

Package ‘msamp’

October 17, 2022

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

RoxygenNote 7.2.1

VignetteBuilder knitr

Suggests knitr, rmarkdown

Imports graphics, stats, grDevices

NeedsCompilation no

Author Martine Ferguson [aut, cre] (<<https://orcid.org/0000-0003-4479-3674>>)

Maintainer Martine Ferguson <martine.ferguson@fda.hhs.gov>

Repository CRAN

Date/Publication 2022-10-17 12:00:05 UTC

R topics documented:

n	2
p	3
plotn	4
Index	6

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

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

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

p

Calculate the probability of a single sample being contaminated

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
```

plotn

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

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 (prob_det) = 0.9.

Index

n, 2

p, 3

plotn, 4