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*Online supplementary material:*

*Table S1. Advantages and disadvantages of total mixed ration mixer.*

*Table S2. Main technical parameters of the double-helix total mixed ration preparation mixer.*

*Table S3. Material mechanical properties.*

*Table S4. Properties of material interactions.*

*Table S5. Coding and level of experimental factors.*

*Table S6. Schemes and results of experiment.*

*Table S7. Significance test of the model.*

*Table S8. Importance of effects of factors on response functions.*

*Table S9. Comparison between model optimization and validation test value.*

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