functioning of the human brain. YSA structure is formed based on the structure of the biological nerve cells in our brain. The YSA has decision-making mechanisms based on learning and learned information just as we are in our minds. Basically, the task of a YAS is to set an output set against the set of inputs shown to it. In order to be able to do this, the network is trained with examples of the problem (learning) and is made capable of solving the problems related to that problem [6] [7] [8].

In order to measure sperm values, computer-assisted sperm analysis of sperm (X and Y sperm) carrying X and Y chromosomes and evaluation of movement parameters in two populations were provided. After bull semen staining, X and Y populations were identified by flow cytometry. The movement parameters varied depending on the sperm concentration. Reduction of sperm concentration resulted in higher speeds and more flat trajectories. Thus, control and flow-sorted sperm concentrations were set to similar numbers (6 million/ml). Control with the classified X and Y sperm was recorded using a high-resolution camera. Sperm analysis was performed using Multijet and Sperm Vision software. The results show that Y spermine does not allow swimming faster than X sperm in a simple solution, X spermine is 3.4% more intense than Y sperm; Y spermine is larger than X sperm and its values can be distinguished from X sperm.

In determining the sex of bovine animals, the speed, size and density characteristics of the semen cell are among the elements used for gender estimation. An accurate analysis of these elements and the prediction of gender in this context is possible. After the cells were examined under the microscope, the analysis results were transferred to the control system and this system was combined with YSA. In all, we had 400 examples. We give here 100 exams. Input parameters in the system are speed (μ/s) (Table 1), magnitude (μ) (Table 2) and density (μ/m) (Table 3). The output parameter is estimated female, male or indeterminate cell (Table 4).

TABLE I. SPEED (S)

	S		S		S		S
1	46,66	26	47,30	51	44,49	76	44,26
2	43,36	27	46,99	52	45,75	77	46,37
3	41,20	28	46,79	53	42,52	78	46,07
4	47,07	29	46,79	54	40,40	79	45,87
5	46,97	30	39,99	55	46,16	80	45,87
6	43,36	31	46,28	56	46,06	81	39,20
7	51,09	32	50,24	57	42,52	82	45,37
8	44,26	33	49,13	58	50,10	83	49,25
9	48,00	34	46,08	59	43,78	84	48,16
10	47,69	35	44,39	60	47,07	85	45,17
11	47,48	36	41,26	61	46,76	86	43,49
12	47,48	37	39,20	62	46,56	87	40,42
13	40,58	38	44,79	63	46,56	88	38,40
14	46,97	39	44,69	64	39,79	89	43,87
15	50,99	40	41,26	65	46,06	90	43,78
16	49,85	41	48,61	66	50,00	91	40,42
17	46,76	42	37,82	67	48,88	92	47,62
18	45,98	43	45,67	68	45,85	93	50,59
19	42,73	44	45,37	69	45,07	94	44,74
20	40,60	45	45,18	70	41,89	95	44,45
21	46,39	46	45,18	71	39,80	96	54,28
22	46,28	47	38,61	72	45,47	97	53,49
23	42,73	48	44,69	73	45,37	98	53,23
24	50,34	49	48,51	74	41,89	99	52,44
25	47,52	50	47,43	75	49,35	100	51,65

TABLE 2. MAGNITUDE (M)

	M		M		M		M
1	53,28	26	65,57	51	60,17	76	59,42
2	59,64	27	63,23	52	68,68	77	64,28
3	56,86	28	62,83	53	58,48	78	61,99
4	68,60	29	60,90	54	55,75	79	61,59
5	68,19	30	56,33	55	67,27	80	59,70
6	61,59	31	65,57	56	66,86	81	55,22
7	67,05	32	68,41	57	60,40	82	64,28
8	57,60	33	65,77	58	65,75	83	67,06
9	66,54	34	62,32	59	62,02	84	64,48
10	64,17	35	66,64	60	65,25	85	61,09
11	63,76	36	56,74	61	62,92	86	65,28
12	61,80	37	54,10	62	62,52	87	55,58
13	57,17	38	65,27	63	60,60	88	52,99
14	66,54	39	64,88	64	56,06	89	63,94
15	69,42	40	58,60	65	65,25	90	63,55
16	66,74	41	63,80	66	68,07	91	57,41
17	63,24	42	69,09	67	65,45	92	62,50
18	69,02	43	63,31	68	62,01	93	67,68
19	58,77	44	61,05	69	67,66	94	62,02
20	56,03	45	60,66	70	57,61	95	59,81
21	67,60	46	58,80	71	54,92	96	72,62
22	67,19	47	54,39	72	66,27	97	71,56
23	60,70	48	63,31	73	65,87	98	71,21
24	66,08	49	66,05	74	59,50	99	70,15
25	64,70	50	63,50	75	64,77	100	70,04

TABLE 3. DENSITY (D)

	D		D		D		D
1	58,30	26	53,90	51	48,22	76	45,02
2	48,62	27	46,18	52	57,17	77	52,83
3	45,42	28	47,60	53	47,67	78	45,27
4	61,08	29	47,71	54	44,54	79	46,67
5	52,74	30	45,47	55	59,89	80	46,77
6	49,54	31	54,00	56	51,71	81	44,58
7	49,65	32	47,50	57	48,58	82	52,93
8	45,12	33	44,66	58	48,68	83	46,57
9	54,69	34	49,94	59	61,00	84	43,78

10	46,87	35	55,47	60	53,63	85	48,95
11	48,31	36	46,26	61	45,96	86	54,34
12	48,41	37	60,10	62	47,37	87	45,31
13	46,14	38	58,11	63	47,47	88	44,93
14	54,80	39	50,18	64	45,25	89	56,93
15	48,20	40	47,14	65	53,73	90	49,15
16	45,32	41	47,24	66	47,27	91	46,18
17	50,68	42	59,19	67	44,44	92	46,27
18	57,45	43	52,04	68	49,69	93	57,98
19	47,91	44	44,59	69	56,32	94	50,98
20	44,76	45	45,96	70	46,96	95	62,21
21	60,19	46	46,06	71	43,88	96	42,34
22	51,97	47	43,90	72	59,00	97	43,01
23	48,82	48	52,14	73	50,94	98	43,12
24	48,92	49	45,86	74	47,86	99	43,22
25	61,31	50	51,07	75	47,96	100	43,68

TABLE 4. RESULTS (R)

	R		R		R		R
1	85,90	26	85,26	51	83,10	76	88,13
2	84,67	27	84,97	52	84,23	77	83,58
3	85,18	28	93,18	53	83,02	78	95,42
4	81,89	29	84,35	54	83,53	79	91,34
5	83,23	30	90,64	55	80,30	80	82,68
6	86,42	31	88,00	56	95,04	81	88,85
7	92,49	32	96,12	57	84,74	82	86,27
8	79,78	33	96,53	58	90,70	83	94,23
9	86,52	34	86,07	59	86,25	84	94,62
10	90,91	35	81,73	60	84,84	85	84,38
11	94,55	36	80,56	61	96,86	86	80,06
12	85,59	37	81,05	62	92,72	87	78,91
13	91,98	38	77,91	63	83,93	88	79,39
14	89,30	39	92,22	64	90,19	89	76,32
15	85,73	40	82,22	65	87,57	90	90,34
16	87,96	41	88,00	66	95,65	91	80,54
17	87,34	42	83,69	67	96,05	92	86,21
18	84,65	43	82,32	68	85,65	93	81,98
19	83,43	44	93,98	69	82,98	94	80,64
20	83,94	45	89,96	70	81,79	95	92,06
21	80,69	46	81,44	71	82,29	96	98,78
22	95,51	47	87,51	72	79,10	97	97,95
23	85,16	48	84,97	73	93,63	98	97,54
24	91,15	49	92,81	74	83,48	99	97,34
25	86,68	50	93,20	75	89,35	100	96,92

III. RESULTS

We used 100 samples where %75 was allocated for training, %20 was used for the test, and %5 was used for verification. We ran the program 5 times. The average accuracy is %92, which means good performance.

There are some examples here:
Example 1.
Training Sample = 70%
Verification = 5%
Test = 25%
Hidden Layer = 20

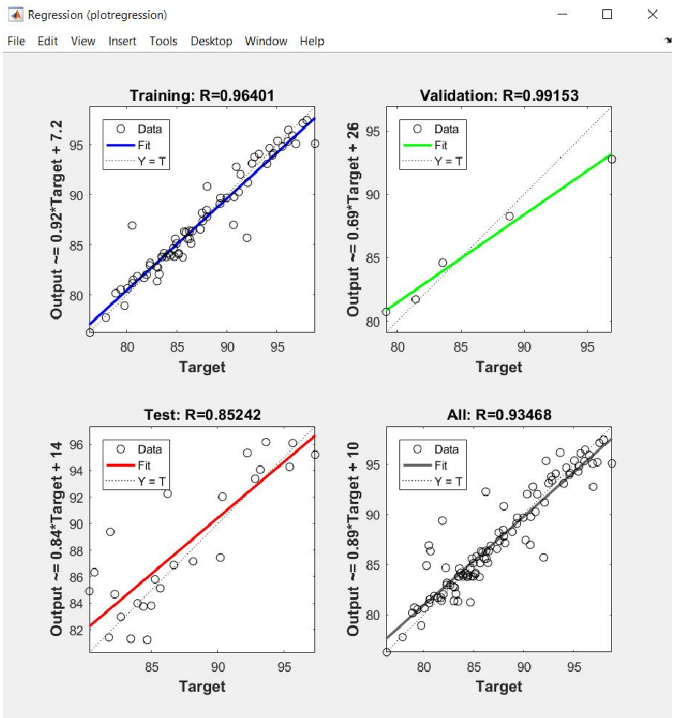

Fig. 1. Regression graphics for Example 1

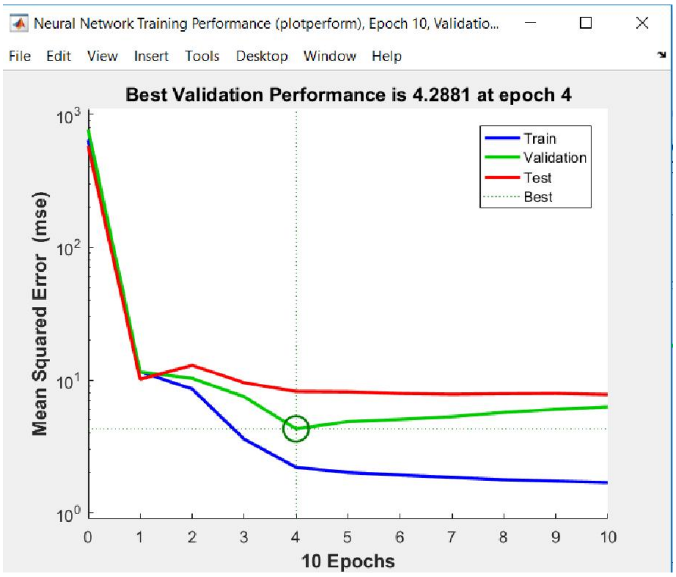

Fig. 2 Performance graphics for Example 1

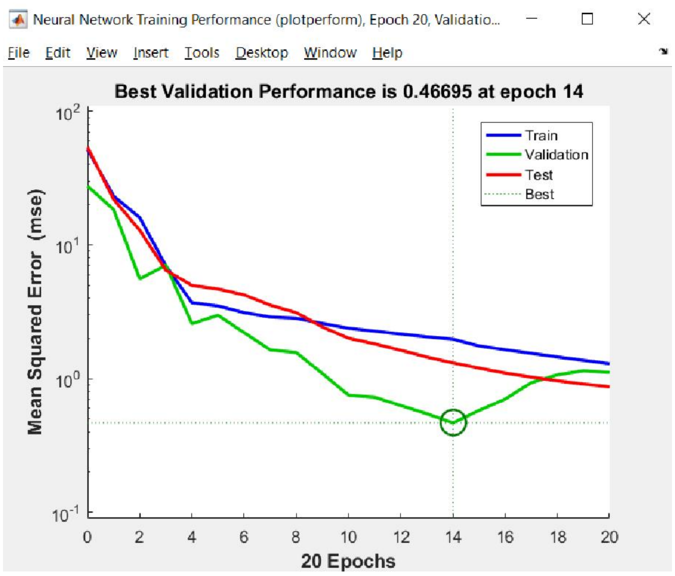

Fig. 4 Performance graphics for Example 2

Example 2.

Training Sample = 70%
Verification = 5%
Test = 25%
Hidden Layer = 10

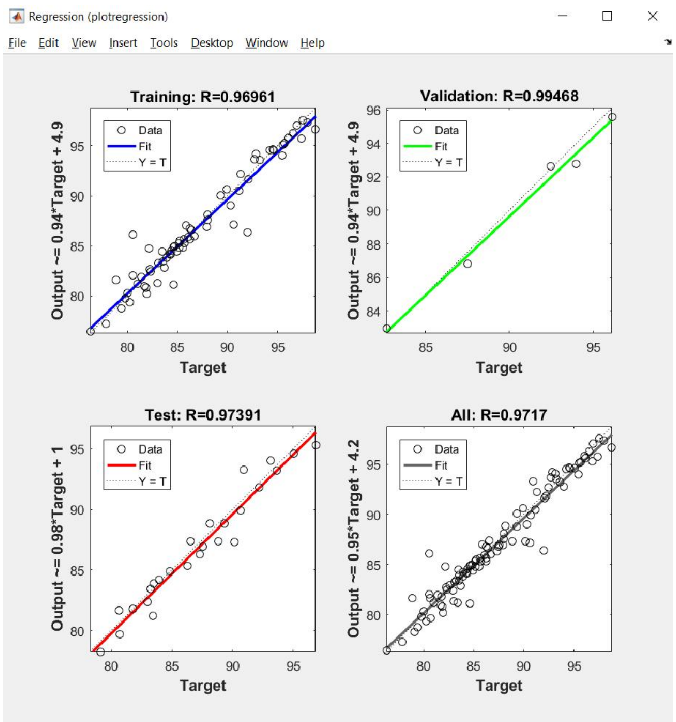

Fig. 3 Regression graphics for Example 2

Example 3.

Training Sample = 70%
Verification = 5%
Test = 25%
Hidden Layer = 30

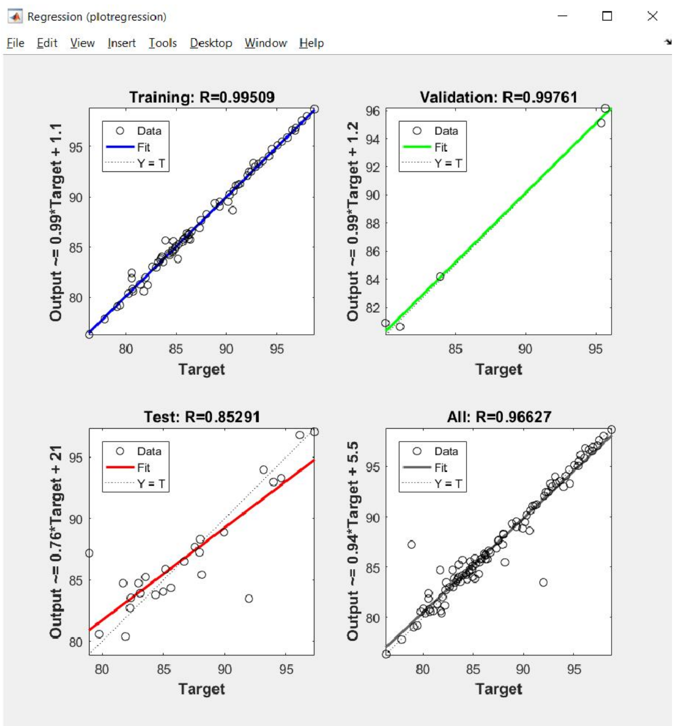

Fig. 5 Regression graphics for Example 3

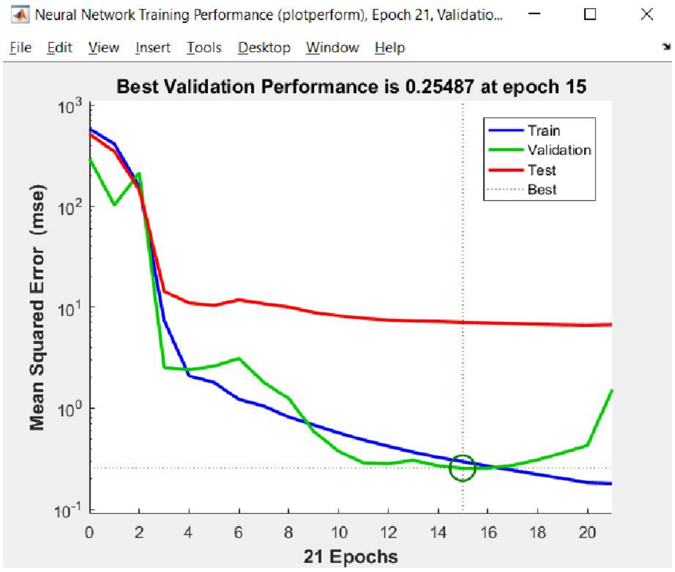

Fig. 6 Performance graphics for Example3

IV. CONCLUSIONS

In our study, bull sperm cells were examined under a microscope. In this study, the forwarding feedback propagation artificial neural network is used as a common and most successful method. The system can be trained, and the results achieved can be used as a theoretical basis for the development of alternative methods for gender estimation.

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