Suppose that there are a blue discs and b discs in total, so that $a, b \in \mathbb{Z}^+ \cup \{0\}$ and $2 \leq a \leq b$. We wish to find the smallest value of b such that $b > 10^{12}$ and $P(\mathrm{BB}) = \frac{a}{b} \times \frac{a-1}{b-1} = \frac{1}{2}$.

Rearranging the final equation, we get

$$\begin{aligned} 2a(a-1) &= b(b-1) \\ \Leftrightarrow 2a^2 - 2a - (b^2 - b) &= 0 \\ \Leftrightarrow a &= \frac{2 \pm \sqrt{4 + 8(b^2 - b)}}{4} \\ &= \frac{2 \pm 2\sqrt{2b^2 - 2b + 1}}{4} \\ &= \frac{1 \pm \sqrt{(b-1)^2 + b^2}}{2}. \end{aligned}$$

In the context of the problem, a clearly cannot be negative, so for each value of b, we can have at most one corresponding value of a for which $P(\mathrm{BB}) = \frac{1}{2}$, namely $a = \frac{1+\sqrt{(b-1)^2+b^2}}{2}$, when this equals an integer.

Hence, the problem boils down to finding the smallest value of b greater than 10^{12} for which $a = \frac{1+\sqrt{(b-1)^2+b^2}}{2}$ is an integer, and this corresponding value of a is the answer we want.

The expression $\frac{1+\sqrt{(b-1)^2+b^2}}{2}$ is an integer if and only if $(b-1)^2 + b^2$ is the square of an odd positive integer. According to this post on Maths Stack Exchange, all such values of b could be found by the stated recursive method. Using this algorithm, we can start from $(r, s) = (1, 1)$,recursively find all other possible solutions of (r, s), and for each one find the given values of (n, k) in the post's context. This n value is then equal to $b - 1$, so each time we check when $b = n + 1$ is greater than 10^{12} and odd, which can be done quite quickly with the help of a program.

Eventually, one should get an answer of $\boxed{756872327473}$.