~~4)~~ Note: N_{out} increases by a factor of $\sqrt{2}$.
But signal power also increases by a factor of 2.
⇒ overall S/N increases by a factor of $\sqrt{2}$.

4) $(V_{GS}-V_{th}) \uparrow \times 2 \longrightarrow (W/L) \downarrow \times \frac{1}{4}$

(Why: To maintain same current)

$\rightarrow g_m = \mu_n C_{ox} \frac{W}{L} (V_{GS}-V_{th}) \downarrow \times \frac{1}{2}$

· g_m decreases by a fator of 2.

→ Noise power will be decreased by a factor of 2

→ signal power will be decreased by a factor of 4.

$\therefore (S/N)_{out} \downarrow \times \frac{1}{2}$

· $HD_2 \downarrow \times \frac{1}{2}$

NOTE:

From 3) and 4), you can reason that under constant bias current,

① To achieve better NF → Increase W/L ~~small current density per width~~

② To achieve better linearity → Increase $(V_{GS}-V_{th})$. ~~large current density per width.~~

A few more remarks

① Increasing W/L with constant I_{Bias} means "small current density" (per width) for low-noise operation

② Increasing $(V_{GS}-V_{th})$ with constant I_{Bias} means "large current density" (per width) for high-linearity operation.