

# Package: msamp (via r-universe)

September 8, 2024

**Title** Estimate Sample Size to Detect Bacterial Contamination in a Product Lot

**Version** 1.0.0

**Description** Estimates the sample size needed to detect microbial contamination in a lot with a user-specified detection probability and user-specified analytical sensitivity. Various patterns of microbial contamination are accounted for: homogeneous (Poisson), heterogeneous (Poisson-Gamma) or localized (Zero-inflated Poisson). Ida Jongenburger et al. (2010) <[doi:10.1016/j.foodcont.2012.02.004](https://doi.org/10.1016/j.foodcont.2012.02.004)> ``Impact of microbial distributions on food safety". Leroy Simon (1963) <[doi:10.1017/S0515036100001975](https://doi.org/10.1017/S0515036100001975)> ``Casualty Actuarial Society - The Negative Binomial and Poisson Distributions Compared".

**License** Unlimited

**Encoding** UTF-8

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**VignetteBuilder** knitr

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**NeedsCompilation** no

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n	<i>Calculate the sample size necessary to detect contamination above target level</i>
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## Description

The `n()` function calculates the sample size,  $n$ , necessary to detect contamination above a target level,  $G$ , in a product lot, where the probability of a single sample unit being above the target level is calculated by the `msamp` function `p()`. The total cost, `cost_tot`, associated with sample size is also output.

## Usage

```
n(
  C,
  w,
  G,
  Sens,
  D = c("homogeneous", "heterogeneous", "localized"),
  r = NULL,
  f = NULL,
  prob_det = 0.9,
  samp_dollar,
  lot_dollar
)
```

## Arguments

C	suspected lot contamination (CFU/g)
w	weight of single sample unit (g)
G	target value to detect (CFU/g)
Sens	sensitivity of the analytical test (%)
D	distribution of the bacteria in the product lot: "homogeneous", "heterogeneous", or "localized"
r	for the heterogeneous case only, the degree of heterogeneity. $r > 0$
f	for the localized case, $r$ is further specified. $0 < f < 1$
prob_det	desired probability of detecting bacterial contamination above the target level in the product lot. Set to 0.9 by default
samp_dollar	cost per sample unit in \$
lot_dollar	fixed cost (if any) of sampling the lot in \$

**Details**

Refer to vignette for details.

**Value**

A list containing:

- **n**: The sample size
- **p**: The probability of a single sample unit being contaminated above the target level
- **cost\_tot**: The total cost associated with sampling of  $n$  samples

**Examples**

```
#A sample of 25 grams (w=25) is collected and analyzed using an analytical
#test with sensitivity of 90% (Sens=.9), to detect at least 5 CFU's/g (G=5).
#The suspected or postulated level of contamination in the lot is 4 CFU's/g (C=4).
#The desired probability of picking at least one sample unit contaminated above the target
#level is 0.9 (prob_det=0.9), the cost of a single sampling unit is $100 (samp_dollar=100),
#and the fixed cost for sampling the entire lot is $200 (lot_dollar=200).

#homogeneous case
n(C=4,w=25,G=5,Sens=.9,D="homogeneous",r=NULL,f=NULL,prob_det=0.9,samp_dollar=100,lot_dollar=200)
# n=376, total cost=$37,722
#heterogeneous case
n(C=4,w=25,G=5,Sens=.9,D="heterogeneous",r=10,f=NULL,prob_det=0.9,samp_dollar=100,lot_dollar=200)
# n=12, total cost=$1,319
#localized case
n(C=4,w=25,G=5,Sens=.9,D="localized",r=NULL,f=.3,prob_det=0.9,samp_dollar=100,lot_dollar=200)
# n=1,254 , total cost=$125,541
```

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p

*Calculate the probability of a single sample being contaminated*

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**Description**

The  $p()$  function calculates the probability of a single sample unit, with weight  $w$ , and postulated contamination,  $C$ , being contaminated above a target level,  $G$ .

**Usage**

```
p(
  C,
  w,
  G,
  Sens,
  D = c("homogeneous", "heterogeneous", "localized"),
  r = NULL,
  f = NULL
)
```

**Arguments**

C	suspected lot contamination (CFU/g)
w	weight of single sample unit (g)
G	target value to detect (CFU/g)
Sens	sensitivity of the analytical test (%)
D	distribution of the bacteria in the product lot: "homogeneous", "heterogeneous", or "localized"
r	for the heterogeneous case only, the degree of heterogeneity. $r > 0$
f	for the localized case, r is further specified. $0 < f < 1$

**Details**

Refer to vignette for details.

**Value**

A numeric value: the probability of a single sample unit being contaminated above target level.

**Examples**

```
#A sample of 25 grams (w=25) is collected and analyzed using an analytical
#test with sensitivity of 90% (Sens=.9), to detect at least 5 CFU's/g (G=5).
#The suspected or postulated level of contamination in the lot is 4 CFU's/g (C=4)

#homogeneous case
p(C=4,w=25,G=5,Sens=.9,D="homogeneous",r=NULL,f=NULL)
# 0.006117884
#heterogeneous case-- dispersion, r, is postulated as 2
p(C=4,w=25,G=5,Sens=.9,D="heterogeneous",r=2,f=NULL)
# 0.2576463
#localized case -- 30% of the lot is postulated to be contaminated
p(C=4,w=25,G=5,Sens=.9,D="localized",r=NULL,f=.3)
# 0.001835365
```

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plotn

*Plots the relation between the probability of detection and the sample size, n*

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**Description**

The plotn() function examines the effect of increasing the probability of detection on the sample size, n, where the probability of a single sample unit being contaminated above the target limit is calculated from the msamp function p()

**Usage**

```
plotn(  
  C,  
  w,  
  G,  
  Sens,  
  D = c("homogeneous", "heterogeneous", "localized"),  
  r = NULL,  
  f = NULL  
)
```

**Arguments**

C	suspected lot contamination (CFU/g)
w	weight of single sample unit (g)
G	target value to detect (CFU/g)
Sens	sensitivity of the analytical test (%)
D	distribution of the bacteria in the product lot: "homogeneous", "heterogeneous", or "localized"
r	for the heterogeneous case only, the degree of heterogeneity. $r > 0$
f	for the localized case, r is further specified. $0 < f < 1$

**Details**

Refer to vignette for details.

**Value**

A plot, of recordedplot class. The probability of detection is on the y-axis and the sample size  $n$  is on the x-axis. Overlaid at intersecting red dashed lines is the sample size for probability of detection ( $\text{prob\_det}$ ) = 0.9.

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